Intonation, *yes* and *no*[*]

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Abstract

English polar particles *yes* and *no* are interchangeable in response to negative sentences, that is, either one can be used to convey both positive and negative responses. While recent research has been devoted to explaining this phenomenon (Kramer & Rawlins, 2009; Cooper & Ginzburg, 2011; Krifka, 2013b; Roelofsen & Farkas, 2015; Holmberg, 2016), questions remain. Primary among them is whether intonation differs depending on whether the response is positive or negative, whether intonation can affect the interpretation of bare polar particle responses, and whether preference patterns are context sensitive. In a series of experiments, we demonstrate that the contradiction contour (Liberman & Sag, 1974) is an intonation that is commonly produced on positive responses to negative sentences, and that it aids hearers in the interpretation of bare particle responses. Beyond intonation, our experimental results add new evidence regarding speakers' preferences for using *yes* and *no* in response to negative polar questions and rising declaratives. We also present new evidence that polar particle preference patterns are not context sensitive.

Keywords: polar particles, yes, no, intonation, prosody, contradiction contour, questions

1 Introduction

In response to positive polar questions (PQs), whether a speaker chooses to say *yes* or *no* depends on the intended answer. Consider (1). If B means to say that Jane is coming, she uses *yes*, not *no*.[1] If she means to answer that Jane isn't coming, she uses *no*, not *yes*.

[*]This essay was recently resubmitted for review. It expands substantially on our NELS paper *It's not just what you say, it's how you say it: Intonation,* yes *and* no. Comments are welcome. We can be reached at daniel.goodhue@mail.mcgill.ca.

[1]Note that (1b) is not always impossible in response to positive PQs. We will return to this below.

(1) A: Is Jane coming?

a. B: Yes, she is.
b. B: # No, she is.
c. B: # Yes, she isn't.
d. B: No, she isn't.

However, in response to negative PQs where negation is low, below the subject as in (2), B is free to choose *yes* or *no* to convey either answer.[2]

(2) A: Is Jane not coming?

a. B: Yes, she is.
b. B: No, she is.
c. B: Yes, she isn't.
d. B: No, she isn't.

We will discuss nuances in the intuitions below, but it is clear that (1b) and (1c) contrast with (2b) and (2c) in that the latter are much more acceptable. We will call this behavior of English polar particles in negative contexts *interchangeability*.[3] Interchangeability is triggered by responses to negative declarative sentences as well. We focus only on responses

[2]High negation questions in which the negation is fronted with the auxiliary, e.g. *Isn't Jane coming?*, do not trigger this effect on polar particle responses, at least not in American English. *Yes* can only mean that she is, while *no* can only mean that she is not (Romero, 2006; Kramer & Rawlins, 2009). This may be related to the fact that contemporary American English seems to lack the inner vs. outer negation distinction discussed in Ladd 1981 and Romero & Han 2004 (see Sailor 2013 for some experimental evidence for this claim). In a dialect of English that allows high negation to be interpreted as inner negation, perhaps interchangeability of *yes* and *no* would be licensed, but this issue awaits empirical investigation. We will not discuss high-negation PQs in detail in this paper.

[3]The phenomenon has been referred to in the literature variously as "ambiguity", "multifunctionality" and "negative neutralization". We want to avoid the term "ambiguity" since the answers in (2) are not ambiguous thanks to the sentences following *yes* and *no*. Moreover, some authors have claimed that bare *yes* and bare *no* responses can only convey a single unambiguous meaning, so it is not even settled whether bare particle responses are ambiguous at all. The term "multifunctionality" similarly already implies a certain interpretation of the facts, since it best fits analyses like Roelofsen & Farkas (2015) in which *yes* and *no* "do double duty" by realizing two different sets of features. The term "negative neutralization" from Kramer & Rawlins (2009) was only meant to apply to negative polarity responses such as (2c) and (2d), so it doesn't capture the full phenomenon.

to PQs and rising declaratives here to simplify the number of experimental conditions and discussion, and to expand on previous work that focussed on responses to falling declaratives. We'll call (2a) and (2b) *positive* answers because *she is* has positive polarity. Positive answers to negative PQs *reject* or *disagree with* the negative bias of the negative question.[4] Likewise, (2c) and (2d) are *negative* answers. Negative answers to negative PQs *affirm* or *agree with* the negative bias of the question.

Experiments on interchangeability have demonstrated that the phenomenon is robust, and that speakers prefer certain responses over others. Brasoveanu et al. (2013) ran an experiment in which they asked participants to choose either a *yes* or a *no* response followed by an overt clause, for example *No, it will*, to indicate agreement with a positive or a negative declarative sentence. The results demonstrate that while only *yes* can be used to agree with a positive declarative sentence, both *yes* and *no* can be used to agree with a negative sentence, with participants preferring *no* over *yes*.[5] For example, (2d) would be preferred to (2c) in response to A.

Kramer & Rawlins (2012) (reported in Roelofsen & Farkas 2015) ran an experiment testing *bare particle responses*, that is, uses of *yes* and *no* that were not followed by an overt clause. The experiment looked at dialogues which involved responses to positive and negative PQs, and varied whether *yes* and *no* were used, and whether the positive or negative answer was true in the context. Participants were asked to rate the felicity of the bare particle responses, and they were also asked whether they thought, given the context, that the responses were *true* or *false*, with *unsure* as a third option. Kramer & Rawlins found a higher degree of interchangeability in response to negative PQs than in responses to positive

[4]Again, we note an asymmetry between high and low negation PQs. Low negation questions are only felicitous in the presence of contextual evidence for the negative answer, thus they convey a negative "bias" (see Büring & Gunlogson 2000 a.o., as well as recent accounts of this effect by Trinh 2014 and Roelofsen & Farkas 2015). This bias is distinct from the positive epistemic bias conveyed by high negation PQs (see Romero & Han, 2004).

[5]This was at least true when the subject was a referential NP. Participants preferred *yes* for responses to sentences with downward- and non-monotone quantificational subject NPs such as *at most n* or *exactly n*, and showed no preference either way for upward-monotone quantifiers such as *some n*. All answers in our experiments had the first person pronoun *I* as subject.

PQs. Among the responses to negative PQs, Kramer & Rawlins's participants rated bare particles more felicitous in contexts in which the negative answer was true, irrespective of which particle was used. Bolstering this result, they found that bare particles were more likely to be judged true in a context in which the negative answer was true. Taken together, the results of this previous experimental work demonstrate that interchangeability in negative contexts is indeed a real phenomenon. They also showed more nuanced patterns, for example *no* is preferred over *yes* when giving an agreeing response to a negative antecedent (e.g. (2d) is preferred over (2c)), and that bare particle responses in negative contexts are preferred as negative agreeing responses (e.g. (2c) and (2d)) rather than as positive disagreeing responses (e.g. (2a) and (2b)).

Theorists such as Kramer & Rawlins (2009); Holmberg (2013, 2016); Krifka (2013b); Westera (2014); Roelofsen & Farkas (2015) have attempted to explain interchangeability in general, as well as the more nuanced *preference patterns* that differentiate the relative felicity of certain responses. Moreover, Roelofsen & Farkas (2015) and Holmberg (2016) have offered accounts meant to explain the various polar particles systems found in the world's languages. Interestingly, almost all prior work notes that factors such as intonation and whether or not the particle is followed by an overt clause or not could play a role in the felicity of the responses. However, there has been little agreement on the nature of the intonational effect. Roelofsen & Farkas (2015) claim that positive responses to negative sentences have to bear verum focus prominence on the auxiliary of the following clause, for example *No, she IS*. Krifka (2013b) claims such positive responses require a "rejecting accent", though he does not describe what that exactly should sound like. Cooper & Ginzburg (2011) predict a rise fall tune on the polar particle *no*. The observations about the role of intonation so far have remained impressionistic, and there has not been any empirical work to test which intonational patterns speakers actually produce. This might have affected the results of prior studies. The experiments in Brasoveanu et al. 2013 and Kramer & Rawlins 2012 did not control for intonation as participants were asked to silently read, but depending on the

intonation they imagined on the responses their judgments might have varied.[6]

Which intonations do naïve speakers actually produce in *yes/no* responses? How do those intonations affect interpretation and preference patterns? We tried to find some answers to these questions by running several production studies eliciting *yes/no* responses to polar questions and rising declaratives. Moreover, in order to see if intonation does indeed convey disagreement in English polar particle responses, we ran a perception experiment asking participants to interpret bare particle responses that bore different intonations. Taken together, these production and perception experiments expand our understanding of how intonation interacts with the use of polar particles in particular, but also of how intonation affects interpretation more generally.

Our experimental results contribute to the empirical landscape beyond the intonational findings. We also collected participants' felicity ratings. Our results partly replicate earlier findings, but also go beyond them. For example we compared responses to polar questions with those to rising declaratives, and we compared *yes* with *yeah* responses. Neither comparison had been tested experimentally before.[7] Finally we ran a follow-up reading experiment in English, modeled on work by Meijer et al. (2015) on German that tested whether preference patterns are sensitive to the polarity of sentences in the context that precede the sentence that *yes* and *no* respond to.

In order to appreciate how intonation affects the interpretation of polar particles and how our results interact with the literature, we need to understand the issues involved in the analysis of polar particles. We therefore start out in section 2 by summarizing some contemporary theories of polar particles. While doing this, we make some new observations that suggest a synthesis of the different theories is needed. Then in section 3, we discuss

[6]In experimental work on Catalan and Russian, González-Fuente et al. (2015) find that Catalan speakers frequently use a rise fall rise intonation they call "contradiction tune", which foreshadows our own results for English. Catalan "contradiction tune" might be quite similar in form to English contradiction contour (Liberman & Sag, 1974), a fact meriting further exploration. Interestingly, González-Fuente et al.'s (2015) intonational results for Russian differ from those for Catalan (and English, based on our results), both in terms of distribution and form.

[7]Roelofsen & Farkas (2015) already noted the intuition that the use of *yeah* might differ from that of *yes* in subtle ways.

relevant background on the contradiction contour (Liberman & Sag, 1974), which, as we will see, plays a major role in responses to polar questions.

Having introduced the relevant background, we then turn to our production experiments in section 4, in which we recorded participants producing polar particle responses to polar questions and rising declaratives in scripted dialogues. In section 5, we describe a perception experiment to test prior claims about the use of bare polar particles. In section 6, we discuss the reading experiment modeled on the work of Meijer et al. (2015) before concluding.

2 Accounts of interchangeability

What does interchangeability in negative contexts tell us about the nature of polar particles like *yes* and *no*? Krifka (2013b); Kramer & Rawlins (2009); Holmberg (2013, 2016); Roelofsen & Farkas (2015) offer various answers to this question. Each account has its merits, and we will discuss some new evidence that suggests that certain aspects of each are needed.

2.1 Krifka 2013b

Krifka (2013b) explains interchangeability by arguing that negative sentences introduce multiple antecedents for *yes* and *no* to pick up. Consider the likely interpretation of the propositional anaphor *that* in the following two examples:

(3) A: You didn't win the jackpot.
   a. B: I expected that.
   b. B: I didn't expect that.

That can either take the proposition that B won the jackpot or its negation as its antecedent, and which interpretation is more likely depends on the plausibility of the different readings given our world knowledge (winning a jackpot is unlikely and therefore should be unexpected). In Krifka's analysis, *yes* and *no* are propositional anaphora which, just like *that*

or *so*, require linguistic antecedents. Polar particles are different from regular propositional anaphora, however, in that they do not just refer to a proposition, they also either assert it (in the case of *yes*) or assert its negation (in the case of *no*). Krifka therefore treats *yes* and *no* as standing in semantically for entire speech acts, and assumes that they have a corresponding syntactic phrasal category which Krifka calls ActP. This analysis aims to explain their syntactic distribution. For example, it can account for why it is not possible to say *Yes surprised me*.

The antecedents for polar particles are contextually salient linguistic expressions that denote propositions, which Krifka calls propositional discourse referents. A positive PQ as in (4) makes available a discourse referent d anchored to the TP, which denotes the proposition *Jane is coming*:

(4) Is Jane coming?
simplified LF: $[_{TP_{\hookrightarrow d}}$ Jane is coming]
a. Yes = ASSERT(d) [meaning: Jane is coming]
b. No = ASSERT($\neg d$) [meaning: Jane is not coming]

The particle *yes* can pick up this discourse referent d as in (4a) and assert *Jane is coming*. It cannot assert $\neg d$ as there is no antecedent denoting that proposition. Similarly, *no* can only negate d producing $\neg d$ as in (4b) because d is the only antecedent available. To produce d, *no* would need to be able to negate an antecedent that is equivalent to $\neg d$, but there is no such antecedent available in the context in (4). Krifka's account hence correctly predicts the non-interchangeability of *yes* and *no* in the context of a positive polar question (1).

The key idea accounting for interchangeability in negative contexts in Krifka's analysis is that these structures make two antecedents available, similar to (3). The first antecedent is the embedded antecedent d anchored to the TP, which denotes the positive proposition *Jane is coming*. The second antecedent is d' anchored to the NegP, which denotes the negated proposition *Jane is not coming*:

(5) Is Jane not coming?
simplified LF: $[_{NegP_{\hookrightarrow d'}}$ not $[_{TP_{\hookrightarrow d}}$ Jane is coming]]

a. (i) Yes = ASSERT(d) [meaning: Jane is coming]
(ii) No = ASSERT ($\neg d$) [meaning: Jane is not coming]

b. (i) Yes = ASSERT(d') [meaning: Jane is not coming]
(ii) No = ASSERT ($\neg d'$) [meaning: Jane is coming]

In (5a), *yes* asserts d, and *no* asserts its negation. In (5b), *yes* asserts d' (which is equivalent to $\neg d$), and *no* asserts its negation.

Under this analysis, bare polar particles are in principle expected to show the same interchangeability in negative contexts, since they should also be able to pick up one of the two antecedents. However, Krifka makes additional assumptions about pragmatic factors which affect which uses of polar particles in general and bare particles in particular should be more or less preferable given a certain discourse. We will return to these finer grained claims when discussing the experimental results.

2.2 Kramer & Rawlins 2009

Under Krifka's analysis, *yes* and *no* are syntactically not related to the sentences that follow them. They form separate speech acts, and the relation to a following sentence would be guided by the same principles that guide sequences of speech acts in discourse more generally. Prior analyses have often assumed a much more direct syntactic relation between the particle and the following sentence, however, in which *yes* and *no* are part of the structure of the following sentence. For example, Kramer & Rawlins (2009, K&R), building on Laka (1990), propose that *yes* and *no* are adverbs in the specifier of the functional polarity head in the left periphery.[8] According to K&R's account, the use of *no* is constrained in that it can only occur if the following sentence contains negation. This is achieved formally by assuming that *no* has an uninterpretable negative feature (uNEG) that must enter into a negative concord

[8]Laka and Kramer & Rawlins refer to this head as Σ, while Holmberg (2016) and Roelofsen & Farkas (2015) treat it as Pol. The distinction will not matter for our discussion, and we'll arbitrarily use the latter convention throughout.

chain with an interpretable negative feature (iNEG). *Yes* does not contribute any features, and thus is not constrained by the polarity of the following sentence. This explains why both are compatible with negative responses to negative questions.

