On the prosody of French ambiguous multiple negative sentences.

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Abstract

While it has long been assumed that prosody can help resolve syntactic and semantic ambiguities, empirical evidence has shown that the mapping between prosody and meaning is complex (Hirschberg & Avesani, 2000; Jackendoff, 1972). This paper investigates the prosody of ambiguous French sentences with multiple potentially negative terms that allow two semantically very distinct interpretations—a single negation reading involving negative concord (NC), and a double negative reading (DN) with a positive meaning reflecting a strictly compositional interpretation—with the goal to further research on the role of prosody in ambiguities by examining whether intonation can be recruited by speakers to signal distinct interpretations of these sentences to hearers. Twenty native speakers produced transitive sentences with potentially negative terms embedded in contexts designed to elicit single-negation or double-negation readings. Analysis regarding the F0 and the duration of the utterances revealed distinct prosodic profiles for the two readings, confirming previous evidence that speakers can produce characteristic acoustic cues to signal intended distinctive meanings (Kraljic & Brennan, 2005; Syrett, Simon, & Nisula, 2014). Our results reveal that NC readings feature a focused subject and a post-focal compressed object, in contrast to DN readings where both the subject and the object were independently focused. They do not relate DN to contradiction but link negative meaning with focus on French negative concord items (NCI). The paper discusses broad implications of these findings for theoretical approaches to NC and outlines further questions for the syntax-prosody interface of these constructions.

Contents

1. Introduction

Sentences in French like (1) that contain multiple potentially negative terms such as *personne* or *rien* (here dubbed NCI for negative concord items (Watanabe 2004)) allow for two distinct readings: the first, interpreted as in (1a), features a single semantic negation and is commonly assumed to be the most accessible one for native speakers. It is known in the literature as the negative concord (henceforth NC) reading. The second, paraphrasable as (1b), known as the double negation (henceforth DN) reading, features two semantic negations that cancel each other to a logically positive statement[1].

Cross-linguistically, DN readings are generally considered to be marked, infrequent and hard to process, but in French, they are quite accessible to speakers, despite the language being commonly classified as a negative concord one (Corblin, 1995; Déprez, 1997; 2000; de Swart & Sag, 2002; de Swart, 2009; Corblin & Tovena, 2001; 2003). This paper confirms and explores this ambiguity, centrally focusing on the characterization of the prosody of the two interpretations to determine whether they have distinctive features, what these are, and how they can inform theoretical models of these dependencies. We explore these questions experimentally in an elicited production study.

(1) Personne n'aime personne ici

a. Concord: Nobody loves anybody here

b. Double negative: Nobody loves nobody here

∴ Everybody loves someone

With their opposite meanings generated from identical strings, flips between NC and DN readings in (1) offer a linguistic counterpart of the visual ambiguity of the Necker cube, where two opposite geometric perceptions arise from a single visual source to reveal the computational complexity of our visual system. These multiple negative constructions implicate complex interactions between the morpho-syntax, semantics, and pragmatics of NCIs and challenge our understanding of the role of prosody in this computation. Here our experimental work investigates whether speakers can produce robust, identifiable phonetic cues and distinctive prosodic profiles that could reliably help distinguish these readings and illuminate the interactions that their computation involves.

[1] As Horn (1989; 1991) insightfully discussed, the resulting positive statement is not equivalent to a declarative without the negative terms. See for instance (Larrivée, 2016) for a discussion of the pragmatics of these double negation statements in French.

Much of the discussion in the literature about multiple negative sentences has focused on the NC reading and the compelling puzzle it raises for semantic compositionality (Ladusaw, 1992; Zanuttini, 1991; Laka, 1990; Giannakidou, 2006; Zeijlstra, 2004; de Swart, 2009; Penka, 2011; Tovena, Déprez, & Jayez, 2004). By contrast, the different factors that contribute to the emergence of DN readings have received less attention[2]. Important disagreements remain as to whether DN readings should be thought of as generated by the grammar in only some of the languages that allow them—so-called DN languages (Zeijlstra, 2004; de Swart & Sag, 2002; de Swart, 2009)—while in others—so-called NC languages—they would be the triggered consequence of special discourse-level pragmatic processes of denial, contradiction or metalinguistic negation, but not be encoded in the grammar (Espinal & Prieto, 2011; Larrivée, 2016). Much controversy also lingers as to whether the privileged access to NC readings in some languages can motivate cross-linguistic macro-parametric distinctions or be better understood as stemming from the language internal interaction of lexical, morphosyntactic or semantic features and processes. Here, we argue that the interaction of prosodic factors with the morpho-syntax of these constructions can help shed light on these issues for the French constructions.

