English reverse prosody in yes-no responses

Daniel Goodhue
Linguistics Department
McGill University
Montréal, Québec, CANADA
daniel.goodhue@mail.mcgill.ca

James Pickett
Department of Linguistics and English Language
The University of Manchester
Manchester, UK
jamesmtpickett@gmail.com

Michael Wagner
Linguistics Department
McGill University
Montréal, Québec, CANADA
chael@mcgill.ca

Abstract

In English, polar particles *yes* and *no* are ambiguous when used to respond to negative declaratives and interrogatives. This paper reports on a production experiment that elicited the intonation contours speakers use when responding to negative declaratives. We found that speakers most frequently use the Contradiction Contour when reversing, and they use declarative intonation when confirming, regardless of the particular polar particle used. Therefore prosody could disambiguate what is an otherwise ambiguous move in a dialogue.

1 Introduction

English polar particles *yes/yeah* and *no* are ambiguous when responding to negative declaratives/interrogatives, whereas these polar particles are unambiguous when responding to positive declaratives/interrogatives. (Cf. Cooper and Ginzburg, 2011a; Farkas and Roelofsen, 2013; Holmberg, 2012; Kramer and Rawlins, 2009; Krifka, 2013)

(1) A: Matt called
A: Did Matt call?
A: Matt called?
a. B: Yes/Yeah, Matt called
b. B: No, Matt did not call
c. B: # Yes/Yeah, Matt did not call
d. B: # No, Matt called

(1) shows possible responses to positive declaratives and interrogatives as reported in the literature. *Yes/yeah* and *no* can be uttered with or without the following sentences in (1-a) and (1-b) respectively. That the polar particles are unambiguous is reflected by the infelicity of (1-c) and (1-d), as opposed to the following paradigm in (2) where all responses are felicitous.[1]

(2) A: Matt didn't call
A: Did Matt not call?
A: Matt didn't call?
a. B: Yes/Yeah, Matt called
b. B: No, Matt called
c. B: Yes/Yeah, Matt did not call
d. B: No, Matt did not call

(2) shows possible responses to negative declaratives and interrogatives. The responses from (2-a) through (2-d) are all acceptable (but see below). Therefore, if a person says only *yeah* or *no* in response to (2), it is ambiguous whether that person means that Matt called or that he did not.

This paper reports a production experiment that we believe makes contributions to three questions about (2) that have remained somewhat controversial in the literature: **1)** Do the particles and the sentences in the responses in (2) bear particular intonational contours, if so which, and on which responses? **2)** Are some responses in (2) more natural than others? **3)** Are polar particle responses infelicitous if they are not accompanied by sentences or sentence fragments, like those in (2)?

[1] However, responses like (1-d) may be acceptable in particular contexts where speaker A questions some presupposition that is so obviously true that it makes the negative answer salient/produces a negative bias. Then speaker B may be licensed to say "No" followed by a positive sentence. Experimental testing may be required to establish this. E.g.:

(i) A: Guess what? I won tickets to see Justin Bieber.
B: [does not react]
A: Do you know who Justin Bieber is?
B: No, I know who Justin Bieber is. I just don't care.

Regarding **1)**, Cooper and Ginzburg (2011a) report that to the extent that *no* is ambiguous in contexts like (2), the reverse meaning in (2-b) will bear a distinct rise fall tune, whereas the confirm meaning in (2-d) is most naturally associated with a fall. Farkas and Roelofsen (2013) claim that responses similar to (2-a) and (2-b) except that they contain sentence fragments (e.g. *Yes/No, he did*) must bear stress on the auxiliary verb, *did*. Alternatively, they claim that speakers can use what they call "Smart Aleck" intonation which rises on the particle and falls on the auxiliary. Krifka (2013) claims that responses like (2-a) and (2-b) require a rejecting accent when responding to a negative assertion, though he doesn't describe what the accent is. These accounts do not offer experimental evidence for the intonations they discuss. The experiment reported here contributes new information regarding question **1)** by showing that the responses in (2-a) and (2-b), which reverse the preceding utterance by having opposite polarity from it, most frequently bear the Contradiction Contour (Liberman and Sag, 1974) on either the polar particle, the following sentence or both. Prior literature has not discussed the use of the Contradiction Contour in contexts like (2). We also found that confirming responses such as (2-c) and (2-d) almost always bear declarative falling intonation on either the polar particle, the following sentence or both.