(6) A: Is Jane not$_{[i\text{NEG}]}$ coming?

a. B: [$_{PolP}$ No$_{[u\text{NEG}]}$ [$_{TP}$ she is not$_{[i\text{NEG}]}$ coming]]

b. B: [$_{PolP}$ Yes [$_{TP}$ she is not$_{[i\text{NEG}]}$ coming]]

While for Krifka the use of polar particles without a following sentence is unexceptional, under this analysis such cases are analyzed as fragment answers, where the TP-complement of the polar projection has been elided. As in all fragment answers, ellipsis requires an appropriate antecedent. K&R assume with Merchant (2001) that elided structure and the antecedent have to mutually entail each other. In the context of a negative question, the antecedent for ellipsis is simply the TP of the question:

(7) A: Is Jane not$_{[i\text{NEG}]}$ coming?

a. B: [$_{PolP}$ No$_{[u\text{NEG}]}$ ~~[$_{TP}$ she is not$_{[i\text{NEG}]}$ coming]~~]

b. B: [$_{PolP}$ Yes ~~[$_{TP}$ she is not$_{[i\text{NEG}]}$ coming]~~]

Yes and *no* are both predicted to be acceptable in (6) and (7). *No* is in a negative concord relationship with iNEG in the elided constituent. *Yes*, on the other hand, does not place any syntactic requirements on the follow-up sentence, and hence is also acceptable here. The source of the interchangeability of *yes* and *no* in negative answers to negative questions is therefore that both particles are compatible with cooccurring with a clause that contains negation.

One issue with this account is that it only deals with one half of the interchangeability phenomenon, negative answers. As K&R note themselves, it is not obvious under their analysis why *no* can appear with a positive clause in response to a negative PQ, e.g. *No, she IS coming.* Since *no* contains a uNEG feature, it must enter into a negative concord chain

with an *i*NEG feature, but there is none present in such a response. To explain this use of *no*, K&R claim that there is a distinct word *no* that encodes, in combination with an obligatory intonational peak on the auxiliary, a reverse feature *u*REV, similar to reverse particles such as French *si* and German *doch*.[9]

Ellipsis is impossible in reversing *no* responses due to the obligatory intonational peak on the auxiliary. While K&R do not discuss positive *yes* responses to negative questions, for example *Yes, she IS*, we believe that their account predicts that ellipsis should be impossible, since there is no appropriate antecedent.

What about polar particles in response to a positive question? The analysis of the use of *yes* in positive responses is straightforward. The elided structure is simply identical to the antecedent *Jane is coming* provided by the question, see (8a). The reason *no* cannot be used in a positive response is also clear: There is no syntactic negative feature that it could enter into a concord chain with, and *no* is therefore not licensed, see (8b).

But how do *no* responses convey negative answers to positive questions? It would seem that the positive question cannot provide the required antecedent for the elided negative sentence in (8c). K&R argue that in such cases, an *i*NEG feature appears in the polarity head, higher up in the structure than the ellipsis site, see (8c). The elided structure only contains a *u*NEG feature, which will not affect the mutual entailment condition on ellipsis.

(8) A: Is Jane coming?

a. B: $[_{PolP}$ Yes ~~$[_{TP}$ she is coming]~~]

b. B: * $[_{PolP}$ No$_{[u\text{NEG}]}$ ~~$[_{TP}$ she is coming]~~]

c. B: $[_{PolP}$ No$_{[u\text{NEG}]}$ $[_{Pol}$ $[i\text{NEG}]$] ~~$[_{TP}$ she is not$_{[u\text{NEG}]}$ coming]~~]

This account of the use of *no* works technically, but it seems a bit ad hoc in that it runs counter to the idea that ellipsis is licensed by mutual entailment. Both Krifka (2013b) and Roelofsen & Farkas (2015) note an additional problem: Since *yes* does not impose any

[9]This idea in some sense foreshadows Roelofsen & Farkas's (2015) account of polar particles, which treats *no* as encoding negative and reverse features, as we will see below.

syntactic requirement on the structure it occurs in, there is actually nothing in this account to stop *yes* from appearing in negative responses to positive PQs. Thus contrary to fact, the following response is predicted to be entirely acceptable.

(9) A: Is Jane coming?
B: $[_{PolP}$ Yes $[_{Pol}[i\text{NEG}]\ ]\ [\sout{_{TP}\ \text{she is not}_{[u\text{NEG}]}\ \text{coming}}]\ ]$

We turn now to an account in the same vein as Kramer & Rawlins 2009 that addresses some of these issues.

2.3 Holmberg 2013, 2016

Holmberg (2013, 2016), like Kramer & Rawlins, treats *yes* and *no* as specifiers of a functional projection, and analyses bare particles as fragment answers in which everything but the polar particle remains unpronounced.

For Holmberg, *yes* and *no* are operators that assign positive and negative values respectively to the polarity head of their complement. The polarity head contains a polarity variable that can have one of three values: positive [+], negative [−], and open [±]. Positive polar questions have open polarity, according to this analysis. Consider (10), where the PolPs in the answers are elided.

(10) A: Is–[±] Jane coming?
a. B: $[_{FocP}$ Yes $\sout{[_{PolP}\ [+]\ [_{TP}\ \text{she is coming}]]}]$
b. B: $[_{FocP}$ No $\sout{[_{PolP}\ [-]\ [_{TP}\ \text{she is not coming}]]}]$

The polarity variables of the answers in these cases are different from that of the question, an apparent problem since the identity condition on ellipsis seems to be violated. Holmberg argues, however, that elided pronoun variables can have different interpretations than their antecedents, and he suggests that polarity variables behave in the same way. For example, *Jane took her car, and Amanda did, too* has an interpretation where Amanda took her own

car. The idea then is that *yes* and *no* bind an elided polarity variable and assign it [+] or [−] respectively. The feature value [−] would be spelled out as *not* if the following sentence were not elided.

While Krifka finds the source of interchangeability in the presence of multiple antecedents in negative sentences, Holmberg finds its source in a structural ambiguity in negative sentences. According to his analysis, negation in English attaches at two different heights. High negation attaches between TP and vP, and low negation is adjoined to vP/VP. When A asks the question "Is Jane not coming?", B is free to interpret the question as having high or low negation. If low as in (11a), then the polarity head is open and *yes* and *no* are both free to bind it. *Yes* will produce a negative response (11a-i), while *no* produces a double negative, which reduces to a positive response (11a-ii). If negation is high as in (11b), then the polarity head is negative and *yes* requires an unelided clause to change it to positive (11b-i), while *no* forms a negative concord chain with it (11b-ii).[10]

(11) *Structures for* "Is Jane not coming?":

a. A: Is–[±] Jane [$_{vP}$ not coming]? low negation PQ
   (i) B: [$_{FocP}$ Yes ~~[$_{PolP}$ [+] [$_{TP}$ she is [$_{vP}$ not coming]]]]~~
   (ii) B: [$_{FocP}$ No ~~[$_{PolP}$ [−] [$_{TP}$ she is not [$_{vP}$ not coming]]]]~~

b. A: Is Jane not–[−] coming? high negation PQ
   (i) B: [$_{FocP}$ Yes [$_{PolP}$ [+] [$_{TP}$ she is ~~[$_{vP}$ coming]]~~]]
   (ii) B: [$_{FocP}$ No ~~[$_{PolP}$ [−] [$_{TP}$ she is not coming]]~~]]

The structural ambiguity of the two attachments heights of negation in the polar question is what makes *yes* and *no* interchangeable in negative contexts in this account. The two polar questions (11a) and (11b) are string identical and interpretively indistinguishable.[11] Similar to the analysis in K&R, a bare *yes* cannot convey a positive answer, but must be followed by

[10] This analysis requires Holmberg to claim that there are two separate entries for *no* in English, one with an interpretable [−] feature enabling it to bind the open polarity variable, as in (11a-ii), and one with an uninterpretable [−] feature enabling it to enter into a negative concord chain in (11b-ii).

[11] Thus, as Holmberg points out, high negation in Holmberg 2016 bears no relation to "high negation" in Romero & Han 2004, which involves even higher attachment under this analysis. Holmberg actually refers to the high negation discussed in the text as "middle negation".

an overt clause as in (11b-i). Holmberg (2013) notes that in some contexts, bare *yes* seems to be able to convey a positive response to a negative question. He suggests that intonation may play a crucial role in making such responses felicitous though he does not discuss what the intonation may be or how it interacts with his account to make the response felicitous.

2.4 Roelofsen & Farkas 2015

Similar to Krifka, Roelofsen & Farkas (2015, R&F) analyze polar particles as anaphora sensitive to preceding antecedents, and similar to Holmberg and Kramer & Rawlins, their analysis makes use of ellipsis. Unlike Krifka, they do not find the source of interchangeability in the presence of two potential antecedents, nor do they find it in a structural ambiguity in the context as Holmberg does. Rather, R&F attribute the interchangeability of *yes* and *no* to their ability to encode two different types of features. On this view, polarity particles in English do "double duty": they can either signal the polarity of the answer being given or they can signal whether the present response agrees or disagrees with a prior utterance. According to R&F, *absolute* polarity features are responsible for the former function, while *relative* polarity features perform the latter. This idea of two uses of polar particles goes back to Pope (1976), and, as discussed above, plays a role also in the analysis of Kramer & Rawlins (2009).

Roelofsen & Farkas (2015) assume a polarity projection in the left periphery, whose head takes a clausal argument, which is elided in the case of bare particle utterances, just like in Holmberg 2016 and Kramer & Rawlins 2009. There are two types of features that are realized on the polarity head. The *absolute* features [+] and [−] presuppose that the complement of the polarity head has positive or negative polarity respectively.[12] The *relative* features [AGREE] and [REVERSE] each introduce presuppositions relative to a unique most salient antecedent in the discourse: [AGREE] presupposes that the complement has the same polarity and identical propositional content to the antecedent, while [REVERSE] presupposes

[12] A sentence has negative polarity if the highest-scoping sentential operator is negation. Otherwise it is positive (Roelofsen & Farkas, 2015, p. 379).

that the complement has opposite polarity and complementary propositional content to the antecedent. *Yes* is capable of realizing [+] or [AGREE], while *no* is capable of realizing [−] or [REVERSE]. Only one of the features it realizes needs to be present to license the polar particle.

Consider the responses to the positive sentence in (12). Since positive responses to positive sentences only meet the presuppositions of the [+] and [AGREE] features, and only *yes* can realize those features, only *yes* is acceptable in (12a). *Mutatis mutandis*, only *no* is acceptable in (12b). Responses with the features [AGREE, −] or [REVERSE, +] would be infelicitous since in each case one of the features would trigger a presupposition failure.

(12) A: Petra passed the test.

a. S: Yes / #No, she did. [AGREE, +]
b. S: #Yes / No, she didn't. [REVERSE, −]

In response to negative sentences, the situation is different. The two valid responses in (13a) and (13b) contain features that can be realized by either *yes* or *no*. Thus either particle can be used in either response. This is how R&F explain interchangeability.

(13) A: Petra didn't pass the test.

a. S: Yes / No, she didn't. [AGREE, −]
b. S: Yes / No, she DID. [REVERSE, +]

In (13a), *yes* is licensed by the presence of [AGREE], and *no* is licensed because [−] is present. Likewise, in (13b) *yes* is licensed because of the presence of [+] and *no* is licensed because of the presence of [REVERSE]. Responses with the features combinations [AGREE, +] and [REVERSE, −] are not felicitous, since one of their‘ presuppositions would not be fulfilled.

Similar to Krifka's analysis, R&F's account is in principle compatible with bare particles conveying either response, but just like Krifka, they make additional assumptions that predict bare particle interpretation to be more constrained, and we return to these when we discuss

the experimental results.

2.5 Summary and synthesis

Now that we have reviewed several theories of polar particles, let's recap how they differ: First, they differ in the structural analysis of polar particles themselves. Some treat them as separate speech acts, syntactically unrelated to the following clause (Krifka, 2013b, the pure sentential anaphor view), others treat them as part of the syntactic structure of the following clause, which may possibly be elided (Kramer & Rawlins, 2009; Holmberg, 2016; Roelofsen & Farkas, 2015, the adverbial view). Second, they differ in how they account for interchangeability. We saw accounts that attribute interchangeability to the presence of multiple potential antecedents (Krifka, 2013b), to a structural ambiguity in the context sentence (Holmberg, 2016), or to the ability of *yes* and *no* realize absolute or relative polarity features (Roelofsen & Farkas 2015, building on Farkas & Bruce 2010 and Pope 1976).

Are there any arguments that can distinguish between these accounts on these two differences? In the following we will make two novel observations that bear on these issues. But before discussing these observations, we note that the various accounts we discussed also differ in other ways. First, they make more fine grained claims about the possible readings of bare particles, and about which of the four possible combinations of polar particles and responses in the interchangeability paradigm in (2) are more or less felicitous. As mentioned before, we postpone discussion of these more fine-grained issues until section 4, in which we discuss results from our production experiments that bear on these predictions. Second, these accounts differ in their crosslinguistic empirical reach. The proponents of each of these accounts discuss ways that they can be extended to explain the behavior of polarity particles crosslinguistically. However, Holmberg (2016) and Roelofsen & Farkas (2015) are more ambitious than Krifka (2013b) in this regard in that they each make proposals for how their accounts might make universal predictions for polar particle responses. Krifka's account would need to be extended in nontrivial ways in order to capture crosslinguistic facts. Given

space limitations and the fact that our experiments below focus only on English, we will not engage in an in depth discussion of the crosslinguistic facts. However the empirical reach of a theory into the crosslinguistic landscape is an important criteria to be weighed in any complete comparison of these accounts.

2.5.1 An argument for the adverbial view

One difference between Krifka's theory of polar particles and the alternatives reviewed above is that it assumes that polar particles do not stand in a direct syntactic relationship with the following sentence. While any analysis must allow for uses of *yes* and *no* as separate speech acts, we present two arguments in favor of an adverbial analysis of polar particles from the intonation of polar particles and their following clauses in English.

The first argument is a simple observation: Polar particles and following sentences can easily be pronounced with a single intonational tune (observed already in Pope, 1976, p. 147, ex. (73R2), and also demonstrated in our experiments below). This seems difficult with sequences of two separate speech acts. Consider (14). In (14b), B clearly makes two separate speech acts.[13]

(14) A: Jane likes steak, right?

a. B: No, she doesn't.
b. B: She doesn't, she's vegetarian.

(14a) can be pronounced using a single intonational contour without difficulty. In the recordings (see footnote 13), it is produced with a single contradiction contour over the whole utterance. However, (14b) cannot be pronounced this way. In the recordings there are three versions. (i) is a single contradiction contour over the whole utterance. (ii) is a single falling contour over the whole utterance. (iii) is a falling contour on *she doesn't*, followed by a separate falling contour on *she's vegetarian*. We believe there is a clear contrast between the

[13] Recordings of numbered examples in which intonation is crucial, starting with example (14), can be found at `http://semanticsarchive.net/Archive/GU4M2ZhN/`.

first two, which are infelicitous, and the third, which is felicitous.[14] If we are correct that two separate speech acts cannot be pronounced with a single intonational tune, then the fact that (14a) can be pronounced with a single contour suggests that polar particles and following clauses can exist in a single speech act. This would run contrary to the predictions of Krifka's account.