Not all sequences of multiple negative expressions display comparable ambiguities. In Standard European French, the variety examined here, DN readings are enforced with the sentential negative marker *pas* in a sentence like (2a) or (2b), although judgments vary across dialects.

(2) a. Ils n'aiment pas rien.
They (neg) like neg nothing
They don't like nothing
b. Pas un étudiant (n') a rien dit
neg one student (neg) has nothing said
Not a student said nothing

But as this paper aims to explore the effects of prosody in negative ambiguities, we restrict our attention to sequences where the two readings alternate, particularly constructions where NCIs interact (i.e.: negative spread), rather than constructions relating NCIs to sentential negation (i.e.: negative doubling) (Den Besten, 1986)[3].

[2] For some notable exceptions see (Iordachioaia, 2009; de Swart, 2009; Déprez, Tubau, Cheylus, & Espinal, 2015; Puskás, 2012; Fălăuş, 2007).

[3] While in some accounts negative spread and doubling are undistinguished, in others they are treated differently (Watanabe, 2004; Déprez, 1997 and following; Labelle & Espinal, 2014).

There is much empirical variability in the accessibility of each of these readings across and within languages and dialects, even in closely analogous constructions. In some languages displaying strict negative concord, like Japanese (Watanabe, 2004), Haitian creole (Déprez, 1999; 1997; 2017), Hungarian (Szabolcsi, 2004), Basque (Etxeberria, Tubau, Déprez, Borràs-Comes, & Espinal, 2018) or Greek (Giannakidou, 2006), sequences of negative expressions like (2) were said to only allow NC readings.

(3) Pèsonn pa di anyen — Haitian Creole (Déprez 1999)
n-person not said n-thing
Nobody said anything

KANENAS *(dhen) ipe TIPOTA. — Greek (Giannakidou 2006:22)
n-person not said.3sg n-thing
'Nobody said anything.'

Likewise, only single negation readings ever arise in French sentences like (4) (essentially synonymous with (1a)) that combine different negative dependent expressions (i.e. negative polarity items (NPIs) vs. NCIs), controversially argued to be essentially alike by some authors, e.g.: (Laka, 1990) and fundamentally distinct by others, e.g.: (Zanuttini, 1991).

(4) Personne n'aime quique ce soit ici[4]
Nobody likes anyone here.

The absence of DN in constructions like (3) served to motivate proposals that NCIs lack a negative denotation, though they remain "negative" in some respect, such as bearing "uninterpretable" negative features (Zeijlstra, 2004). By contrast, in other languages like standard English, Dutch, or German, negative expressions like (5) are claimed to only allow DN, even if this reading remains marked (Zeijlstra, 2004).

(5) Nobody likes nothing
They (NEG) like NEG nothing
They don't like nothing

Although NC readings like (1a) are assumed to be the default in French, some factors were shown to favor DN readings for multiple negative constructions of this kind. First, morpho-

[4] The absence of DN reading in (4) is not unexpected since NPIs are uncontroversially semantically non-negative expressions. Yet if as Puskas argued (2012, p. 612), sequences of semantically non-negative NCIs can lead to DN in contradictory contexts under agreement with a verum focus operator, the question of why DN is impossible for expressions like *quique ce soit* in these contexts resurfaces. Restricting abstract syntactic features (i.e.: [i/uNeg]) to only NCIs seems to name a problem rather than solve it, especially since the distribution of NPIs is also constrained by syntax (Linebarger, 1987).

syntactic factors such as the use of full nominal expressions as opposed to pronominal ones, especially in preverbal position as in (6), favor DN in French as in Spanish, Catalan or Italian, (Acquaviva, 1999; Déprez, 2000; Déprez et al., 2015; Déprez & Yeaton, 2018). DN is also favored when one NCI is syntactically focused as in (7) (Larrivée, 2016; Puskás, 2012), or occurs in a distinct scope domain as in (8). Moreover, DN is favored in fragment answers to negative questions as in (9) in French or English, although interpretation can vary in Spanish, Catalan or Romanian (Corblin, 1995; Espinal & Tubau, 2016; Fălăuș & Nicolae, 2016).