Regarding **2)**, Krifka (2013) uses an optimality theoretic framework to argue that the preference of responses to (2) are ranked in the following order from most to least acceptable: (2-d), (2-c), (2-a), (2-b).[2] Our experiment provides a different answer to **2)** in the form of naturalness judgments given by participants that reveal that all responses in (2) are judged natural with the exception of (2-c) which is somewhat degraded.[3] [4]

Regarding **3)**, both Farkas and Roelofsen (2013) and Krifka (2013) claim that reverse responses like (2-a) and (2-b) must occur with following sentences. We do not answer question **3)** here, though the asymmetry of intonational contours we found on the polar particles suggests that speakers may be able to distinguish the meanings of the responses in (2) in the absence of following sentences on the basis of intonation. Future experimentation is required to establish this.

In section 2, we will briefly discuss Krifka's (2013, to appear) theories of polar particles and reversing moves in conversations. Then we will characterize the Contradiction Contour phonologically and semantically, and discuss its relation to Krifka's account. In section 3, the methods of the experiment are described. In section 4, the experimental results are discussed. In 5, we conclude and discuss future directions.

2 REJECT and the Contradiction Contour

In this section we will briefly describe Krifka's (2013) theory of polar particles and how it is linked to the REJECT operator, which Krifka (to appear) claims is sometimes encoded by English "protest prosody". Then we will describe the Contradiction Contour phonologically and semantically, and discuss it's connection to REJECT.

Krifka (2013) analyzes polar particles as anaphoric expressions that refer to some antecedent in the discourse. He compares them to other propositional anaphora like *that*.

(3) A: Two plus two isn't five
[$_{\text{NegP-}\phi}$ NEG [$_{\text{TP-}\psi}$ 2+2 is 5]]
a. B: Everyone knows *that* (i.e. ϕ)
b. B: *That* (i.e. ψ) would be a contradiction

Propositional anaphora find two possible antecedent discourse referents in negative phrases, like (3). One propositional discourse referent, ϕ, is made available by the NegP, and another, ψ, is produced by the TP. *That* can refer to either proposition, as seen in (3-a) and (3-b).

Krifka proposes that *yes* picks up a salient propositional discourse referent and asserts it. *No* picks up a salient discourse referent and negates it.

(4) A: [$_{\text{TP-}\psi}$ Maxine arrived on time]
A: [$_{\text{CP}}$ Did [$_{\text{TP-}\psi}$ Maxine arrive on time]]
a. B: Yes = ASSERT(ψ)
b. B: No = ASSERT($\neg\psi$)

[2] Krifka notes that this ranking is context dependent.

[3] Brasoveanu et al. (2011) found that speakers prefer (2-d) over (2-c) when the subject of the sentence is a referential NP (e.g. *Matt/he*). When the subject is shifted to an upward monotone quantifier (e.g. *some X*), the preference disappears, and the preference flips if the subject is a downward monotone or non-monotone quantifier (e.g. *at most X* or *exactly X* respectively). Only referential NPs were used in our experiment.

[4] Cf. Cooper and Ginzburg (2011b) who report a corpus study that shows that positive polar interrogatives are more likely to elicit a positive response whereas negative polar interrogatives are more likely to elicit a negative response.

In (4), we see that positive assertions and interrogatives only make one propositional discourse referent available as an antecedent, ψ. Therefore, *yes* can only assert ψ and *no* can only negate it, which captures the data in (1) above.