A second, and related argument is due to Michael Rochemont (p.c.), who pointed out to us that it is possible to shift prominence to a polar particle and deaccent a following sentence as in (15):

(15) A: Does Jane like coffee?
  a. S: YES, she likes coffee.
  b. S: NO, she doesn't like coffee.

We observe that, compared to (15), attempts to shift prominence between separate sentences in (16a) and (17a) seem less natural. Cf. (16b) and (17b) in which the second clause has its own prominence, and which are felicitous:

(16) A: Does Jane like coffee?
  a. S: # She DOES, she likes coffee.
  b. S: She DOES, she LIKES coffee.

(17) A: Who likes coffee?
  a. S: # JANE, she likes coffee.
  b. S: JANE, SHE likes coffee.

If prominence shifts can indeed only occur within sentences, this suggests that contrary to Krifka's analysis, *yes* and *no* are at least sometimes part of a larger syntactic structure with the following sentence. We note further that they pattern with what are uncontroversially

[14] One might object that the (i) pronunciation is infelicitous because the contradiction contour is not licensed on *she's vegetarian* in the dialogue in (14). But even if we imagine the (i) pronunciation of (14b) in response to the utterance *Jane likes steak, she isn't vegetarian*, it still sounds infelicitous, suggesting the problem lay in trying to use a single contour on both sentences.

propositional adverbs in this regard:[15]

(18) a. Of COURSE, she likes coffee.
b. SURE, she likes coffee.

The meaning of the prominence shifted utterances in (15) as well as those in (18) seems to have focus on the polarity of the proposition (similar to "verum focus", see Höhle, 1992), which is compatible with Holmberg's and R&F's proposed connection between polar particles and the polarity head. These observations, taken together with crosslinguistic facts discussed by Kramer & Rawlins (2009), Roelofsen & Farkas (2015) and Holmberg (2016), arguably speak in favor of analyzing the syntax of polar particles similarly to propositional adverbs, high in the left periphery, and analyzing uses of bare *yes* and *no* as involving ellipsis.

Note that adopting an adverbial account of the syntax of polar particles is still compatible with Krifka's account of interchangeability. One can imagine an ellipsis version of Krifka's account to accommodate these observations. Suppose that *yes* and *no* always attach high in the left periphery, as in K&R's, Holmberg's and R&F's analyses. Suppose further that *yes* requires its complement to have identical propositional content and polarity to a salient antecedent, essentially R&F's [AGREE] feature, while *no* requires its complement to have the opposite propositional content and polarity from a salient antecedent (essentially R&F's [REVERSE] feature). This revision to Krifka 2013b takes seriously the idea presented in Kramer & Rawlins 2009, Holmberg 2013, 2016, and Roelofsen & Farkas 2015 that polar particles stand in a syntactic relationship with the following sentence. Moreover, it makes use of the technical innovations of R&F's relative polarity features. At the same time, it makes the same predictions as Krifka's anaphor theory in other regards (apart from the prominence shifting facts above) since it captures interchangeability via the same basic insight proposed in Krifka 2013b: Interchangeability in the context of negative questions and statements

[15]There are interesting differences between these, e.g. *of course* is felicitous when followed by a negative sentence, while *sure* seems to be incompatible with a negative follow up, except perhaps in sarcastic utterances.

would still be explained via the assumption that negative sentences introduce two discourse referents, one corresponding to the NegP and one corresponding to the TP.[16]

2.5.2 An argument for the multiple antecedents view of interchangeability

Krifka hypothesizes that *yes* and *no* are sensitive to multiple propositional discourse referents arising from negative sentences. If *yes* and *no* can pick up multiple antecedents from other kinds of sentences, this would provide independent evidence in favor of the multiple antecedent view. Krifka (2013b, p. 5) already demonstrates the existence of multiple antecedents with the propositional anaphor *that*, similar to our example (3). (19) provides more direct evidence for the analysis from uses *yes*/*no* responses themselves.

(19) A finds B and C arguing about whether John is home, and decides to add her two cents.
A: I know Mary believes John is home.
a. C: No, he isn't.
b. C: No, she doesn't.
c. C: No, you don't.

[16]Note, however, an additional twist: Prominence shifts seem to interact with interchangeability:

(i) Is Jane not coming?
a. YES she's coming
b. ??YES she isn't coming
c. NO she isn't coming
d. ??NO she's coming

Based on the intuitions of a few informants as well as our own, (ib) and (id) seem to be degraded relative to the other responses. This might suggest that in responses like (ia) and (ic), the polar particles can be within the same clause as the following sentence, while in responses like (ib) and (id), they cannot be (although it could also be that an interaction with focus/givenness accounts for the asymmetry). We will not try to give a full explanation of these facts here, but we offer two further observations. First, Huddleston & Pullum (2002, p. 848) claim that the responses *Yes it isn't* and *No it is* are ungrammatical as single clauses. It may be that while on the face of it English polar particles seem to be interchangeable, uses of *yes* with a following negated sentence and of *no* with a following non-negated sentence are in fact necessarily separate utterances. This might be taken as an argument in favor of an account like Roelofsen & Farkas's (2015), which allows *yes* and *no* to realize either absolute or relative polarity features, if we were to make the additional assumption that relative features are more pragmatic in nature, while only absolute features are true polarity features that take part in a syntactic structure with a following clause. Clearly more work is needed, both to fully establish the empirical facts, and to flesh out an explanation.

The three responses each make reference to a different antecedent. Under Krifka's assumption that propositional discourse referents are introduced by any syntactic constituent in the preceding utterance that conveys a propositional meaning, these interpretations are straightforwardly accounted for.

In R&F's terms, each of the responses in (19) has the feature bundle [REVERSE, −]. R&F's account can explain (19), but in order for the presupposition of the [REVERSE] feature to be met in each response, it has to be assumed that each embedded propositional constituent introduces an antecedent. Thus under R&F's account, we are forced to make the same crucial assumption undergirding Krifka's account, namely that polar particles can refer to more than one propositional discourse referent made available by a preceding utterance.

Given that both of the accounts must allow for the existence of multiple antecedents arising from other embedding environments, and given that *that* is sensitive to both positive and negative discourse referents arising from negative sentences, analyzing *yes* and *no* as picking up propositions embedded under negation à la Krifka seems appealing. It explains the phenomenon of interchangeability without positing any other extra factors such as multiple kinds of polarity features, or sensitivity to the structural height of negation.

In response to (19), a *Glossa* reviewer observes that there are other embedding environments in which the embedded antecedents are often not readily available (we have adapted the examples slightly):

(20) Mary hopes that Peter wrote a thank you note.
   a. No, she doesn't. / Yes, she does.
   b. ??No, he didn't. / ??Yes, he did.

(21) If Mary is at home, Peter will be too.
   a. ??Yes, she is. / ??No, she isn't.
   b. ??Yes, he is. / ??No, he isn't.

We think that the cause of these preference patterns is pragmatic. In particular, the

availability of an antecedent may be constrained by whether the resulting assertion is relevant to the question under discussion (QUD, Roberts, 1996/2012). Discourse referents attached to matrix propositions are usually relevant to the QUD, thus are usually available. In (19), the QUD is whether John is home, and the issue is disputed. Thus Mary's beliefs on the topic may be relevant, and since this is the case, what A knows about Mary's beliefs on the topic is also relevant.

Suppose we alter (20) by switching the matrix subject to the first person pronoun *I*. The resulting *I hope that Peter wrote a thank you note* may be taken as an indirect question about whether Peter wrote a thank you note. Thus we would predict the responses in (20b) to be more felicitous, and we believe this matches intuitions. We further observe that when the conditional in (21) is embedded into a larger discourse with a QUD about either Mary or Peter's whereabouts, the relevant responses may improve, however the intuitions are subtle.

If we return now to considering embedding via negation, it should not be surprising if we don't see similarly strong asymmetries with respect to whether the embedded antecedent is available or not. If the truth of a proposition is relevant to the QUD, then we would also expect its negation to be relevant, thus discourse referents arising from both propositions should be available to polar particles.

We conclude that there is some independent evidence for a multiple antecedents account of interchangeability such as Krifka 2013b. In combination with the evidence in favor of an adverbial parse (as advocated fore by Kramer & Rawlins, 2009; Holmberg, 2016; Roelofsen & Farkas, 2015), this suggests that the correct theory may be a combination of ingredients from the described accounts. But as mentioned above, there is still non-trivial work to be done to extend a multiple antecedents analysis of interchangeability so that it could capture crosslinguistic facts, a task that remains beyond the scope of this paper. Further comparisons of the theories discussed above, in particular their accounts of preference patterns, will be taken up when we discuss our experimental results.

3 The contradiction contour

We are particularly interested in the role that intonation plays in the interpretation of polar particles. Before running the experiments reported below, our intuition was that a rising tune, the contradiction contour (Liberman & Sag, 1974), would sometimes appear on polar particles that indicate a positive response to a negative question, but not on particles indicating a negative response to a negative question. It turns out that we are not alone in this intuition. Pope (1976, p. 147, ex. (73R2)) identifies a rise-fall-rise tune across the entire utterance of *yes, he is* in response to a negative sentence that we think is the contradiction contour, though she did not identify the intonation as having the meaning that Liberman & Sag propose. If the contradiction contour does have this distribution in yes-no responses, then its presence in ambiguous bare particle responses to negative questions could influence hearer interpretation in a perception task. We will see that our production experiments verify the existence of such an intonation, and our perception experiment demonstrates that the intonation has such an interpretational effect.

Liberman & Sag (pg. 421) write, "This contour is appropriate (although of course optional) just when the speaker is using the utterance that bears it to contradict—he may contradict what has just been said by another, he may contradict some assumption or implication of what has been said or done by another, or he may contradict himself." (22) exhibits a common use of the CC.[17] The image in Figure 1 is a pitch track of B's utterance as produced by a participant made using Praat (Boersma & Weenink, 2016).

(22) A: You're not a friend of Jenny's.
B: No (CC). I'm a friend of Jenny's (CC).

According to Ladd (1980), the CC is a high-falling tone, followed by a low-rise pitch accent on the nuclear or main stress of the sentence. We note that the initial rise is more reliably

[17] "(CC)" following an utterance indicates that the utterance bears a CC tune. There are two CCs in (22). Again, recordings of all examples where intonation is crucial can be found at `http://semanticsarchive.net/Archive/GU4M2ZhN/`.

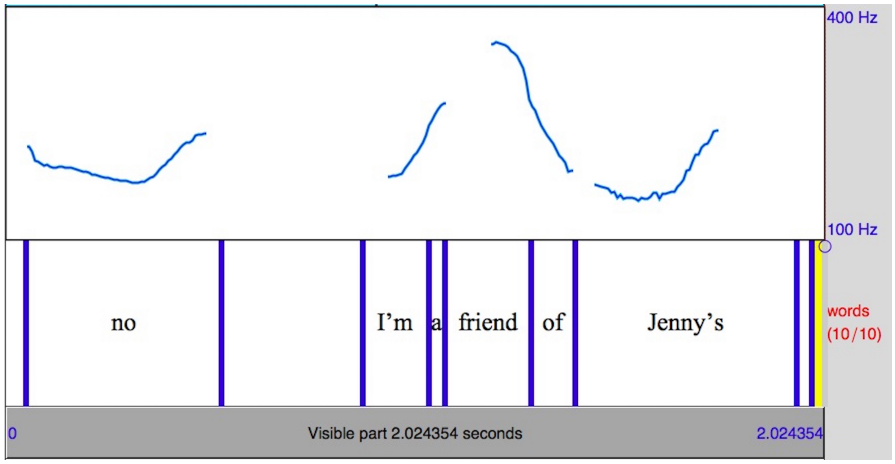

Figure 1: A visual representation of B's utterance in (22).

present when there is more material preceding the nuclear accent, as in the full sentence *I'm a friend of Jenny's*. On a monosyllable like *no*, the tune starts high and falls to the low pitch accent before the final rise. In Iberian Spanish, Torreira & Grice (2017) demonstrate experimentally that tunes may have one form when produced with a single prosodic word, but another, longer form when produced with two or more prosodic words. We think something similar may be happening in English, although more phonological work is needed.

Pierrehumbert & Hirschberg (1990) transcribe the CC in ToBI as L* L-H%, while Constant (2012) transcribes it as L*(+H) L-H%. However, these transcriptions do not accurately capture the fact that the CC necessarily has an initial rise or starts high before reaching the final low pitch accent. Hedberg et al. (2003) move towards capturing this fact. They conduct corpus work and note that the CC may have a high onset with one or more L* pitch accents before reaching the obligatory final L*L-H% nuclear tune (p. 2). They transcribe some instances as H* !H* L* L-H%, and others as L*+H L* L-H%. The latter is identical to the transcription offered by Ladd (1996). A possible issue we see with these transcriptions is that it is not clear that the initial rise or high tone is a pitch accent, that is, it does not need to align with a stressed syllable. For instance, in the monosyllabic *no* in (22), the tune reliably starts high despite that there can only be one pitch accent, and it is a low one. Thus, we believe a more accurate transcription might be %H L* L-H%, with the possibility

of iterated L* pitch accents after %H.

3.1 Contradiction contour vs. rise-fall-rise

Since the CC rises, falls and rises, it can be hard to distinguish from the rise-fall-rise contour (RFR, usually transcribed as L*+H L-H%) when sentence prominence is shifted to the initial position as under subject focus. In fact, Liberman & Sag argue that the two are one in the same contour. Ladd (1980) argues that this is not the case. We demonstrate Ladd's observation that the CC and the RFR are distinct both phonetically and semantically with the following examples.

(23) A: Jane doesn't like movies.
   a. B: Jane likes movies (CC).
   b. B: JANE likes movies (RFR).

(23a) has the CC with the nuclear stress falling on the object. (23b) has the RFR with subject focus shifting nuclear stress to the subject. The two sound very similar, but only in this particular case where the CC has object prominence while the RFR has subject prominence and the subject is monosyllabic (cf. Ladd, 1980). If we replace the name *Jane* with a polysyllabic name with stress at least three syllables in, like *Alvarado*, then the phonetic forms of the two contours clearly become distinct.

(24) A: Alvarado doesn't like movies.
   a. B: Alvarado likes movies (CC).
   b. B: ALVARADO likes movies (RFR).

Whereas the contour in (24a) rises and falls utterance initially, in (24b) the contour does not start rising until the third syllable *ra*. This is because RFR locates its initial rise on the stressed syllable of the focussed constituent, whereas the CC has a rise fall preceding the low pitch accent. Thus it is clear we are dealing with two contours each with a distinct phonetic

form.

The two contours can be seen to be semantically distinct by comparing the asymmetrical intuitions between (24) and (25).