(6) Aucun enfant ne mange rien. (Déprez 2000)

No child NEG eat nothing

No child eats nothing/anything

(7) Il n'y a personne qui n'aime rien ici

There is nobody who Neg like nothing here

There is nobody who likes nothing here

(8) Personne ne se fâche pour rien

Nobody gets angry for nothing

(9) Qui n'a rien dit ? Personne.

Who said nothing? Nobody

But with simple ambiguous negative sentences like (1), context and prosody can play a role in influencing interpretation. Regarding context, while no specific pragmatic conditions have been noted to elicit NC readings, DN has often been observed to be facilitated in contexts that involve the correction or denial of a previously negated proposition (Horn, 1991; Puskás, 2012, p. 613). The question remains, however, whether these pragmatic conditions are necessary to elicit these readings. We address this question here both in our experimental design and our results and argue that for French, this is not the case. Concerning prosody, while a number of experimental studies have been conducted on the prosody of ambiguous negative sentences in a variety of languages including English, Afrikaans, Spanish, and Catalan with variable results and conclusions, there has been, at present, no investigation of French negative sequences like (1). Only impressionistic, at times diverging, intuitions have been offered, e.g.: (Corblin & Tovena, 2001), with little discussion of how prosody interacts with the syntax and semantics of these constructions. The present work aims to start filling in this gap. In this paper, we present a production experiment designed to compare the acoustic and prosodic properties of the two readings to explore whether their intonation profiles are distinct and, if so, how. As our

experimental design used scripted scenarios to elicit the relevant readings, our study also contributes to exploring the nature and the role of context in this ambiguity. The study furthers the existing literature in several ways. First, we experimentally confirm how accessible the ambiguity of sentences like (1) is for native speakers of French, corroborating the importance of prosody and context in disambiguating them. Second, we provide the first characterization of the acoustic cues recruited for this task. The paper offers detailed acoustic analyses and prosodic characterizations of the French negative sequences and goes on to establish that prosody indeed distinguishes the two readings. We show that beyond individual variability, there are definable acoustic and prosodic correlates to each interpretation. This is interpreted as evidence that they involve distinct prosodic make-ups that can feed different semantic interpretations or syntactic structures. The paper also contributes further characterization of the prosody of focus in French as well as the role of focus in negative interpretation. Based on our empirical results, we discuss possible imports that these prosodic distinctions unfold for current theoretical models of negative concord and the mapping between syntax and semantics they propose. Our results offer a challenge to the assumption that the realization of a contradictory contour and its correlative pragmatic processes are required to license double negative readings (Prieto et al., 2013, among others). This invites a reconsideration of the role of prosody/syntax/semantics interface and of some of the pragmatic aspects of these negative sequences, though working out a precise model of these interactions goes beyond the goal of the present study.

The paper is organized as follows. In Section 2, we start by surveying the current empirical landscape in the literature regarding the accessibility of negative concord and double negation readings in distinct languages (Section 2.1). Next, we briefly summarize the various theoretical models of NC to examine their predictions with respect to marked DN or NC readings (Section 2.2). We end this part by reviewing the results of previous prosodic studies that compared the two readings in other languages with the goal of drawing from these works to avoid potential design pitfalls and foster stronger conclusions. We then turn to the discussion of our production experiment with Sections 3 and 4 explaining our experimental design and corresponding analyses. Section 5 reports our results, and Sections 6.1 and 6.2 discuss the prosodic structures they support. Section 6.3 ends the paper by putting our results in theorical perspective, discussing some of the more general outcomes they support and the further questions they raise.