In (3), A's negative statement produced two discourse referents. The same happens in (5):

(5) A: [$_{\text{NegP-}\phi}$ NEG [$_{\text{TP-}\psi}$ Maxine arrived on time]]
A: [$_{\text{CP}}$ Did [$_{\text{NegP-}\phi}$ NEG [$_{\text{TP-}\psi}$ Maxine arrive on time]]]

a. B: Yes = ASSERT(ψ)
b. B: Yes = ASSERT(ϕ)
c. B: No = ASSERT($\neg\psi \approx \phi$)
d. B: No = ASSERT($\neg\phi \approx \psi$)

In (5), A utters a negative declarative *Maxine didn't arrive on time*, or a negative interrogative *Did Maxine not arrive on time?*. Each utterance makes two propositional discourse referents available: ϕ is produced by NegP, ψ is produced by TP. In (5-a), *yes* picks up ψ and asserts it, while in (5-b), *yes* picks up ϕ and asserts it. In (5-c), *no* picks up ψ and negates it (which approximates ϕ), while in (5-d), *no* picks up ϕ and negates it (which approximates $\neg\neg\psi$, which in turn approximates ψ).[5] Therefore, Krifka's account captures the ambiguity seen in (2).

Krifka's (to appear) theory of conversation states that speakers attempt to add a proposition to the common ground when they utter any kind of declarative, including rising declaratives (e.g. *Dave called*, *Dave called?*, *Dave didn't call*, and *Dave didn't call?*) and negative interrogatives (e.g. *Did Dave not call?*). If an interlocutor wants to deny the addition of one of these propositions to the common ground (e.g. by uttering *no* or *I don't believe that*), a REJECT operator is required to remove the first proposition from the common ground. Otherwise both the initial proposition and the denial of that proposition would be in the common ground, creating an inconsistent context set. Although REJECT is obviously not encoded by a single expression, it is encoded lexically in polar particles of some languages (e.g. *si* in French and *doch* in German). When denying or reversing negative declaratives and interrogatives in English, Krifka claims REJECT is encoded as "protest prosody". Therefore, Krifka's theory predicts protest prosody to appear in responses like (5-a) and (5-d) where B's response contradicts A's initial utterance.

As mentioned above, Krifka (2013, to appear) does not further characterize the protest prosody/rejecting accent of English. The goal of this paper is to characterize the prosodic intonation English speakers use when reversing and when confirming preceding questions, more particularly uninverted negative questions with a final rise ('rising declaratives'). We found that English speakers frequently use the Contradiction Contour (CC) on the polar particle and/or the following sentence when uttering a positive proposition that reverses the negative proposition of the preceding utterance. Moreover, speakers rarely use the CC when confirming the negative proposition of the prior utterance, and they judged such utterances unnatural.

The CC has been described by Liberman and Sag (1974) as an utterance wide contour that has an initial rise, with a fall across most of the utterance followed by an utterance final rise. Two separate instances of the CC can be found in figure 1 below: the first on "No", the second on "I'm a friend of Jenny's". The second utterance most clearly illustrates Liberman and Sag's description. They do not discuss what form the CC would take when it appears on a monosyllabic utterance such as "No". We found that in such cases the CC falls initially before meeting the utterance final rise (see the first pitch track in figure 1). This is perhaps unsurprising since, according to Ladd (1980), the CC places a low pitch accent on the nuclear stress of the utterance, with a high falling tone preceding the nucleus, which is what we see on "No". Liberman and Sag (1974) characterize the meaning of the CC as follows: "We find that 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." (pg 421)

From the observations of the CC's distribution in our experiment and the observations of Liberman and Sag, we argue that the CC is a prosodic contour that is felicitous on an utterance of the

[5] Cf. Cooper and Ginzburg (2011a) for a different approach that analyzes $\neg\neg\psi$ and ψ as truth-conditionally equivalent, but not identical, propositions. Krifka assumes a classical logic framework in which $\neg\neg\psi$ and ψ are equivalent.