(25) A: Who do we know who likes movies?
  a. B: # Alvarado likes movies (CC).
  b. B: ALVARADO likes movies (RFR).

The meaning of the CC as described by Liberman & Sag requires some element of contradiction. This requirement is clearly met in (24), but not in (25), which is why (24a) is intuitively felicitous while (25a) is not. While the RFR is compatible with contradiction, e.g. (24b) is felicitous, contradiction is not a core part of the RFR's felicity conditions, e.g. (25b) is also felicitous. Ward & Hirschberg (1985) have described RFR as implicating uncertainty relative to some scale. Constant (2012) has argued that RFR indicates that focus alternatives to the present utterance cannot safely be claimed, while Wagner (2012) has argued that it indicates that an alternative utterance is possible. We will not try to settle the meaning of the RFR here. The point is just that, whichever characterization of the meaning of the RFR is correct, it is clearly felicitous in both (24) and (25), whereas the felicity conditions of the CC are only met in (24), demonstrating that the two are distinct contours with distinct meanings, with only the CC requiring contradiction.

3.2 Defining "contradict"

Defining the notion of "contradict" in the quote from Liberman & Sag (1974) above is not trivial, as is anticipated by Liberman & Sag, who allow for contradictions of implications of both verbal and non-verbal actions. If we were to define a contradiction as two contradictory (in the logical sense) assertions in a discourse that aim to add mutually exclusive propositions to the common ground, then we would not predict the use of the contradiction contour in responses to PQs, e.g. in (26).

(26) It's been a busy day at work. You have ten clients to meet with before your boss gives a presentation at 4 pm that everyone is expected to attend. You are intent on going to the presentation because you have an important question to raise. In your haste to meet with all ten of your clients, you completely lose track of time. Your coworker Thomas knocks at your door. You look at the clock which reads 4:07 pm and you realize you are late for the presentation. Thomas asks:
Thomas: Are you not coming to the presentation?
You: No (CC). I'm coming to the presentation (CC).

The apparent antecedent of the CC is not a prior assertion, but the information provided by the context and the question, which at best imply evidence in favor of the negative response (see for example Büring & Gunlogson, 2000; Krifka, 2013a; Trinh, 2014; Roelofsen & Farkas, 2015). Clearly, a weaker notion of contradiction is needed.

One possible analysis is that an utterance of p(CC) requires a propositional discourse referent anchored to $\neg p$, and thus involves a propositional anaphor similar to polar particles under Krifka's (2013b) analysis. Another is that the CC has the same basic meaning as reverse features proposed by Kramer & Rawlins (2009) and Roelofsen & Farkas (2015) discussed above. That is, it requires a salient discourse referent with complementary propositional content from p. But such analyses would miss an important difference between polar particles and the CC. Consider (27), in which A asks a positive PQ.

(27) [Like in (26), A has reason to suspect that B is not coming to the presentation. However now the context leaves open whether or not B is in fact coming.]
A: Are you coming to the presentation?

a. B: I'm coming to the presentation (CC).
b. B: Yes, I am
c. B: No, I'm not
d. B: # Yes, I'm not
e. B: # No, I am

The judgments in (27b) through (27e) are exactly as expected given existing theories of polar particles: Since A asks a positive PQ, *yes* and *no* can only be used as in (27b) and (27c). (27d) and (27e) are unavailable. Note however, that using the CC on a positive response as in (27a) is perfectly acceptable here. An analysis that treats the CC as similar polar particles creates the following puzzle: Why is the CC licensed on a positive response here

when interchangeability is not licensed?

To explain how the CC is licensed, we will make use of the notion of *contextual evidence* introduced by Büring & Gunlogson (2000) for constraints on polar questions. We propose that the CC requires contextually salient evidence against the asserted proposition. We can model evidence as follows:

(28) *Contextual Evidence*: Evidence for p is a change in the context that increases the likelihood that p is true.

As Büring & Gunlogson note, contextual evidence needs to be publicly available. We further note that contextual evidence can come from any kind of perceptual experience or from interlocutors' actions, including speech acts. Moreover, contextual evidence does not necessarily affect the speaker's (private) expectations about p. For example, the contextual evidence for p in (29) and (30) does not seem to affect S's commitment to $\neg p$:

(29) S is an experienced animal tracker who knows that mountain lions no longer live in these parts. S sees some mountain lion scat, and says to herself.
S: There aren't any mountain lions around here (CC).

(30) H: There are mountain lions around here.
S: There aren't any mountain lions around here (CC).

Using p as a label for the proposition that *there are mountain lions around here*, we take (29) and (30) to both be contexts in which there is contextual evidence for p by our definition in (28). In (29) evidence for p is in the form of S's perception of scat (combined with S's expertise and assumptions), and in (30) the evidence for p is in the form of H's assertion of p. In both cases S asserts $\neg p$ despite the evidence for p. This presumably means that S's beliefs or epistemic state has not been altered with respect to p by the new evidence. So, while evidence for p is some publicly available feature of the context that would ordinarily increase the likelihood that p is true, it needn't necessarily cause S to change her own private

beliefs about p.

This notion of evidence can be motivated based on broad principles of question answering. Consider Roberts's (1996/2012) formulation of Gricean relevance (Grice, 1989), which we summarize in (31).

(31) A conversational move is relevant to the question under discussion iff it either introduces a partial answer to the QUD, or raises another question as part of a strategy to answer the QUD.

Suppose that questions denote sets of alternative propositions (Hamblin, 1973). For Roberts, a partial answer is a proposition the contextually entails that one of the Hamblin alternatives is true or false. We believe there may be reason to recast relevance in terms of our notion of contextual evidence in (28).

(32) A conversational move is relevant to the QUD iff it either *provides evidence for or against one or more of the propositions denoted by the QUD*, or raises another question as part of a strategy to answer the QUD.

(32), but not (31), is broad enough to be compatible even with very indirect responses to questions. Consider (33).

(33) A: Who will come to the reading group meeting today?
B: Jane's mother is in town.
$\rightsquigarrow$ Jane is unlikely to come to the meeting.

B's response does not contextually entail that Jane is not coming, thus it does not provide a partial answer to the QUD in Roberts's sense. It is nevertheless an intuitively valid response. When combined with world knowledge about visiting mothers, it provides evidence for the proposition that *Jane will not come to the meeting* by our definition of evidence in (28), that is it increases the likelihood that the proposition is true. Since this proposition is the negation of a partial answer to A's question, B's response counts as providing evidence

against an answer, and (32) is met.

The notion of contextual evidence in (28) is further motivated by its use in Büring & Gunlogson (2000) and Trinh (2014) to state generalizations about the felicity of different types of questions:

(34) a. rising declaratives: Require contextual evidence for p.
b. low negation PQs: Require contextual evidence for $\neg p$.[18]

Following Truckenbrodt (2011) and Goodhue et al. (2016), we assume intonational contours compose with proposition denoting constituents and act as partial identity functions, placing felicity requirements on the utterance. We use the notion of contextual evidence in (28) to formulate the meaning of the CC:[19]

(35) CC takes a proposition p and presupposes that there is evidence for the complement of p, that is there is evidence for $\neg p$

The ultimate assertion with the CC will have the same propositional content as p. It is the tension between presupposing contextual evidence for $\neg p$ and being true iff p is true that creates the signal of disagreement that the CC is known for.[20, 21]

[18]Importantly, *evidence* and *bias* should not be confounded. High negation PQs require a previous commitment to p (i.e. Romero & Han's 2004 positive bias), but they also seem to frequently require evidence for $\neg p$.

[19]Portes & Reyle (2014) provide a QUD account of French "implication" contour (IRF), which the authors claim primarily encodes a contradiction. Therefore, one might wonder whether such an account could also be applied to the CC. Note however that there are empirical differences in the distributions of the two contours. E.g. Portes & Reyle's example (3), in which IRF is acceptable, would be unacceptable with the CC in English, but acceptable with a contrastive accent on *curtains*:

(i) A: There aren't any shutters here.
a. B: # Yeah (CC). There are curtains (CC).
b. B: Yeah (Contrastive). There are CURtains (Contrastive).

Therefore, IRF may be more similar to English contrastive accents than to the CC.

[20]As Ladd (1980) notes, the CC cannot be embedded. This suggests that the CC might actually be an operator over speech acts, similar to Wagner's (2012) proposal for the RFR contour. Another possibility is that the CC contributes a conventional implicature, as in the analysis of expressive meaning in Potts 2005.

[21] A possible challenge to treating the CC as a presuppositional operator is that, assuming the principle

There are certain similarities between the CC and polar particles. Both are dependent on previous context. But the CC and polar particles differ in that polar particles require a discourse referent denoting a certain proposition, while the CC merely requires contextual evidence for a certain proposition. This explains the asymmetry in (27).

4 Production Experiments

There are three main groups of empirical questions that we aim to address with the experimental work below:

1. Does a special intonation appear on positive *yes*/*no* responses to negative PQs? If so, can it affect the interpretation of bare particles?

2. When responding to a negative sentence, which particles do speakers prefer to use when giving a response with negative polarity? With positive polarity? How are bare polar particle responses to negative sentences interpreted?

3. If the negative sentence that the polar particle responds to is itself responding to a negative sentence, are preference patterns affected, and in particular is *yes* now more acceptably interpreted as a negative response, e.g. "she didn't"?

As already discussed in the introduction, previous experimental work has already provided partial answers to the questions in 2. Brasoveanu et al. found that *no* was preferred over *yes* when giving a negative agreeing response to a negative sentence, e.g. "No, she didn't." However their study does not consider positive responses to negative sentences, which are included in our experiments. Moreover, Kramer & Rawlins (2012) found that bare

of maximize presupposition (Heim, 1991), we might expect the CC to appear obligatorily in all contexts in which it is licensed. However, as Liberman & Sag note, the CC is used optionally. It may be that the CC includes some additional expressive meaning that a speaker may or may not consider appropriate in a given context. However, we think it is likely that a speaker is always free to choose one tune or another given some context and sentence to be uttered. Thus, if we wish to maintain an analysis of tunes as imposing felicity conditions on utterances as a general program, we may need a more general explanation for this optionality.

polar particles are more likely interpreted as agreements with negative sentences, e.g. "she didn't." Our results will suggest that it is crucial to control for intonation when exploring these questions.

Question 3 has been addressed for German in Meijer et al. (2015), where it was found that preference patterns are not context sensitive. We will report on similar experiments in section 6.

Finally, our experiments provide empirical evidence answering question 1 for the first time.

In total we will report on six experiments. 1 - A production experiment that gathers intonations and naturalness ratings for the polar particles *yes* and *no* in response to both positive and negative polar questions (PQs) in which inversion has taken place and the auxiliary is fronted (section 4). 2 - A production experiment testing *yeah* and *no* in response to negative rising declaratives, that is, questions with declarative word order that have a rising intonation typically associated with PQs (Gunlogson, 2001; Nilsenovà, 2006). 3 - A follow up to experiment 2 that tests naturalness ratings for bare particles (section 4). 4 - A perception experiment that tests participants' interpretations of bare *yes*/*no* responses to negative PQs, controlling for intonation (section 5). 5 & 6 - Two rating experiments that are intended to rule out alternative interpretations of our results, and to increase comparability to the results in Meijer et al. (2015) (section 6). These experiments received ethics approval from the McGill Research Ethics Board under file number 401-0409.

4.1 Methods

The methods of production experiments 1, 2 and 3 are similar. We will describe the methods for 1 in detail first, then we will note how it differs from experiments 2 and 3.

In each trial, the participant silently read a context story, followed by two lines of dialogue. See (26) above and (36) below for samples of our stimuli. Participants were asked to produce the second line of dialogue as naturally as possible. When ready, they would press any button

to hear a recording of the first line of dialogue through headphones, and then they would be recorded producing the second line. The recording of the first line always featured rising, polar question intonation.

Experiment 1 has three factors: QUESTION, whether the questioner asked a positive or a negative question; PARTICLE, whether the participant used the polar particle *yes* or *no*; and ANSWER, whether the participant gave a positive answer (*yes/no, I am coming*) or a negative answer (*yes/no, I'm not coming*).

Each level of the factor ANSWER required a different context story. The context in (26) sets up a positive answer (e.g. *yes/no, I'm coming to the presentation*). The context in (36) sets up a negative answer:

(36) It's been a busy day at work. You have ten clients to meet with before your boss gives a presentation at 4 pm that everyone is expected to attend. You've been to hundreds of your boss's presentations, and you think they are boring and keep you from doing important work. You plan to meet with your clients, and if you can't finish meeting with all ten by 4 pm, then you'll just have to miss the presentation since clients come first. Your coworker Thomas knocks at your door at 4:07 pm. He asks:
A: Are you not coming to the presentation? (A's expectation: you are not)
B: No ___ I'm not coming to the presentation

Regardless of whether the context sets up a negative or positive answer, all contexts were designed to make contextual evidence for the negative response salient. E.g. in both (26) and (36), there is contextual evidence suggesting that the participant's character is not coming to the presentation. When a negative polar question was used, it reinforced the contextual evidence, at least if the analysis of negative polar questions in (34b) is correct.[22] There were eight context pairs total (eight items). Responses were always complete sentences, but we will refer to them as "Am" and "Am Not" in plots and tables for brevity. We instructed participants to pause at "___" to maximize unique intonations on polar particles themselves.

[22] A NELS reviewer notes "...that in recent work [Trinh (2014)] has argued that positive polar questions are incongruent with contextual evidence towards not-ϕ." While Trinh's examples seem to support this claim, we believe that positive PQs are acceptable in our experimental contexts which feature contextual evidence toward not-ϕ. Further work on the licensing conditions of positive PQs is needed.

This made annotations of intonations easier, and also enabled us to use participants' polar particle productions in the perception experiment to be discussed in section 5. Participants were not made aware that the experiment was about intonation.

After recording each trial, we asked for the participant's naturalness judgments: "Please indicate how natural this response seems on a scale of 1 to 5 (1=least natural, and 5=most natural)." We intended for participants to rate the naturalness of the response they were asked to give, not the naturalness of their own production of the response. Evidence that they conformed to our intentions is found in the fact that the intonations they produced had no effect on their naturalness ratings.

The three factors were crossed, $2 \times 2 \times 2$, making eight conditions. Each participant saw each condition for each item in eight randomly ordered blocks of trials with one condition from each item.[23] We ran 30 native speakers of North American English (mostly McGill undergraduates), but had to exclude 7 due to technical difficulties, making for 1,472 observations total.

To facilitate analysis, we split the results between the levels of the factor QUESTION. I.e., we analyzed the results of responses to negative questions and positive questions separately, each as a 2×2 design with the two factors PARTICLE and ANSWER.

Experiment 2 tested responses to negative rising declaratives, e.g. *You're not coming to the presentation?*, instead of polar questions as in experiment 1. Moreover, instead of using *yes*, *yeah* was used. Otherwise, the design was the same, crossing the two two-level factors, PARTICLE and ANSWER, 2×2. There were six items and four conditions.[24] There were 22 participants, all native speakers of North American English, who were mostly undergraduate students. There were hence 528 observations total. The trials were pseudo-randomized so

[23]If need be, this enables a latin-square analysis by looking at only the first quarter of trials. The same holds for all other experiments to be described below.