2. Background.

2.1 Negative Concord and Double Negation readings cross-linguistically

When and how speakers access single or double negation readings in multiple negative sequences is a critically relevant issue in the long-standing theoretical debates on the nature of negative dependencies in general, and of negative concord constructions in particular as it bears on the nature of NCIs as negative terms (Zanuttini, 1991; Watanabe, 2004; de Swart & Sag, 2002; de Swart, 2009; Fălăuș & Nicolae, 2016; Déprez et al., 2015). In recent literature, unexpected variation and disagreements have emerged questioning the empirical landscape carved by the classic threefold classification between DN, and strict and non-strict NC languages[5]. In some NC languages like French, DN readings in negative spread constructions like (1), have been acknowledged to be readily available[6]. In others like Catalan, Spanish, or Italian, they are regarded as rare and marginal (Espinal & Tubau, 2016). Some of these generalizations, based on sometimes conflicting native speaker's intuitions, have been confirmed experimentally. For instance, in a picture choice experiment Déprez et al. (2013) and Déprez et al. (2015) showed that pictures representing DN readings were chosen at almost 50% in Standard European French, at 30% in Italian (Iacoponi & Déprez, 2017) and at 25% in Catalan (Déprez et al., 2015). These studies that revealed DN readings to be far more accessible than previously thought, uncovered crosslinguistic and language-internal variations in the accessibility of DN readings in non-strict NC languages that offer an updated more nuanced empirical landscape. Furthermore, for strict NC languages, claims that DN is unavailable (Giannakidou, 2006) have only been partially confirmed. For instance, in Basque, pictures representing DN were essentially never chosen by speakers (Etxeberria et al., 2018). But for Greek (Barouni, 2016), Romanian (Fălăuș, 2007; Iordachioaia, 2009), Mauritian Creole (Déprez & Henri, 2018), or Hungarian (Puskás, 2012) "exceptions" to the no-DN generalization have been repeatedly noted. DN readings were shown to be clearly available for native speakers under a range of conditions that include lexical distinctions among NCIs (Mauritian Creole), the necessary co-presence of interacting NCIs (Romanian), or the use of syntactic focalization (Hungarian). Here as well, the empirical picture appears more complex than previously described, with some strict NC languages failing to license DN readings

[5] Although this classification has proved useful descriptively, many languages have been shown to manifest mixed systems that challenge it (Déprez, 2011; Déprez & Poletto, 2019; Barouni, 2016; Espinal & Tubau, 2016; Szabolcsi, 2018), among others.

[6] While the accessibility of DN readings has been experimentally confirmed in Déprez et al. (2013; 2014) DN remains rare in corpora and requires specific contexts most often involving denial or contradiction (Larrivée, 2016).

entirely, and others allowing them under distinct conditions. Similarly, while NC readings have long been claimed to be unavailable in standard English, recent experimental evidence has shown that they occur quite readily (Déprez, 2014; Blanchette & Lukyanenko, 2019). These authors argued that NC readings must be part of the grammar of American English, since speakers can assess constraints on their grammaticality independently of whether they acknowledge using them in their own idiolects. Similar controversy arose in German and Dutch where NC readings have been described as rare and marginal in the standard dialects (Zeijlstra, 2004) but are clearly instantiated in substandard dialects (Van der Auwera et al., 2006; Van der Auwera, 2012). In view of such empirical findings, the status of marked readings (DN in NC languages, NC in DN languages) in the languages that allow them presents a challenge. Should the grammars of NC languages permit DN readings just like the grammars of DN languages do, albeit with possibly distinct constraints? Or on the contrary, should DN readings be considered as largely irrelevant to the grammar of NC languages, if as Espinal & Prieto (2011) have argued, they are pragmatically-triggered non-compositionally inferable outputs of denial mechanisms akin to metalinguistic negation (Horn, 1989)? Related questions also arise about NC readings in DN languages (Zeijlstra, 2010; Blanchette & Lukyanenko, 2019). Answers to these questions bear on the validity of syntactic models of negative dependencies that take DN and NC as consequences of syntactic macro-parametric options, or on the contrary, defend that they are both language-internal options permitted by the grammar (de Swart & Sag, 2002; de Swart, 2009; Iordachioaia, 2009; Déprez, 2000; 2011).

Clearly, even if DN readings are marked, the fact that they can emerge at all is useful to probe what distinguishes negative dependencies that allow them from those that never do. The mere possibility of DN readings is one of the most solid empirical facts distinguishing negative concord constructions from other negative dependencies (Giannakidou, 2000; Zanuttini, 1997; Déprez, 2000; Déprez, 2011; de Swart, 2009). Indeed, no amount of prosodic emphasis, contradictory contour, or context has ever been observed to license DN readings in sentences featuring NPIs, or NPIs interacting with their licensing negation or with NCIs. As such, a better understanding of the factors governing the availability of DN readings and the role that prosody can play as one of these factors appears to be central to inform empirically sharper and theoretically deeper accounts of negative concord and of negative dependencies generally.

2.2 The theoretical landscape of negative concord

A glance at the current theoretical landscape of negative concord dependencies reveals three broad families of accounts predominantly distinguished by the semantic and morpho-syntactic

representations assumed for NCIs, and sometimes for sentential negative markers (Zeijlstra, 2004, and following). These make diverging predictions as to the possibility of DN readings in NCI sequences.