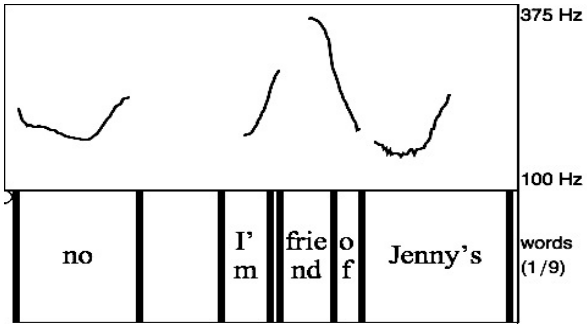

Figure 1: *F0 pitch track of the contradiction contour appearing twice: once on "No", and once on "I'm a friend of Jenny's".*

proposition ϕ if and only if the proposition $\neg\phi$ is salient in the context. This characterization of the CC is formalized in (6).

(6) $[\![\text{CC}]\!]^c = \lambda P_{\langle s,t\rangle}$: $\neg$P is salient in c. P

Notice that the negation could be swapped from one proposition to the other here. I.e. the CC can be uttered on a proposition $\neg\phi$ if ϕ is salient in the context. All that is needed to license the CC is a salient proposition that is incompatible with the CC proposition. An explanation of how one proposition is recognized to be the negation of another is beyond the scope of this paper.[6]

Our analysis of the CC is similar to Krifka's proposal in that there is a REJECT operator whose presence can be encoded by prosody. Our approach diverges from Krifka's, however, in at least one way: We attribute the meaning of the REJECT operator directly to the contour, and assume that in the absence of the contour there is no REJECT operator. Therefore the distribution of the CC-REJECT is similar, but not identical, to the distribution of Krifka's REJECT. For example, Krifka's REJECT operator is necessary for any denying move in a dialogue, whereas the CC appears to be optional, as Liberman and Sag (1974) already point out. Moreover the distribution of Krifka's REJECT is not as restricted as that of the CC in (6), as evidenced by the fact that his REJECT appears when disbelief in a proposition is expressed (without its negation being salient)—a move that does not license the CC. In section 4 below, we will show how our characterization of the CC accounts for the contour's distribution.

The goal of of our experiment is to capture which intonations English speakers use when responding to negative rising declaratives, and to obtain naturalness judgments about the responses participants were asked to produce. We expected that there would be an asymmetry between the intonations used in the Reverse conditions and those used in the Confirm conditions, a prediction shared to varying degrees by researchers who have studied English response particles, including Cooper and Ginzburg, Farkas and Roelofsen, Holmberg, Kramer and Rawlins, and Krifka.

3 Methods

The participants were 22 North American English speakers, mostly undergraduate students. There were six items, each comprised of six conditions, four test-conditions with negative rising declaratives and two additional conditions which we will not report on in this paper for reasons of space. 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.

Participants were presented with a context story on a computer screen. After they had read it, they pressed a key to hear a question through headphones. Then they pressed a key to start recording their response to the question. Participants were given a script to use for responding. Then participants were asked to judge the naturalness of the response on a scale from 1 to 5. Below are example contexts, questions and responses for a reverse response and a confirm response.

(7) Reverse context:
You are at home eating lunch. After several days of rain it's warm and sunny, and you are planning to go to the park after you finish eating. Your new roommate walks in and asks if you want to go to the movies with him this afternoon. You like movies and want to see a film thats currently at the theater, but not today because the weather is so nice you want to take advantage of it by being outside. When you tell him you'll pass, your new roommate asks:
Q: You don't like movies?
A: No ___ I like movies.

(8) Confirm context:

[6] Cf. Farkas and Roelofsen (2012) for an account in terms of complementary sets of possible worlds, and Cooper and Ginzburg (2011a,b) for an account in terms of Type Theory with Records.

You are at home eating lunch. After several days of warmth and sun a storm has moved in and it's raining. As you eat, you are trying to figure out what you will do with your afternoon. Your new roommate walks in and asks if you want to go to the movies with him. This would be a good solution except that you hate movies and prefer to spend your time reading or talking with friends. When you tell him you'll pass, your new roommate asks:
Q: You don't like movies?
A: No ___ I don't like movies.

Participants were instructed to treat the "___" in the responses as a pause between the polar particle and the following sentence. This was done to ensure that participants produced an intonation contour unique to the polar particle rather than producing a single contour across the entire utterance. Below the four conditions with negative questions in the context:.