[24]In fact, there were six conditions, four test-conditions with negative rising declaratives, and two additional conditions testing responses to positive PQs. In these two latter conditions in experiment 2, we did not fully cross the two factors, PARTICLE and ANSWER, since we took it as given that *yeah, I'm not* and *no, I am* are infelicitous in response to a positive PQ. We will only report on the subset of the data with negative rising declaratives, since experiment 1 captures responses to positive PQs more fully.

that participants never saw the same condition twice in a row, and trials from the same item were organized into different blocks to maximize their distance.

Finally, experiment 3 is a follow up experiment to experiment 2 with the exact same design, except that participants were only asked to produce the particles *yeah* and *no* themselves, with stage directions indicating the meaning of the response. E.g. if the question was "You're not coming to the presentation?", the response would have been indicated to the participant as follows: Yeah (You want to convey: I'm coming to the presentation). There were 33 participants.

4.2 Naturalness Results

Figure 2 displays a plot for the naturalness ratings of responses to positive PQs in experiment 1. Figure 3 displays plots for experiments 1, 2 and 3: The experiment 1 plot (left) shows how participants rated responses to negative PQs, while the experiment 2 plot (middle) and the experiment 3 plot (right) show ratings for full sentence responses and bare particle responses respectively to negative rising declaratives.

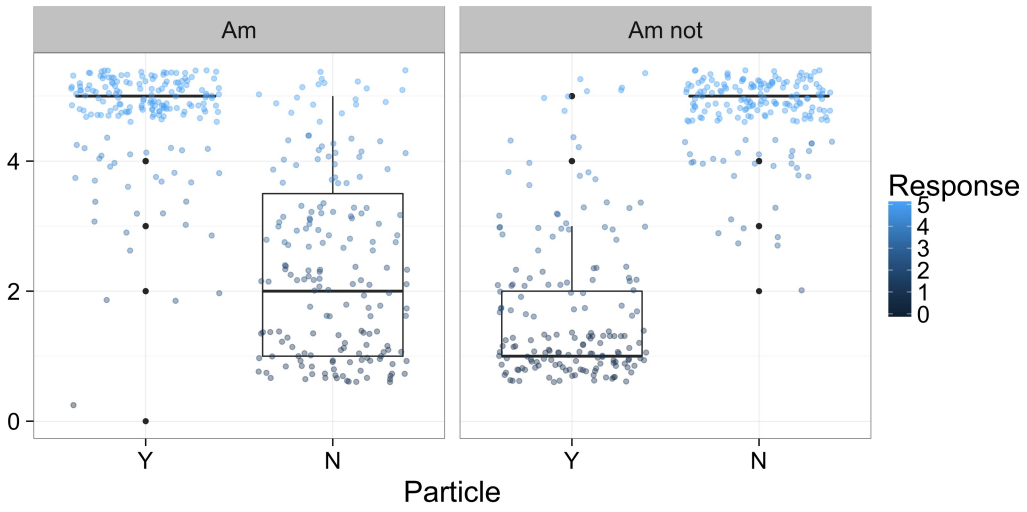

Figure 2: Naturalness ratings of responses to positive polar questions in experiment 1

As expected, Figure 2 shows that when indicating a positive response to a positive PQ, *yes*

is rated as highly natural and *no* is rated as unnatural, and vice-versa in negative responses. *Yes* and *no* are therefore indeed not interchangeable in response to positive PQs.[25]

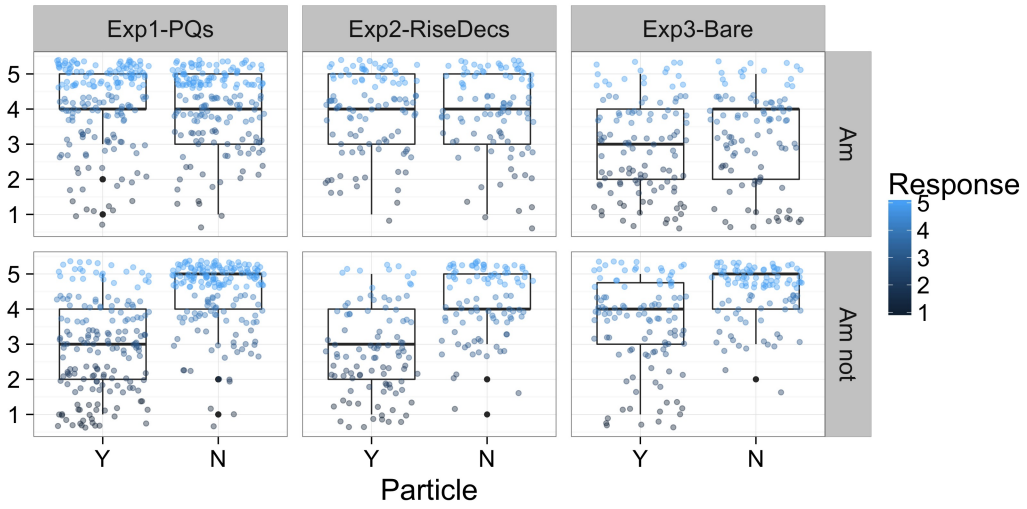

Figure 3: Naturalness ratings of responses in three experiments. Experiment 1 (left), responses to negative polar questions. Experiment 2 (middle), responses to negative rising declaratives. Experiment 3 (right), bare particle responses to negative rising declaratives.

Turning our attention now to Figure 3, in experiments 1 and 2, we observe that *yes/yeah* and *no* are overall acceptable in both positive and negative responses. Experiment 3 exhibits certain nuances to be discussed shortly, but nevertheless has a distinct qualitative pattern from responses to positive PQs in Figure 2. Taken together, the results indicate a high degree of interchangeability of English polar particles when used in response to negative questions or rising declaratives.

We fitted cumulative link mixed model regressions for each experiment, with random intercepts and slopes for participant and item (see Table 1). We also ran a cumulative link mixed model regression with random intercepts and slopes for participant and item on all of the data combined, so that we could check for statistically significant differences between

[25]However, we note that *No, I am*, while clearly degraded relative to *Yes, I am/No, I'm not*, is nevertheless rated as somewhat more natural than *Yes, I'm not*. This effect is statistically significant. We suspect that this is because *no* is able to pick up on a questioner's negative bias, even when they are asking a positive PQ. Thus if a questioner asks ?p, but in doing so in a certain context clearly implies that they now suspect $\neg p$, the speaker can reply, *no, p*.

the different experiments.[26]

	Exp1-PQs	Exp2-RiseDecs	Exp3-Bare	All
ParticleY.vs.N	-1.58 (0.29)***	-1.25 (0.23)***	-1.31 (0.31)***	-1.66 (0.25)***
AnswerAm.vs.Am not	0.75 (0.35)*	0.67 (0.29)*	-2.04 (0.45)***	0.73 (0.32)*
ParticleY.vs.N:AnswerAm.vs.Am not	3.23 (1.11)**	2.37 (0.41)**	2.06 (0.78)**	3.73 (0.87)***
Exp1Exp2				-0.58 (0.28)*
Exp1Exp3				-0.84 (0.31)**
ParticleY.vs.N:ExpExp2				0.24 (0.34)
ParticleY.vs.N:ExpExp3				0.37 (0.34)
AnswerAm.vs.Am not:Exp1Exp2				0.00 (0.44)
AnswerAm.vs.Am not:Exp1Exp3				-2.74 (0.46)***
ParticleY.vs.N:AnswerAm.vs.Am not:Exp1Exp2				-1.22 (1.06)
ParticleY.vs.N:AnswerAm.vs.Am not:Exp1Exp3				-1.94 (1.11)

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 1: Cumulative link mixed models for naturalness ratings in experiments 1, 2 and 3, as well as a model including data from all three experiments for comparison

First we consider the models for experiments 1 and 2. The interaction between PARTICLE and ANSWER, which is the largest effect, is due to the fact that in positive answers, both *yes/yeah* and *no* are equally acceptable, while in negative answers, *yes/yeah* is rated as significantly less natural than *no*. Moreover, PARTICLE had an overall effect in that *no* responses are rated more natural than *yes/yeah* responses, and ANSWER had an overall effect in that positive responses are rated more natural than negative responses. These effects are driven by the fact that *no* is more acceptable than *yes/yeah* when the answer polarity is negative. *No* is not more acceptable than *yes/yeah* in general. Likewise, positive responses are not more acceptable than negative responses in general.

The pattern of the naturalness ratings for experiment 3 are somewhat different from those for experiments 1 and 2. *Yeah-am not* responses are still rated as significantly less natural than *no-am not* responses, however there is a clear main effect of ANSWER in that positive responses are significantly less natural than negative responses in general. As we will see below, this effect is clearly bigger in experiment 3 than in the other two.

Considering now the model for all of the data, we note significant differences between the data from experiment 1 and 2, and between experiment 1 and 3: Overall, the polar particle responses are rated slightly less natural in response to polar questions than in response to

[26]We did not include the intonation that participants produced as a predictor since exploratory data analysis as well as a separate model showed there was no effect. Thus, the intonation participants produced had no effect on how natural they rated a response to be.

rising declaratives. We had no expectations about this, and do not expect there to be a theoretical motive behind it.

As one would expect from Figure 3, there is a large effect of ANSWER polarity on the difference between experiments 1 and 3. Positive (*am*) responses were significantly less natural in experiment 3 than in experiment 1. Otherwise there are no other significant differences between experiment 1 and the other two experiments.

4.2.1 Discussion of Naturalness Ratings

Recall question 2 from section 4, "When responding to a negative sentence, which particles do speakers prefer to use when giving a response with negative polarity? With positive polarity? How are bare polar particle responses to negative sentences interpreted?" Our participants prefer to use *no* to convey a negative polarity response to a negative PQ or rising declarative. This result confirms that of Brasoveanu et al. (2013), but also expands on it since their study considered responses to declarative sentences while ours is on polar questions and rising declaratives. Moreover, our participants are equally happy using *yes* or *no* to convey a positive polarity response, which had not been tested before. However, participants disprefer using bare particles to convey a positive response. This result confirms Kramer & Rawlins's (2012) felicity judgment findings. Moreover, we found a significant interaction effect, showing that negative *no* bare particles are more felicitous than negative *yes* bare particles. This is a new result since this trend was seen in Kramer & Rawlins's (2009) data, but was not significant there.

How do the theories of polar particles proposed by Krifka (2013b), Holmberg (2016) and Roelofsen & Farkas (2015, R&F) compare in light of these results? The main result of the naturalness ratings is that *no* is more natural when agreeing with a negative question than *yes*. The theories of Krifka and R&F capture this result. To see this, we need to describe briefly how preference patterns are accounted for in these theories.

Krifka hypothesizes two pragmatic markedness principles to explain preference patterns.

(37) a. *DisAgr: Penalizes disagreement with the other speaker.
b. *NonSal: Penalizes reference to less-salient discourse referents.

The relative salience of discourse referents is contextually determined. Krifka argues that in unmarked contexts the discourse referent anchored to the embedded TP is more salient than its negative counterpart because negative sentences are usually uttered in contexts in which the positive sentence is already salient. Krifka uses these principles in the optimality theory (OT) tableau in Figure 4 to predict different preferences for *yes*/*no* responses to negative sentences.

	expression	reference	resulting meaning	*DisAgr	*NonSal	Favorite
a	*yes*	d′	'He did.'	*		((☜))
b	*yes*	d	'He didn't.'		*	(☜)
c	*no*	d′	'He didn't.'			☜
d	*no*	d	'He did.'	*	*	

Figure 4: [From Krifka (2013b), ex. (52)] Calculation of optimal forms in an OT tableau.

Krifka's account of preference patterns accurately predicts the result from the naturalness ratings that *no* is more natural than *yes* in negative agreeing responses. For Krifka, this is because *no* picks up the most salient discourse referent, the positive one, and negates it, while *yes* incurs a violation for picking up the less salient negative discourse referent.

The ranking in Figure 4 erroneously predicts negative *yes* responses to be preferred to positive *yes* responses. However, Krifka notes that *DisAgr is only ranked higher than *NonSal in responses to assertions, which indicate a high degree of commitment to the proposition on the part of original speaker, making disagreement costly. In response to questions, *NonSal is ranked higher, which predicts negative *yes* responses to be less natural and is more in line with the results.

Under either ranking, there is a problem for Krifka's theory however. Positive *no* responses are predicted to be the least natural. This does not match our participants' judg-

ments.

Roelofsen & Farkas (2015) argue that some feature combinations in their account are more marked than others. The more marked a feature is, the greater its need to be realized overtly. [REVERSE] is more marked than [AGREE] since complementation is more marked than identity. [−], which stands for syntactically negative, is assumed to be more marked than [+], which means positive polarity, because crosslinguistically negativity always seems to be pragmatically marked (cf. Horn, 1989). Moreover, absolute polarity features are marked in the presence of [REVERSE] since [+] and [−] each necessarily contrast with the polarity of the antecedent when [REVERSE]'s presupposition is met. Finally, R&F argue that by virtue of both being unmarked, [AGREE] and [+] should be an unmarked combination of features, and [REVERSE] and [−], by virtue of both being marked, should be the second most "natural" combination of features.[27] From these markedness assumptions, R&F derive the following markedness scale from least to most marked for the four possible feature combinations.

(38) Markedness scale: [AGREE, +] < [REVERSE, −] < [AGREE, −] < [REVERSE, +]

In [AGREE, −] responses, only one of the features is marked, [−]. Since only *no* realizes this feature, *no* is predicted to be more natural than *yes* for realizing agreements with preceding negative sentences. This prediction matches the results. Furthermore, R&F predict *yes* and *no* to be equally natural when indicating a positive response to a negative PQ, which is

[27] R&F use the term "natural class" for these two feature combinations to motivate this assumption, importing a term from phonology. However, it is not clear to us why two marked features should be likely to co-occur. In fact, the combination of two marked features is assumed to be the least likely combination in phonology. The "worst-of-the-worst", in the terminology of Smolensky (2006), is least likely to occur crosslinguistically (e.g., voiced aspirates are rare). Indeed, if we were to abandon this assumption that [REVERSE] and [−] form a natural class due to being more marked, one might have assumed that [REVERSE, −] should be more marked than [AGREE, −], given R&F's other markedness assumptions. This would lead to a different ranking:

(i) Markedness scale: [AGREE, +] < [AGREE, −] < [REVERSE, −] < [REVERSE, +]

But perhaps there is another way to motivate the claim that the feature combination [REVERSE, −] should be more likely to occur, or more "natural".

borne out by the results above.

Holmberg (2016) argues that speakers who disprefer negative *yes* responses do so because they interpret the preceding negative PQ as having a syntactically high negation between TP and vP. Those who interpret the PQ as having a low negation, adjunct to vP/VP, are predicted to find such negative *yes* responses to be completely natural. Therefore, this account predicts that such responses should be rated by individual participants either as completely natural or completely unnatural, but should not receive in between ratings. However this is not what we found. The median rating of 3 in our results were not caused by participants being evenly split between ratings of 5 and ratings of 1. Instead, negative *yes* responses are consistently rated as somewhat degraded relative to all other response combinations by most of our participants. Thus Holmberg's account does not capture the results from the naturalness ratings.