In the first family of accounts, NC is conceived as a type of agreement relation between dependent NCIs, assumed to be non-negative existential (~∃x) (or universal (∀x~); Giannakidou, 2000) expressions with [uNeg] features, and a unique (sometimes unpronounced) negative operator licensing them both semantically and syntactically through a feature agreement relation. Languages are taken to differ parametrically as to whether they allow negative agreement and have an overt or covert (un)interpretable negative operator. These approaches (adopted for French in Zeijlstra (2004; 2008; 2010)) predict that DN readings in sequences of NCIs are not allowed by the grammar or the semantics of negative agreeing languages. They must arise through additional abstract negative operators licensed under pragmatic denial by Verum Focus, contrastive topicalization (Puskás, 2012) or particular constraints on ellipsis (Fălăuș & Nicolae, 2016).

In the second family, NCIs are semantically negative quantifiers (NegQ) and concord readings result from a semantic process of resumptive quantifier formation (May, 1990). On this view, sequences of NCIs (but not NCIs themselves) are semantically ambiguous with NC or DN readings depending on whether their NeqQ are interpreted through scopal interaction (DN) or the formation of a resumptive polyadic quantifier (NC). Such approaches proposed for French in Déprez (2000), De Swart and Sag (2002), and De Swart (2009) do not invoke macroparametric distinctions between languages and predict that both DN and NC readings could surface in all languages with NegQ, including English or German. The challenge here is to account for how languages differ in their NC/DN distribution and to understand how speakers resolve the choice between scopal and polyadic quantification. For De Swart (2009), access to NC and DN is regulated cross-linguistically through optimality-based language-specific grammars with constraint reranking. This approach, however, leaves aside language-internal variation.

Finally, for the third family of accounts, NCIs are ambiguous expressions sometimes semantically negative, and sometimes not. NCI ambiguity is approached differently in distinct models. It can be lexical (Herburger, 2001; Surányi, 2006) or morphological, with NCIs varying in arbitrarily assigned interpretable or uninterpretable Neg-features (Espinal & Tubau, 2016), or structural with Neg-features on DP or NP (Déprez, 2000). The shifting interpretation of NCIs has also been taken to stem from the interaction of NCI-internal binary/unary Neg-

features and a feature-movement operation (Neg-raising) that can lead Neg-features to either semantically cancel one another (-+- =+) or be separately interpreted (Collins & Postal, 2014). For Déprez (2011; 2018) Neg-features can be semantically interpretable only when occurring at phase edges, both in the internal structure of NCIs (internal phase) and through the NCIs position in the sentence (external phase). How Neg-features reach phase edges can vary micro-parametrically across and within languages. On this dynamic view, NC and DN readings are subject to internal and external morpho-syntactic and structural conditions that can differ both cross-linguistically and language-internally.

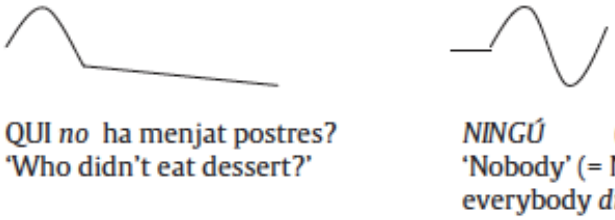
2.3 Previous studies on the intonation of double negative sentences

As with other linguistic ambiguities, intonation has been assumed to play an important role in favoring particular interpretations in negative sequences. Various suggestions as to how intonation affects the interpretation of sentences like (1) in French have been offered in the literature. Corblin (1996, p. 15) suggests that "If one of the negative quantifiers is stressed, the bi-negative reading is highly favored", while Corblin and Tovena (2003, p. 24) consider, more specifically, that DN readings arise if the subject *personne* is emphasized. Similar intuitions are reported in an early Linguist List post (1999) (Query Linguist list 10.1587 Negation in French) that informally surveyed French speakers on the interpretation of sentences like (1) and their relation to prosody. Yet while some speakers indeed felt that emphasis on the second syllable of the subject was what governed their access to the double negation, others reported differing intuitions. For one speaker, emphasis on the subject NCI triggered a double negation reading with purely existential interpretation of the NCI (someone loves someone). For yet others, it was the NC interpretation that stood out prosodically, requiring a "symmetrical emphasis" on both NCIs. Finally, some speakers found that DN readings required emphasis on the object NCI. In sum, and perhaps unsurprisingly, the post revealed interesting variability among French speakers' intuitions with respect to the interpretation of these sentences and their relations to prosody.