(9) Experimental conditions
   a. **Question**: You don't like movies?
   b. **Yes-Reverse**: Yeah, I like movies.
   c. **No-Reverse**: No, I like movies.
   d. **Yes-Confirm**: Yeah, I don't like movies.
   e. **No-Confirm**: No, I don't like movies.

Each token was categorized for the intonation that appeared on the polar particle and again for the intonation that appeared on the following sentence. Intonations produced by participants were separated into four categories: the contradiction contour (CC) was described in section 2; declarative falling intonation (Declarative) has been identified by Pierrehumbert and Hirschberg (1990) as H* L L% in ToBI transcription; rise fall intonation (RiseFall), which is probably a variation of declarative intonation, and which rises to a high peak on the nuclear stress of the sentence and then falls. We excluded a small number of utterances which seemed to carry a different contour (such as the so-called rise-fall-rise contour) or which we couldn't easily classify along this scheme. Contra Liberman and Sag (1974), we consider the CC and the rise-fall-rise to be two (of at least four) distinct contours in English. We agree with Ladd (1980) that they can be distinguished in terms of the location of the rise (preceding the nucleus in the CC, on the nucleus in rise-fall-rise).

4 Results and discussion

In this section, we present the results of a production study that recorded English speakers' responses to negative rising declaratives. We show how the results can be explained by our characterization of the CC above in section 2. Finally we discuss participants' naturalness judgments of the responses they produced.

Figure 2 represents the amount that each intonational category was produced on the polar particles *yeah* and *no* in response to negative rising declaratives like *You don't like movies?*. The y axis shows the percent that each category was produced per condition. The x axis indicates which condition each bar refers to. The percentages for each category are stacked into a single bar for each condition. From bottom to top: the CC is dark grey, Declarative fall is medium grey, and RiseFall is in light grey.

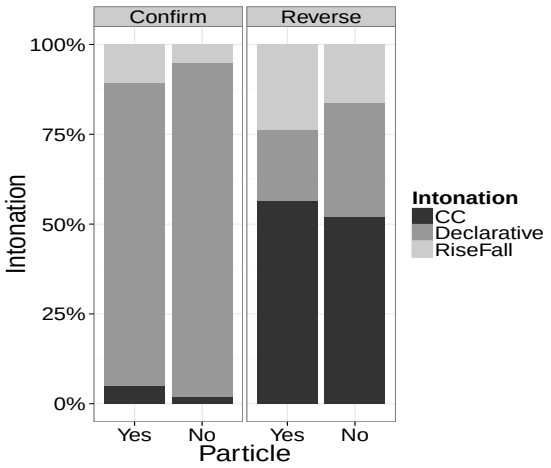

Figure 2: *Frequency of particle intonation per condition as a percentage*

Figure 2 and table 1 (below) show that the CC appears on 56% of *yeah* particles and 52% of *no* particles in the Reverse conditions, and that it appears on 5% and 2% of *yeah* and *no* particles respectively in the Confirm conditions. Given our characterization of the CC above in section 2, this is unsurprising. Under our analysis, the CC can appear on a proposition only if the negation of that proposition is salient in the context. The proper context for the CC is created in the Reverse conditions because the questioner made $\neg\phi$ salient (e.g. *You don't like movies?* = $\neg\phi$), so the participant

Table 1: Percent of intonation response on polar particle by condition.

Meaning	Particle	CC	Dec	RF
Confirm	Yes	5%	84%	11%
	No	2%	93%	5%
Reverse	Yes	56%	20%	24%
	No	52%	32%	16%

is licensed to utter ϕ with the CC (e.g. *Yeah/No, I like movies* = ϕ). Moreover, the proper context for the CC is not created in the Confirm conditions because the questioner and the participant utter the same proposition $\neg\phi$ (e.g. *The participant doesn't like movies* = $\neg\phi$).