We used *yeah* in experiment 2 because we had the intuition that it would be more acceptable in negative, agreeing responses. Roelofsen & Farkas report this same intuition in a footnote, and suggested more empirical work is needed. We were therefore surprised that negative agreeing responses were dispreferred with *yeah* in this experiment, just like *yes* was in experiment 1. It is an open question whether systematically varying *yes* and *yeah* in the same experiment might nevertheless produce preferences for the latter in the negative response level of the ANSWER condition.

As for the decreased naturalness of positive bare particle responses in experiment 3, both Krifka and Roelofsen & Farkas predict this result. Both argue that positive sentence polar particle responses to negative utterances require overt following sentences, and that such responses are less natural with bare particles. Holmberg predicts bare *yeah* to be less natural when conveying a positive response since it requires an unelided elliptical clause to change the polarity from negative to positive. However, the correspondingly low rating of bare *no* indicating a positive response is not predicted by Holmberg. Interestingly, the results of the perception experiment in section 5 below will not be the same as these naturalness

ratings by our speakers. That is, the way hearers interpret bare particles differs from the preferences suggested by the ratings observed in production.

4.3 Intonation results

The recorded responses in experiments 1, 2 and 3 were annotated for intonational contour by an RA and the first author. A contour can appear on *yes* and *no* themselves, on the sentence following them, or across both. We therefore annotated contours on polar particles and their following sentences separately. After listening to a subset of the data, we determined the vast majority of productions fell into one of three intonational categories: declarative fall, contradiction contour (CC), and rise fall. Intonations were marked "unclear/other" if it did not fit any of these categories, and "problematic" in case of disfluencies, recording errors, etc. Polar particles were marked as "none" when the participant produced a single contour over the whole utterance.

The form and meaning of contradiction contours were discussed in section 3. Declarative falls have a high final pitch accent followed by a fall, H* L-L%. Rise fall intonation is an upstepped high pitch accent that can appear on either the particle or the following sentence.

Counts and percentages of intonations used in response to PQs and rising declaratives in experiments 1, 2 and 3 are summarized in Table 2.[28]

Contour	n contours on particles	n contours on sentences
Declarative Fall	1863 (70%)	1456 (72%)
Contradiction Contour (CC)	450 (17%)	411 (20%)
Rise Fall	207 (8%)	99 (5%)
Other/Unclear	28 (1%)	57 (3%)
None	126 (5%)	n/a

Table 2: Contour annotation counts and percentages on particles and following sentences for experiments 1, 2 and 3. Note that there are more observations of particle contours than following sentence contours because experiment 3 featured bare particles.

[28] A category for polar question rises was included in the annotation, but was only used 4 times total. Question rise annotations are included in the "other/unclear" row of Table 2.

Considering Table 2, we can see that declarative falling intonation is by far the most frequent contour observed, followed CC, and then rise fall. There were relatively few contours that fell into the other/unclear category, suggesting that the annotation scheme was well suited to the data.

Cooper & Ginzburg (2011) claim that when *no* is used to convey a positive response to a negative PQ, it will bear a distinct rise fall tune. We think that our rise fall category corresponds to what they have in mind, however it does not have the restricted distribution they have suggested. While it does appear more frequently in positive responses to negative sentences, it is well represented in negative responses as well, as demonstrated in Table 3. Moreover, it was produced relatively infrequently (see percentages). Thus it does not seem likely that the rise fall is the special intonation hypothesized by theorists to be reserved only for positive responses to negative sentences.

Particle and answer polarity	n rise falls on particles	n rise falls on following sentences
Yes, I am	58 (3.7%)	13 (1.2%)
Yes, I'm not	24 (1.5%)	8 (0.7%)
No, I am	37 (2.4%)	16 (1.4%)
No, I'm not	16 (1%)	12 (1.1%)

Table 3: Rise fall annotation counts for responses to negative sentences for experiments 1, 2 and 3. Percentages reflect percent of all responses to negative sentences in all three experiments.

Before moving on, we note that we believe that the production of rise fall in our data set was correlated with verum focus prominence shifts, that is prominence shifts to the auxiliary, for example *Yes, I AM coming.* Roelofsen & Farkas (2015) argue that verum focus is obligatory in positive disagreeing responses, but we note that, like rise fall, it appeared in both positive and negative responses in our data. We believe this makes intuitive sense: Verum focus can emphasize the truth of an assertion regardless of whether it has the same or opposite polarity of the preceding sentence. E.g. when responding to the negative PQ *Are you not coming to the presentation?*, both verum focus and rise fall intonation can appear

on either a positive response (*No, I AM coming*), or a negative response (*No, I'm NOT coming*).

The tune of the most interest in our results was the contradiction contour (CC), due to its distribution: It was produced almost exclusively in positive responses to negative sentences. Figure 5 shows the proportion of CC that participants produced in response to positive polar questions (left), negative polar questions (second from left), negative rising declaratives (second from right), and in bare particle responses to negative rising declaratives (right). The top panels show the proportion of CC produced by participants on the particles themselves, while the bottom panels show the proportion of CC on the following sentences. Positive sentence answers are in blue, negative in purple. For instance, the Exp1-PosPQs column (leftmost) shows that the CC was produced on the sentence in 36% of trials in which positive sentences followed the particle *no*, but only in 2% of trials in which negative sentences followed the particle *no*.

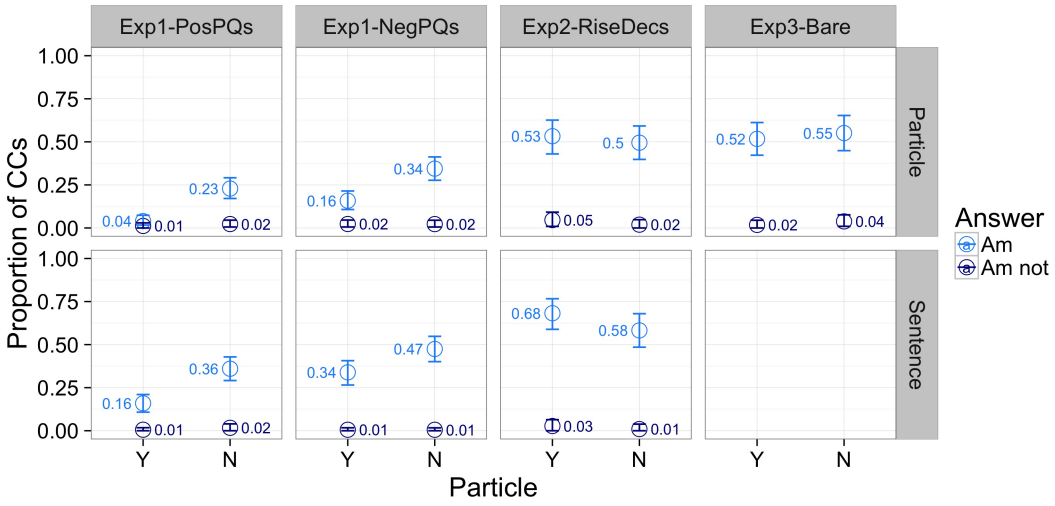

Figure 5: Proportion of CC produced on particles and on sentences in response to three different kinds of sentences. (From left to right) Responses to positive polar questions, responses to negative polar questions, responses to negative rising declaratives, and bare particle responses to negative rising declaratives.

Descriptively, the CC appears quite frequently in positive responses, but hardly ever in negative responses, suggesting an effect of ANSWER polarity. In each case, the rate of CC

is greater on following sentences than on the particles themselves. Rates of CC are greatest in response to rising declaratives (experiments 2 and 3), followed by responses to negative polar questions (experiment 1-Negative), and with the least amount produced in response to positive polar questions (experiment 1-Positive).

Furthermore, in responses to PQs only, the CC appears more frequently on *no* than *yes*, suggesting an effect of PARTICLE choice.

We fitted a mixed effects logistic regression for the combined data with random intercepts and slopes for participant and item (for discussion on the advantages of mixed effects regressions, see Baayen, 2008; Barr et al., 2013; Jaeger, 2008). The dependent variable was whether or not the CC was produced. The model tested whether it matters that the response was positive or negative (ANSWER), and that *yes* or *no* was used (PARTICLE). It also tested whether it matters that the context sentence was positive or negative (CONTEXTPOS.VS.NEG., the difference between the positive half of the experiment 1 and the rest of the data), whether the context consisted of a polar question or a rising declarative (CONTEXTPQ.VS.RISEDEC, the difference between the negative half of experiment 1 and experiments 2 and 3), and whether the particle was bare or not (CONTEXTFULL.VS.BARE, the difference between experiment 2 and experiment 3), as well as interactions between PARTICLE and these latter predictors (see Table 4).

The effects of ANSWER and POLARITY just mentioned are borne out by the model. We also found several other effects: More CC is produced in response to negative PQs and rising declaratives than in response to positive PQs (CONTEXTPOS.VS.NEG). More CC is produced in full sentence responses to rising declaratives than bare particle responses (CONTEXTFULL.VS.BARE). Finally, as one might expect from plot 5, whether *yes* or *no* was used had a fairly large effect on the difference in CC production between responses to positive and negative sentences (CONTEXTPOS.VS.NEG) and on the difference between PQs and rising declaratives (CONTEXTPQ.VS.RISEDEC).

	Model 1
(Intercept)	-2.26 (0.33)***
AnswerAm.vs.AmNot	4.59 (0.46)***
ParticleY.vs.N	-0.60 (0.17)***
ContextPos.vs.Neg.	-1.52 (0.34)***
ContextPQ.vs.RiseDec	-0.65 (0.39)
ContextFull.vs.Bare	0.96 (0.45)*
ParticleY.vs.N:ContextPos.vs.Neg.	-1.40 (0.35)***
ParticleY.vs.N:ContextPQ.vs.RiseDec	-1.13 (0.37)**
ParticleY.vs.N:ContextFull.vs.Bare	0.73 (0.49)

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 4: Logistic mixed effects regression modeling whether the contradiction contour was used on the particle or the sentence (or both). The models includes which answer was intended (*I am* vs. *I am not*), which particle was used (*yes* vs. *no*), and which context it was used in.

4.3.1 Discussion of intonation results

Consider again question 1 from section 4, "Does a special intonation appear on positive *yes*/*no* responses to negative PQs?" The answer is yes, the CC appears on positive *yes*/*no* responses to negative PQs. This result confirms the suspicions of researchers that some sort of special intonation appears only in positive responses to negative sentences. It also establishes for the first time that it is the contradiction contour that is used in these circumstances. This is significant since, now that we know that this intonation plays a crucial role in these contexts, we can test experimentally whether it has a significant impact on the interpretation of bare polar particles (discussed in section 5).

The fact the CC appears in positive responses to negative PQs could be taken to show one of two things. Either the CC requires a linguistic antecedent with opposite polarity, or it merely requires contextual evidence for that proposition, as we claimed in section 3. We can determine which is the case by looking at responses to positive PQs in contexts that supply evidence for the negative answer before the question is asked (as all of our experimental contexts did). If the former view is correct, then the contextual evidence shouldn't matter and the CC should only appear on negative responses. If the latter is correct, then the polarity of the PQ shouldn't matter and the CC should appear on positive responses. As

noted above, we found the latter to be true. The CC is not reserved just for identifying positive polar particle responses to negative PQs, it is sensitive more generally to contextual evidence for a proposition that is opposite from the proposition that the speaker asserts. This fits with our analysis of the contradiction contour in section 3.

As noted in footnote 21 at the end of section 3, one might expect the CC to appear in 100% of trials in which it is licensed, assuming it is a presuppositional operator and maximize presupposition is in effect. But this is not what we found. Liberman & Sag (1974) were right when they claimed the CC is optional. Thus we need to allow for the CC to be used only in a subset of cases in which it is licensed. Considering our data here, an interesting fact in connection with this is that the CC was produced more frequently in response to negative rising declaratives than in response to negative polar questions. Thus we also need an explanation for why certain types of antecedent sentences elicit the CC more frequently than others. It may be that negative rising declaratives convey stronger evidence for $\neg p$ than negative polar questions. The expression of stronger evidence for $\neg p$ may more frequently license the use of an intonation reserved for disagreement (i.e. the CC) by an interlocutor who wants to assert p. This result may therefore be taken to show that a theory of the evidence required to license different kinds of negative questions should predict that negative rising declaratives require more or stronger evidence for $\neg p$ than negative PQs.

The second interesting result is that the CC is produced more frequently in *no* responses than *yes* responses in experiment 1 (plots (a) and (b)), but not in experiment 2 (plot (c)). One possible explanation for this effect is that *no* is generally more likely to be used in disagreements than *yes* when we take into account responses to positive PQs. Therefore it is more likely to appear with the CC. This correlation affects speakers' choices even in cases where in principle the CC would be licensed on *yes*. One possible reason that this effect is missing in experiment 2 and 3 is that the latter used *yeah* whereas *yes* was used in experiment 1. For a reason that remains unknown, it may be the case that *yeah* more readily admits CC intonation than *yes*.

5 Perception Experiment

As we asked in questions 2 and 1 from section 4: How are bare polar particle responses to negative sentences interpreted? Does the contradiction contour (CC) affect the interpretation of bare particles? While Roelofsen & Farkas (2015) predict bare particles to be ambiguous, they also say that they are more likely to be used to convey a negative response to negative PQs. Krifka (2013b) predicts that bare *no* will unambiguously convey a negative response. Holmberg (2016) predicts that bare *yes* will unambiguously convey a negative response.

Given the finding from our production experiments that *yes* and *no* themselves can carry the CC, we wondered whether its presence affects a listener's interpretation. Here is a sketch of how the CC might affect the interpretation of a bare particle: In response to "Are you not coming to the presentation?" a polar particle can either convey a positive disagreeing response (*I am*), or a negative agreeing response (*I'm not*). Therefore, it may be unclear to the hearer which interpretation was intended. Intonation can provide a clue, however: If the particle bears the CC, the speaker conveys that the response disagrees with some contextually salient evidence. The negative question requires that there is contextually salient evidence in favor of the negative response (Büring & Gunlogson, 2000; Krifka, 2013a; Trinh, 2014; Roelofsen & Farkas, 2015). If this is the evidence that the CC signals disagreement with, then the particle must indicate the positive response.

On the other hand, the choice not to use the CC in a context in which there is negative evidence might lead a listener to conclude that the speaker does not disagree with the evidence, leading to a negative interpretation. We conducted a perception experiment to test whether the interpretation of bare polar particles was indeed affected by intonation in this way.