Figure 2 and table 1 further reveal that the polar particles in the Confirm conditions bore declarative intonation 84% for *yeah* and 93% for *no*. In Reverse conditions, polar particles bore declarative intonation 20% for *yeah* and 32% for *no*, which shows that, although the CC is the most frequent contour when reversing, declarative intonation is still a licit contour when reversing. Finally, RiseFall intonation was produced 24% for *yeah* and 16% for *no*. Recall that RiseFall is a special instance of declarative intonation that contains a high peak.

We analyzed the data by coding a binary factor for whether or not the CC was used, and conducted a mixed model logistic regression with Particle ('yes' or 'no) and Reversal ('reverse', 'confirm') and their interaction as fixed factors, and participant and item as random effects that included slopes for the fixed factors and their interaction. We found a significant main effect of Reversal ($z = 6.4, p < 0.001$), and no main effect of Particle ($z = -0.57, p < 0.32$) and no interaction between Reversal and Particle ($z = -0.82, p < 0.47$). In other words, the choice between 'yes' and 'no' had no influence on the choice between the CC intonation and other options. We used a mixed model logistic regression analysis over alternatives such as ANOVA because ANOVA is inadequate in the analysis of proportions (Jaeger 2008), and mixed model logistic regression allows the researcher to control for item and participant random effects at the same time. For discussion on why other methods are problematic see Barr et al. (2013) and Baayen (2008).

Figure 3 represents the amount that each intonational category was produced on the sentences following the polar particles in response to negative rising declaratives like *You don't like movies?*.

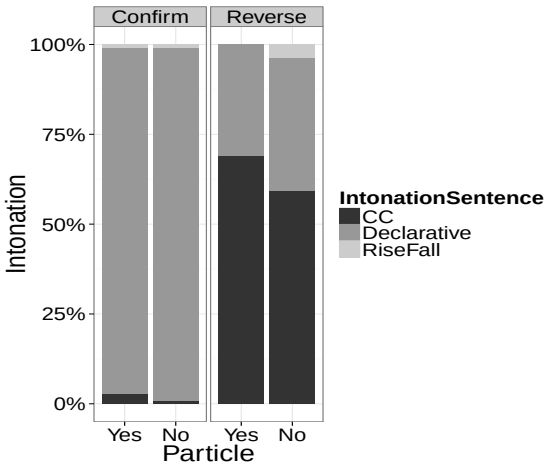

Figure 3: *Frequency of sentence intonation per condition as a percentage*

Table 2: Percent of intonation response on sentence by condition.

Meaning	Particle	CC	Dec	RF
Confirm	Yes	3%	96%	1%
	No	1%	98%	1%
Reverse	Yes	69%	31%	0%
	No	59%	37%	4%

Figure 3 and table 2 show that the CC appears in the Reverse conditions on 69% of the sentences following *yeah*, and on 59% of the sentences following *no*. The CC appeared in the Confirm conditions on 3% of sentences following *yeah*, and 1% of sentences following *no*. This is unsurprising for the same reasons that it was unsurprising for figure 2. However in figure 3 the CC accounts for an even greater proportion of the intonations in the Reverse conditions than in figure 2.

Figure 3 and table 2 reports also show that, in the Confirm conditions, declarative intonation was produced on 96% of sentences following *yeah* and 98% of sentences following *no*. In Reverse conditions, declarative intonation was produced on 31% of sentences following *yeah* and on 37% of sentences following *no*.

Again, we coded choice of CC in a binary factor and fitted the same type of mixed model for the choice of sentence contour. We found a significant

main effect of Reversal ($z = 2.3, p < 0.02$), and no main effect of Particle ($z = 0.23, p < 0.81$) and no interaction between Reversal and Particle ($z = -0.30, p < 0.77$). In other words, the choice between 'yes' and 'no' had no influence on the choice between the CC intonation and other options on the sentence.

So both on the particle and on the sentence, speakers were likely to use the CC in the reverse condition but not in the confirm condition. It is interesting to show the break down of how well the intonations on the two constituents correlated. Figure 4 shows which intonation participants produced on the following sentence dependent on whether they produced the CC on the preceding polar particle. The x axis represents whether or not participants used the CC on the polar particle. The y axis represents what percentage the participants produced the CC vs. non-CC on the following sentence.

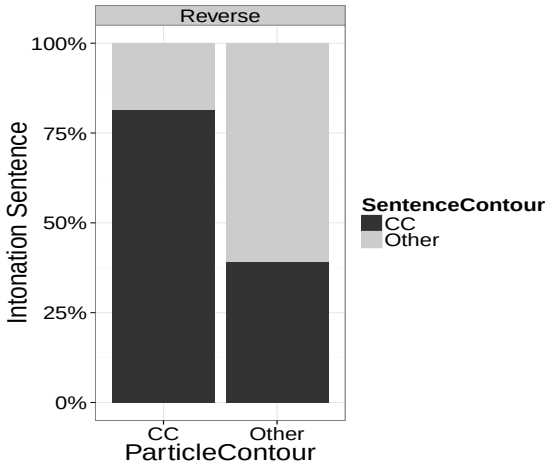

Figure 4: *Sentence intonation within particle intonation*

Of primary interest in figure 4 is what participants did when they produced a non-CC intonation on the polar particle in the reverse condition (the bar on the right): participants produced the CC on the sentence following a non-CC polar particle on 39% of utterances. This means that in over a third of reverse utterances that did not bear the CC on the polar particle in figure 2 above, the participant went on to produce the CC on the following sentence. Since the CC was used very rarely on the polar particle in the confirm condition, those data points are not represented in figure 4.

It seems reasonable to assume that a reversal is encoded in a response when the CC is placed on *either* constituent. Figure 5 shows the percentage of responses bearing the CC in the confirm and reverse condition. If the participant produced the CC either on the particle or the following sentence or both, we count the utterance as bearing the CC (dark grey); if it didn't bear the CC on the particle nor on the sentence, then that observation is counted No CC (light grey).

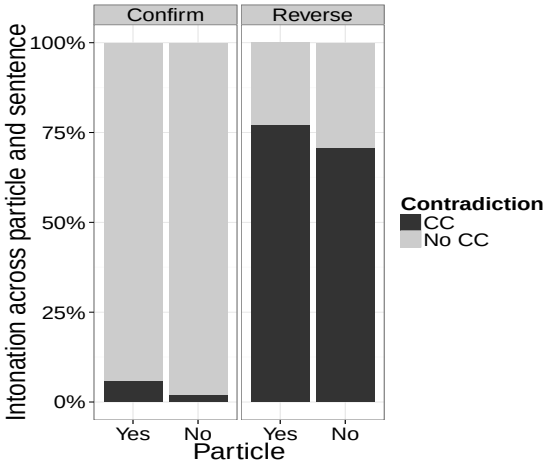

Figure 5: *Intonation across particle and sentence*

The CC appears at least once in 76.9% of responses in yes-reverse (third bar from left) and in 71.4% of responses in no-reverse (fourth bar from left). This means that participants produced the CC contour either on particle or sentence 74% of the time in the reverse condition. Moreover, participants only produced the CC 4% of the time in the confirm condition. Therefore not only is the presence of the CC strongly correlated with reversal of the salient negative proposition, but the absence of the CC is strongly correlated with confirmation of the negative proposition made salient by the question.

In section 1 above we posed the following question: **1)** Do the particles and the sentences in responses to negative utterances bear particular intonational contours, if so which, and on which responses? The answer suggested by the data in this section is that reverse responses (responses with opposite polarity from the negative declarative they respond to) bear the CC on the polar particle or the following sentence 74% of the time, but confirm responses (responses with the same polarity as the negative declarative they respond to) do so very rarely. We assume that the small

number of occurrences that we found might be inflated because overall the CC-conducive contexts were very frequent in the experiment and there may have been some persistence of intonational uses across trials.

4.1 Naturalness judgments

Figure 6 shows participants' judgments of the naturalness of the responses they were asked for. All conditions show a median naturalness rating of 4, except for *yeah* confirming responses, which received a median naturalness judgment of 3.