5.1 Methods

Participants were presented with a context story on a computer screen. The experiment's contexts were similar to those in the production experiments, except that now they crucially leave open whether the character will give a positive or negative response:

(39) **Context**: Taylor and Mark are coworkers. Their boss is giving a presentation at 4 pm that they are both supposed to attend. Mark is running a bit late, and on his way to the presentation at 4:05, he notices Taylor is on the phone and hasn't gone to the presentation yet either. The following dialogue ensues:
Mark [Heard through headphones]: Are you not coming to the presentation?
Taylor [Heard through headphones]: Yes

The question recordings came directly from the stimuli of production experiment 1. The bare particle answers were extracted from recordings of the participants in experiment 1. The perception experiment had three factors. PARTICLE: whether the word uttered is *yes* or *no*. INTONATION: whether the intonation used was the CC or a declarative fall (Dec). ORIGIN: whether the sound file used was originally followed by a positive or negative sentence in the production experiment. Thus the response in (39) is PARTICLE = *yes*. Suppose the recording used has the CC, then INTONATION = CC. Finally, if the recording came from a trial in the production experiment in which *yes* was originally followed by a positive sentence, e.g. *I'm coming to the presentation*, then ORIGIN = positive.

On each trial, participants first silently read the context and the dialogue, then pressed a key to hear the dialogue. Afterwards, the participants were asked how they interpreted the response:

(40) **Question**: Based on Taylor's response, which of the following is true:
1. Taylor is coming to the presentation.
2. Taylor is not coming to the presentation.

The participants were 25 North American English speakers, mostly undergraduate students.

There were eight different dialogues (items), and the experiment was run so that each participant saw all conditions in all items, therefore 1,536 observations total.[29] The trials were randomized so that participants never saw the same condition twice in a row, and trials from the same item were organized into different blocks to maximize their distance.

5.2 Results

The results are visualized in Figure 6. The CC made participants more likely to interpret the particle as conveying a positive answer. There were also more positive interpretations if the particle was *yes* was used. For the particle *yes*, it didn't seem to matter whether it originated from a positive or negative response—the rate of interpreting it positively was roughly the same. However, for the particle *no*, it mattered whether it was originally followed by a positive or a negative sentence, with the latter making negative interpretations more likely. So it looks like there may be an interaction between PARTICLE and ORIGIN.

We fitted a logistic mixed effects regression, which included particle, intonation, origin, and all interactions, with random effects and slopes for participant and item (see Table 5).

	Perception
(Intercept)	$-0.65\ (0.15)^{***}$
Particle	$-1.60\ (0.65)^{*}$
Origin	$0.34\ (0.29)$
Intonation	$2.47\ (0.32)^{***}$
Particle:Origin	$0.93\ (0.47)^{*}$
Particle:Intonation	$-0.09\ (0.84)$
Origin:Intonation	$-0.02\ (0.76)$
Particle:Origin:Intonation	$-0.31\ (1.10)$

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 5: Logistic mixed model looking at how the three factors PARTICLE, INTONATION and ORIGIN, and all possible interactions affect whether listeners interpret the bare particle to mean *I am* or *I am not*.

The largest significant effect was for INTONATION. Particles bearing the CC were significantly more likely to be interpreted as a positive sentence, e.g. *I am coming to the*

[29] One participant was removed for completing less than 50% of trials, and 10 observations were removed due to participants choosing neither possible answer.

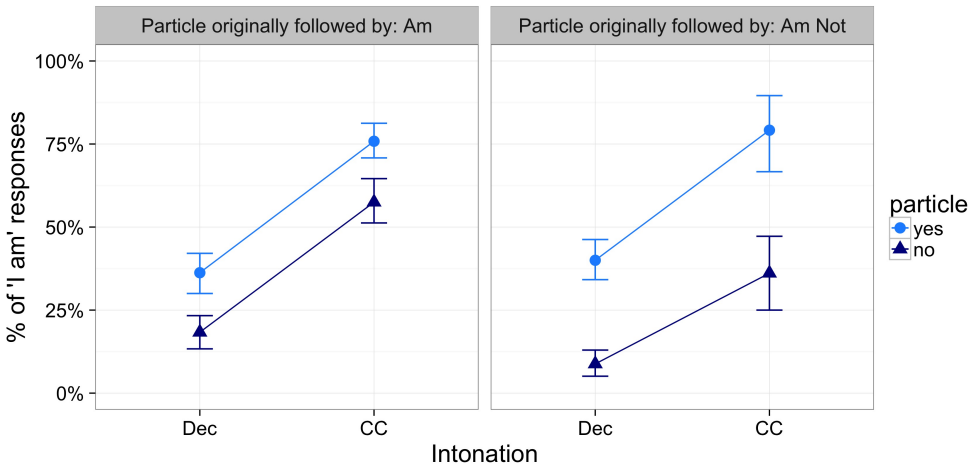

Figure 6: % positive *I am* interpretations of bare particle responses by PARTICLE (*yes* vs. *no*, INTONATION (CC vs. Dec), and ORIGIN (whether the particle was originally part of a positive or negative response in the production study that it was culled from).

presentation (26% positive interpretation with Dec, 65% with CC). There was also an effect of the choice of PARTICLE. *Yes* responses were significantly more likely to be interpreted as conveying a positive sentence response, e.g. *I'm coming to the presentation* (30% for *no*, 53% for *yes*).

Whether an utterance was originally uttered in a negative agreeing response or a positive disagreeing response (our factor ORIGIN) did not significantly affect interpretation (p>0.32), nor was there an interaction between ORIGIN and INTONATION (p>0.39). This gives our intonational annotation some validation—it could have been that our categorization missed some crucial prosodic cues revealing the intent of the speaker that is not captured by annotating whether they used the CC or not, or maybe what we annotated as CC could have been quite different depending on which type of utterance it occurred in. But there is no evidence for either of these conceivable problems with the way we annotated the data.

On the other hand, participants were more likely to interpret *no* responses as agreements with the negative question when the *no* sound file came from a negative agreement response in experiment 1 than when it came from a positive disagreement response (the interaction between ORIGIN and PARTICLE in Table 5). We make two observations about this effect:

First, because there were relatively few CCs produced in confirming responses in the production experiments, the perception experiment could not be completely balanced. That is, there were only three *noes* followed by negative sentences that were produced with the CC in experiment 1, and only two *yeses*. To have had a completely balanced design, we would have needed eight of each. Therefore, the data for this experiment includes relatively few observations in which polar particles that were originally followed by a negative sentence bore the CC (the rightmost dots in figure 6—this is why the error bars are larger here than elsewhere in the plot). Since there are fewer negative-origin CCs, we might expect any effect of ORIGIN to be attributable to INTONATION. That is, fewer CCs result in more negative interpretations, given the strong effect that the CC has on interpretation.

The second observation is that despite this lack of balance leading to possible interference by INTONATION, it must be noted that even the negative-origin *no* responses bearing Dec intonation were interpreted as a negative response more frequently than the positive-origin *no* responses with Dec intonation. Thus, it seems likely that this interaction effect between PARTICLE and ORIGIN is at least in part genuine: Negative-origin *noes* must sound more negative to our participants than their positive-origin counterparts. This means that there is likely an effect of prosody on these *no* responses not captured by the intonation annotation. We note that this effect, though likely real, is smaller than the main effects of INTONATION and PARTICLE.

5.3 Discussion

The questions we set out to answer were: How are bare polar particle responses to negative sentences interpreted? Does the contradiction contour (CC) affect the interpretation of bare particles? We found that in response to negative PQs, bare *yes* is interpreted as a positive response at about chance level (53% of trials), while bare *no* is interpreted as positive in 30% of trials. However, intonation has a big effect on bare particle interpretation, both in the case of *yes* and *no*. Particles bearing the CC are interpreted as positive in 65% of trials,

while particles bearing a declarative contour are interpreted as positive in only 26% of trials. Let's consider how these results relate to the predictions of the theories discussed above.

None of the theories discussed above explicitly discusses predictions for the interpretations of bare polar particles that have different intonations. The theory of Krifka (2013b) predicts that in order to convey a positive response to negative PQs, *no* must be followed by an overt sentence. Holmberg (2016) makes the same prediction for *yes*. Roelofsen & Farkas (2015) predict negative interpretations of bare particles to be preferred, other things being equal. One might read this as meaning that a systematic manipulation of intonation could alter the expected interpretation. On the other hand, R&F claim that positive interpretations of polar particles will require an overt following clause with verum focus. While our results do not compare bare particle responses to those with following sentences, they show that intonation can have a strong effect on interpretation, enabling positive interpretations of bare particle responses to negative polar questions. This result is not anticipated in the previous literature. However theorists have suggested, even if in vague terms, that intonation could have some effect, and that positive responses to negative questions in particular would bear a special intonation, even if that intonation is predicted to appear on a following clause. Our results lend empirical support to this intuition, but expand on it by identifying for the first time that this unique intonation is the CC, that it can appear on bare particles themselves, and that it has a large effect on interpretation.

Given our proposed meaning for the CC, one could ask why positive interpretations are not at 100% when the CC is present. One might expect this since low negation questions give rise to evidence for the negative answer, so in order for the requirement introduced by the CC to be met, the speaker must be asserting the positive answer. But note that using the CC on a negative response to a negative question is possible in principle, if there is also positive contextual evidence (in addition to the negative evidence necessary to license the negative question). This was just not the case in our production study, which is why we found almost no negative responses with the CC. However, the contexts in our perception

experiment may have been open enough to leave some room for listeners to posit that there may have been such evidence. Sometimes, even raising a question of the form *not p?* can suggest that the speaker considers there to be some evidence for p (in addition to evidence for *not p*), and license the CC on a negative response. The following question (adapted from examples by Trinh, 2014) both suggests contextual evidence that B is not left-handed (antecedent for CC in (41a)), and given the lower odds of being left-handed the formulation of the question suggests a prior belief of A that B is left-handed, which B can take as positive evidence (antecedent for CC in (41b)):

(41) A always thought B was left-handed, but now sees B writing with her right hand.
A: Are you not left-handed?
a. B: I'm left-handed (CC).
b. B: I'm not left-handed (CC).

The main effect of PARTICLE is that *yes* responses were significantly more likely than *no* responses to be interpreted as conveying a positive sentence response. Viewed through the lens of Krifka's theory, this is expected since a pragmatic constraint is in effect, *NONSAL: being anaphoric to a less salient discourse referent is dispreferred. Since the negative discourse referent is typically less salient, both *yes* and *no* prefer picking up the inner, positive discourse referent, which results in a positive response interpretation for *yes* and a negative interpretation for *no*. R&F also predict *no* to be more frequently interpreted as a negative response, since it realizes the [−] feature of the [AGREE, −] response. However, they predict positive responses to the be the most marked, thereby requiring an overt following clause, so they predict that bare particles will more likely be interpreted as negative responses in general. This latter prediction does not fit with the effect we found here. Holmberg predicts bare *yes* should only be interpreted negatively, which is exactly the opposite of the main effect of PARTICLE in our experiment.

Suppose Krifka's theory is right, participants are driven by *NONSAL to interpret polar particles as picking up the inner antecedent. But now we have a question: if the positive

antecedent is preferred, why is *yes* with declarative intonation only interpreted as positive in under 50% of observations? It should be interpreted positively much more of the time. This can be explained if there is a preference to use the CC whenever possible. Failing to use the CC in a context where there is negative evidence (such as in response to negative PQs) then licenses the inference that the speaker must agree with the negative evidence. The absence of the CC is a cue in favor of the outer, negative antecedent.[30]

There is an aspect of Kramer & Rawlins's (2012) results to their truth value judgment task, discussed above in section 1 that diverge from ours. They found that when trying to convey a positive response (*I am*), bare *yes* is mostly judged false, while *no* is judged more ambivalently. In our experiment, *yes* was more likely than *no* to be interpreted as conveying a positive response. The discrepancy might be due to the fact that Kramer & Rawlins did not control for intonation. Our participants were more likely to produce the CC on *no* than on *yes* (production experiment 1), and bare particles carrying the CC are more likely to be interpreted as positive (perception experiment). It is plausible then that Kramer & Rawlins's participants imagined more *no* responses with the CC when silently reading the dialogues, leading to more positive interpretations, while *yes* was imagined with more Dec intonation. This would lead to more negative interpretations of *yes* than *no*, and therefore more judgments of falsity when the particle was meant to convey a positive response in K&R's experiment. We note that the possibility of such issues is a good argument in favor of controlling for intonation when asking participants for judgments about bare particle responses.

Before moving on, we would like to note that the interpretation patterns found here differ in a substantive way from the naturalness ratings found in the production experiments. The latter were best predicted by the theory of Roelofsen & Farkas (2015), especially the fact that *yes* and *no* were rated equally natural when conveying a positive response. On the other hand, as just argued above, the main effect of PARTICLE in the perception experiment

[30]It could be that this inference by the listeners is an artifact of our experiment, since utterances with and without the CC were juxtaposed across trials—in a more natural situation, this effect might be smaller.

is best predicted by the theory of Krifka (2013b). This difference in results will be discussed further in section 7.

6 Reading Experiment

Recall question 3 from section 4: "If the negative sentence that the polar particle responds to is itself responding to a negative sentence, are preference patterns affected, and in particular is *yes* now more acceptably interpreted as a negative response?"

Meijer et al. (2015) attempt to answer this question for German, and they note that Krifka (2013b) and Roelofsen & Farkas (2015, R&F) make different predictions with respect to these questions. As discussed above in section 4.2.1, Krifka argues that negative sentences are usually uttered in a context in which the positive discourse referent is already salient, thus making the positive TP discourse referent more salient to anaphora. However, the relative salience of discourse referents introduced by negative sentences can be flipped according to Krifka, in an all negative context like (42).

(42) [From Krifka (2013b), ex. (54)]
A: Which of the mountains on this list did Reinhold Messner not climb?
B: Well, let's see... He did not climb Mount Cotopaxi in Ecuador.
C: Yes. / No.

According to Krifka, *yes* is most naturally interpreted as meaning "he didn't climb it," since *yes* picks up the more salient negative discourse referent. *No* is also predicted to be most naturally interpreted as meaning "he didn't climb it," since, even though this would require picking up the less salient positive discourse referent, *DisAgr is more highly ranked than *NonSal when responding to an assertion (see the OT tableau in Figure 4). Finally *yes* is predicted to be preferred over *no* when indicating a negative response, since *DisAgr plays no role when the response agrees, and *yes* picks up the more salient discourse referent. This all holds for German *ja* and *nein* as well, with the difference that *doch* is preferred for

indicating a positive response to a negative sentence.

On the other hand, neither R&F nor Holmberg predict shifts in context to have any effect on preference patterns in polar particle responses.

Meijer et al.'s (2015) results do not favor either theory. They found that *ja* was preferred over *nein* when indicating a negative, affirming response, which runs counter to R&F's predictions.[31] This preference held regardless of whether the context WH-question was positive or negative, counter to Krifka's predictions. While these results may likely be accounted for by an existing account via some auxiliary assumptions, it remains to be seen how.

We wondered whether these results would be the same in English. The goal of this experiment was to see if using our stimuli in Meijer et al.'s (2015) paradigm would change participant naturalness ratings, either in the way predicted by Krifka, or to be more like the results of Meijer et al. for German.

6.1 Methods

This experiment has three two-level factors, $2 \times 2 \times 2$. Two are identical to the first set of production experiments, the PARTICLE used (*yes* vs. *no*), and the polarity of the ANSWER (positive vs. negative). In all conditions, these responses are made to a negative declarative antecedent. The third factor was manipulating the polarity of the CONTEXT sentence preceding the antecedent. The goal was to stay as similar to our original stimuli as possible while mirroring the experimental paradigm of Meijer et al. (2015). This is why we used declaratives rather than polar questions. Participants were asked to rate the naturalness of the responses, and they were asked a follow up verification question. Here is an example stimulus.

[31] In fact, they found two groups, one preferring *ja* for negative agreements, and one preferring *nein*. This result is interesting but not crucial to our purpose here.

(43) **Setup**: You and your coworker Harley are closing down the restaurant for the night. Harley is trying to determine ...
Positive context: ...which tasks have been done already.
Negative context: ...which tasks haven't been done yet.
Antecedent: You didn't take the trash out.
Positive, disagreeing response: Yes/No, I took the trash out.
Negative, agreeing response: Yes/No, I didn't take the trash out.

The participants were 12 North American English speakers (mostly McGill undergraduates), making for 768 observations total. The trials were pseudo-randomized so that participants never saw the same condition twice in a row, and trials from the same item were organized into different blocks to maximize their distance.

6.2 Results and Discussion

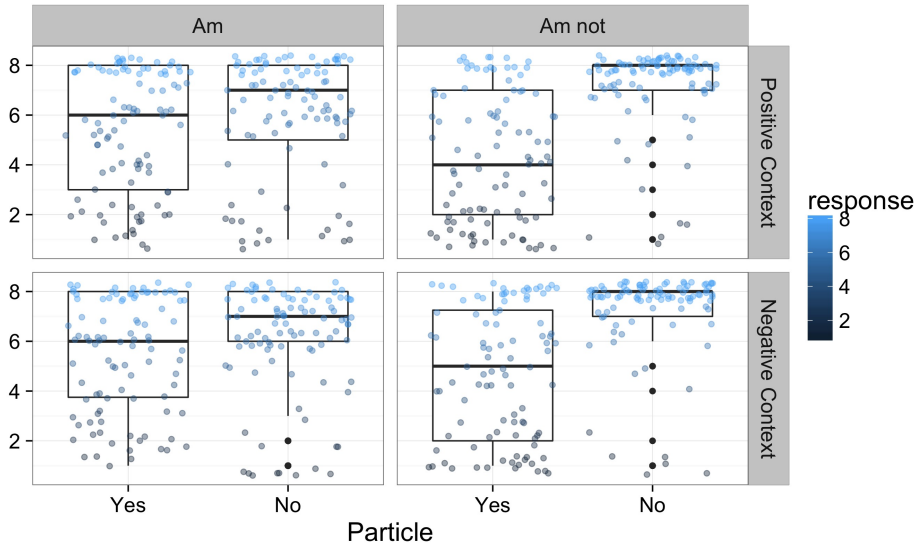

Figure 7: Naturalness ratings by three factors: PARTICLE (*yes* vs. *no*), ANSWER (*I am* vs. *I am not*), and CONTEXT (whether the sentence preceding the sentence that *yes* and *no* respond to was positive or negative).

From Figure 7, we expect there to be an interaction between PARTICLE and ANSWER as we saw in the production experiments in section 4. It appears as if the polarity of the context preceding the antecedent is unlikely to have any effect, except perhaps on *yes, I'm*

not responses, which appear to be rated slightly more natural in negative contexts (median 5 in negative contexts to median 4 in positive contexts). If this result is significant, it would lend support to Krifka's hypothesis that preceding context polarity modulates naturalness ratings. The null hypothesis is that the preceding context has no effect.

We fitted a cumulative link mixed model regression with all three factors and all possible interactions, with random intercepts and slopes for participant and item (see Table 6). We found a significant main effect of PARTICLE, as well as a significant interaction between PARTICLE and ANSWER, as expected and like in the other production experiments. We did not find a significant three way interaction (p>0.67), nor were any other factors significant. A likelihood ratio test revealed no difference between this model and one with only PARTICLE, ANSWER and their interaction (p>0.46).

	Reading
ParticleYes.vs.No	−1.51 (0.43)***
AnswerAm.vs.AmNot	−0.36 (0.35)
ContextNegative.vs.Positive	−0.21 (0.14)
ParticleYes.vs.No:AnswerAm.vs.AmNot	2.59 (0.30)***
ParticleYes.vs.No:ContextNegative.vs.Positive	0.06 (0.28)
AnswerAm.vs.AmNot:ContextNegative.vs.Positive	0.37 (0.28)
ParticleYes.vs.No:AnswerAm.vs.AmNot:ContextNegative.vs.Positive	−0.26 (0.56)

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 6: Cumulative link mixed effects model looking at three factors affecting whether readers found the responses natural given the context: Which particle was used, what the intended reading was, and whether the context preceding the antecedent was positive or negative.

Therefore, we fail to reject the null hypothesis. *No, I'm not* responses are rated more natural than their *yes* counterparts regardless of context, which is predicted by Roelofsen & Farkas's account. However, we note that, according to Meijer et al.'s (2015) results, context polarity had no effect on naturalness in German either, yet the result did not clearly fit with R&F's predictions. Therefore, when taking our results together with Meijer et al.'s, the results of both experiments demonstrate that controlling for the polarity of a preceding context sentence has no effect on preference patterns in either English or German, at least

not in this experimental paradigm.

Thus, it seems that the answer to question 3, "If the negative sentence that the polar particle responds to is itself responding to a negative sentence, are preference patterns affected, and in particular is *yes* now more acceptably interpreted as a negative response?" is no. Naturalness ratings of particle responses appear to be insensitive to systematic manipulation of the polarity of context sentences, as predicted by Roelofsen & Farkas (2015).

Nevertheless, we think there is some merit to the intuition that in a context like (42), *yes* more naturally indicates a negative, agreeing response, whether as a bare particle or with a following overt sentence. We point out that we only fail to reject the null hypothesis here, and that it is possible that the experiment is underpowered. In future work, we would like to see other experimental designs used to test whether context can affect preference patterns. If, after further testing, *yes*-negative responses remain dispreferred regardless of context, then it seems likely that a context-insensitive theory like R&F's is on the right track.

7 Concluding discussion and future directions

In section 4, we posed three groups of research questions, reprinted below.

1. Does a special intonation appear on positive *yes*/*no* responses to negative PQs? If so, can it affect the interpretation of bare particles?

2. When responding to a negative sentence, which particles do speakers prefer to use when giving a response with negative polarity? With positive polarity? How are bare polar particle responses to negative sentences interpreted?

3. If the negative sentence that the polar particle responds to is itself responding to a negative sentence, are preference patterns affected, and in particular is *yes* now more acceptably interpreted as a negative response?

As discussed in the introduction, various researchers working on polar particle responses

have shared the intuition that a special intonation may appear in positive responses to negative utterances, and that this intonation may have an effect on the interpretation of polar particles. However there has been disagreement over the form that the intonation takes, and no quantitative data has been presented in support of any particular claim. The main finding of our work is that there is indeed a particular intonation that is produced in positive responses to negative utterances, and that intonation is a fall rise that we identify as the contradiction contour (Liberman & Sag, 1974). The CC is the only intonation we found that is systematically produced in positive responses that disagree with the negative bias of negative PQs, while not appearing in negative, agreeing responses.

The results of our perception experiment demonstrate that this intonation has a strong effect on how hearers interpret bare polar particle responses to negative utterances: participants are much more likely to interpret a bare *yes* or *no* as indicating a positive response when it bears the CC than when it bears falling intonation. Building off of Liberman & Sag, we have argued that the CC, when used on an assertion of p, conveys that there is contextual evidence for $\neg p$. This hypothesis accounts for why it is used almost exclusively on positive responses, given that our contexts made evidence in favor of the negated proposition very salient. Prior to viewing the results of this experiment, it would have been hard to guess how sensitive to intonation naïve participants are. Perhaps the most surprising result of this work is that hearers' interpretations of bare *yes*/*no* responses appear to be strongly influenced by the intonation appearing on these monosyllables. We believe this result suggests that intonation plays a prominent role in the interpretation of any utterance, and that models of natural language meaning should take intonation into account. Moreover, it shows that when the researcher probes intuitions about the interpretation of strings (whether from the armchair or in an experimental setting), that she or he ought to bear the possible effect of intonational differences in mind, i.e. one should control for intonation.

Regarding question 2, one clear finding from the naturalness ratings, again replicating a finding from Brasoveanu et al. (2013), is that *no* is more acceptable than *yes* when giving a

negative, agreeing response to a negative sentence. Both Roelofsen & Farkas's (2015) and Krifka's (2013b) theories account for this preference, as discussed above, while Holmberg's (2016) does not.

Besides this result, the production naturalness ratings and the perception results clearly bear on question 2 in other ways, however determining exactly how the results bear on previous theoretical claims about preference patterns is complex. There are two reasons for this. First, the discussion of preference patterns from the literature does not distinguish between preferences regarding the *use* of polar particles from preferences regarding the *interpretation* of bare particle responses. Second, the data on preferences provided by our experiments come in two different forms: (i) naturalness ratings by the producers of polar particles with complete, overt following sentences,[32] and (ii) forced choice interpretations of bare particle responses in a perception experiment. The results in form (i) and form (ii) do not perfectly align with one another, and could be argued to support the predictions of two different theories.

The results in form (i) reveal that participants find producing *no* followed by a positive sentence and *yes* followed by a positive sentence to be equally acceptable. This holds true both when the particles are followed by overt sentences in experiments 1 and 2, and when they were bare in experiment 3. This result runs counter to Krifka's (2013b) theory, which clearly predicts that positive *no* responses should be less natural than positive *yes* responses, regardless of previous context (see the OT tableau in Figure 4). Roelofsen & Farkas (2015), on the other hand, predict that both *yes* and *no* should be equally acceptable when indicating positive responses, which is what we found in the naturalness ratings of the production study.

The results in form (ii) reveal that participants are more likely to interpret bare *no* as conveying a negative response than bare *yes*, regardless of the intonation used on the bare particle. While the result from the preceding paragraph contradicted the predictions of Krifka (2013b), those very same predictions are confirmed by this result. Since positive *no*

[32]With the exception of experiment 3, which provided naturalness ratings of bare particle responses.

responses are predicted to be less natural, it makes sense that we would find that bare *no* responses are more likely to be interpreted as negative than bare *yes* responses (again, see the predictions in Figure 4). Roelofsen & Farkas's (2015) theory predicts both bare *yes* and bare *no* to be more likely interpreted as negative. In order to be interpreted as positive, R&F claim that they need to be followed by an overt clause like *he DID*. The idea that this overt clause is obligatory in such positive, disagreeing responses and that therefore negative interpretations of both bare *yes* and bare *no* are more likely, is incompatible with the finding that bare *yes* is more likely to be interpreted as positive. Finally, Holmberg's (2016) theory also has trouble explaining this result, since it makes the strong prediction that bare *yes* in English cannot be interpreted as a positive response to a negative utterance, but instead must be followed by an overt positive clause.

Therefore, the results for question 2 and how they bear on existing theories of polar particles are somewhat mixed. It may be that more testing using various experimental paradigms are needed. For example, perhaps if we had allowed participants the freedom to give responses in their own words, along the lines of the completion task described in González-Fuente et al. (2015), then perhaps the production and perception results would have been more similar. A drawback to this approach is that the experimenter cannot control whether the participant will even use a polar particle at all.

Another possibility is that a more nuanced theory of polar particle preference patterns is needed. There may be two or even three distinct dimensions along which particle responses vary that each affect speaker/hearer preferences, and that therefore should not be conflated in theoretical explanation: (i) whether the particle is being used to give a positive or negative response, (ii) whether that response agrees or disagrees with an interlocutor's position, and (iii) whether the particle response is bare or not. Obviously these issues may turn out to be linked, as is already argued by existing theories, however our experimental results suggest nuances that are not yet explained.

Another possibility is that theorists may propose theories that only apply to production

and not perception or vice versa. In that case, auxiliary assumptions would need to be made about how interpretation works.

Regarding question 3, the experimental results from section 6 reveal that, so far, no experimental paradigm has successfully demonstrated that manipulating the polarity of preceding context sentences affects the result that negative *yes* responses are dispreferred. This result contradicts the predictions of Krifka (2013b), and supports those of any theory that predicts preference patterns to be context insensitive, such as Roelofsen & Farkas (2015) and Holmberg (2016). We note that the same experimental paradigm manipulating context sentences failed to have an effect on German preference patterns (see Meijer et al., 2015), but in that case the result went against the predictions of both Krifka (2013b) and Roelofsen & Farkas (2015). We make the tentative conclusion that context has no effect on preference patterns. More testing may be needed to definitively settle this question.

Our experiments have several limitations. For one, we only used contexts which convey negative contextual evidence. We did not vary evidence in order to keep the complexity of the experiments under control. As noted in footnote 22, there are theoretical questions about whether it is even felicitous to use a positive PQ in the presence of negative contextual evidence. We believe our experimental contexts do license the use of both positive and negative PQs, but this raises the question of why. Is it because theories that predict this to be impossible are wrong, or is it because our contexts were complex enough that they could be taken to have both positive and negative evidence? If it is the latter, then why was the CC only produced on positive responses, regardless of whether the PQ was positive or negative? If evidence can be manipulated between purely negative and purely positive in a production experiment, we predict it to have an effect on the distribution of the CC, with CC appearing on negative responses in the presence of positive evidence and on positive responses in the presence of negative evidence.

Another limitation is that the perception experiment only tested CC against falling intonation. We noted that rise fall intonation was distributed relatively evenly across conditions

in the production experiment. However it may nevertheless be interesting to run a perception experiment with rise fall intonation on the polar particles to see how it affects interpretation.

Moreover, there are clear next steps to be taken in this line of work. In particular, which intonations are produced in response to other kinds of sentences such as falling declaratives, positive rising declaratives, high negation questions, tag questions? In the introduction, we said we focussed only on responses to PQs and rising declaratives to simplify the number of experimental conditions and discussion, as well as to expand on the work of Brasoveanu et al. (2013), which focussed on responses to falling declaratives. Therefore, it remains to be seen how using falling declaratives might affect intonation and naturalness ratings in our experimental paradigms. Likewise, positive rising declaratives would be interesting to test, as they are usually thought to require evidence for the positive response (Gunlogson, 2001; Nilsenovà, 2006). Thus we might expect the CC to appear in negative responses to these questions. However, there is always possibility that the very question itself, even if phrased as a positive rising declarative, suggests some doubt on the part of the speaker, i.e. an expectation that $\neg p$. Thus it may be possible that, depending on context manipulations, the CC could appear in positive responses as well as negative responses to such utterances.

To conclude, we have provided experimental evidence demonstrating that a particular intonation, the contradiction contour, is used primarily in positive, disagreeing polar particle responses to negative polar questions and rising declaratives, and that this tune has a large impact on the interpretation of bare particle responses to negative polar questions. This suggests that when trying to determine the preferred interpretation of bare particles, intonation should be taken into account.

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