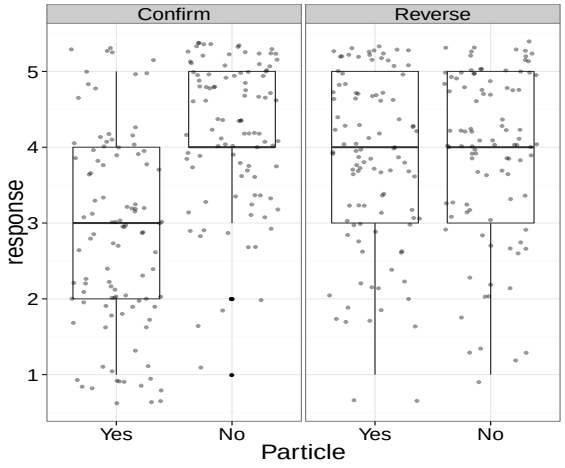

Figure 6: *Naturalness judgment on a scale of 1 to 5*

The results are interesting because they suggests that speakers don't have strong preferences for using *yeah* over *no* or vice versa when reversing negative declaratives, contrary to what is expected according to Krifka's (2013) optimality theoretic account of speaker preferences for certain responses over others discussed above in section 1. Moreover, *yeah* for confirming is judged somewhat degraded compared to the other responses while Krifka ranks this response as second most acceptable. In Farkas and Roelofsen 2013 the authors report that *yeah* in some dialects of English can only confirm a prior utterance (pg 23). Since our experiment used *yeah* to the exclusion of *yes*, one would then expect *yeah* as a reverse response to be judged unnatural and as a confirm response to be judged natural, contrary to our data. Perhaps the North American English speakers tested in Montreal, QC (a mix of Canadians and Americans) do not speak the relevant dialect. These naturalness data then start to reveal an answer to question **2)** posed in section 1: Are some responses to negative utterances more natural than others? The answer suggested by our data is, they are all fairly natural, although *Yeah, I don't like movies* slightly less so.

5 Conclusion

This paper reported on a production experiment investigating the prosodic tunes English speakers produce when responding to negative questions. The experiment showed that in lab contexts, when the response reverses the negative bias of the question, speakers produce the Contradiction Contour (CC) 74% of the time, so it is by far the preferred sentence contour in this context. When the response confirms the negative bias of the question, speakers produce the CC a negligible amount, but instead overwhelmingly produce declarative intonation. Gaining an understanding about when particular contour is preferred/dispreferred is an important step in figuring out what its semantic and pragmatic content is (For a similar attempt at characterizing the contexts in which speakers produce/avoid the rise-fall-rise contour see Wagner et al., 2013). The particular polar particle produced in the response (e.g. *yeah* vs. *no*) had no effect on the intonation observed.

In section 1 above, we identified three questions of interest regarding the ambiguity of polar particles *yes* and *no* when responding to negative declaratives and interrogatives. Here we restate each question and the contribution made by this paper: **1)** Do the particles and the sentences in the responses to negative declaratives and interrogatives bear particular intonational contours, if so which, and on which responses? The answer suggested by the data is that 74% of reverse responses bear the CC, and confirm responses almost always bear declarative intonation. **2)** Are some responses to negative declaratives and interrogatives more natural than others? The answer suggested by the data is all possible responses are judged equally natural (median 4 out of 5) with the exception of yes confirming responses (e.g. *yeah, I don't like movies*), which are judged slightly less natural (median 3 out of 5). **3)** Must polar particles be accompanied by sentences or sentence fragments for the responses to be acceptable? The present experiment does not answer this question, but suggests a future avenue of research: since polar particles in reverse responses usually bear the CC, and in confirm responses they almost always

bear declarative intonation, it may be that speakers can distinguish the meaning of polar particles in response to negative declaratives and interrogatives on the basis of prosodic intonation. A perception study is required to test this.

We proposed a semantic characterization for the CC based on the distribution of the contour and on informal descriptions from Liberman and Sag (1974). The CC is modeled as a partial identity function that takes a proposition as an argument, and imposes the presupposition that the negation of that proposition is salient in the context. Future research will determine whether this characterization of the CC accurately captures the facts.

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