Remarkably, despite the numerous theoretical discussions of French multiple negative constructions in the literature (Muller, 1991; de Swart & Sag, 2002; de Swart, 2009; Corblin et al., 2004; Giannakidou, 2006; 2020 for a recent survey and references cited therein) there has, as of yet, been no systematic investigation of their prosody and of the role that prosody could play in disambiguating or influencing their interpretation. This absence stands in notable contrast to studies on the intonation of multiple negative sentences recently conducted in other

languages like English (Blanchette et al., 2018), Dutch (de Swart & Fonville, 2014), Afrikaans (Huddlestone, 2010), Catalan, or Spanish (Espinal & Prieto, 2011; Prietoet al., 2013). Using various experimental methods, these works all provide evidence that prosody influences the interpretation of NCIs in sequences or in isolated fragment answers to negative questions. Generally, they highlight the conclusion that DN readings correlate with a special prosody, even if, at present, points of convergence regarding the characteristic features of this prosody remain elusive.

Four perception studies (Huddlestone (2010) and Huddlestone and De Swart (2014) for Afrikaans, Espinal et al (2016) for Spanish, and Espinal & Prieto (2011) for Catalan) associate DN readings with what they term a "contradictory contour". This contradictory contour is described as a sequence of H*L*L-H% for Huddlestone and a sequence of L+H* LM% (namely a rising pitch accent L+H* on the accented syllable followed by a complex boundary fall-rise pitch movement at the end) for Espinal and Prieto (2011) following Prieto et al (2013). Interestingly, these contradictory contours share similarities across the languages studied, particularly regarding the end of the contour. In most cases, the contradictory contour involved the combination of a low tone followed by a rising or fall-rise final boundary tone. These results suggest that in NC languages, a marked "contradictory contour" ending in a low tone followed by a high boundary tone succeeds in triggering DN rather consistently. Hence, the mapping of a contradictory contour to a DN interpretation appears likely, though not necessary. On the basis of their prosodic findings, Espinal & Prieto (2011) argue that DN readings in NC languages like Catalan and Spanish do not reflect the classic compositional computation of two semantic negations, but rather, the output of an inferential process of denial (Geurts, 1998). Utterance of NCIs with a corrective or contradictory contour conveys the rejection of a negative presupposition and yields a corrective positive reading as a conversational implicature. For instance, in the question-answer dialogue in Figure 1, the NCI with the contradictory contour L+H* L!H% leads to a DN reading signifying that everyone ate dessert, because the negative presupposition of the question (someone did not eat dessert) is challenged and corrected by the speaker, hence deriving a positive interpretation through a denial mechanism (Geurts, 1998).



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375 *Figure 1. Schematized contradictory contour for the DN reading of a negative answer to a*
376 *negative question in Catalan (Espinal & Prieto, 2011, example 11)*

377 By the term "contradictory intonation contour" the author refers to the production of a contour
378 used to deny a discourse-accessible proposition (Goodhue & Wagner, 2018). But as a
379 contradictory contour is not unique to double negation sentences and can be used to deny
380 sentences of any polarity, this leads Espinal and Prieto to claim that DN readings are not
381 encoded in the syntax or semantics of the NC languages they study.

382 In the perception studies reviewed here, no consistent mapping between NC interpretation and
383 a particular contour was observed. More neutral contour perceptions were associated with
384 greater speaker hesitation and variability both in Huddlestone (2010) and in Espinal and Prieto
385 (2011). Likewise, in the production studies of Fonville (2013) and De Swart and Fonville
386 (2014) in Dutch, the mapping between a particular pair of tones, i.e.: pitch accents on each of
387 the NCIs in a binary sequence[7] and a given interpretation was not always constant. Although
388 de Swart and Fonville identified a pair of tones that uniquely mapped to DN readings, namely
389 (H* L*), they also found many DN readings that did not map to this tone pair. Concerning NC
390 readings, no pairs of tones were found to uniquely map to this reading, although one (H*,-)
391 was more frequently used than others. Although these studies offered a prosodic ToBI-based
392 characterization of the stimuli, only one (Espinal and Prieto (2011)) provided a parallel
393 phonetic/acoustic analysis to ground it. Additionally, the stimuli that participants evaluated
394 were not always produced in naturalistic settings. The perception studies by Huddlestone
395 (2010) used stimuli recorded by two speakers asked to produce distinct contours in absence of
396 guiding verbal contexts. Hence their stimuli reflect what the speakers thought constituted DN/
397 NC contours, not spontaneous elicitations. The production study of de Swart & Fonville (2014)
398 embedded the tested sentences in verbal contexts designed to elicit NC or DN readings, yet the
399 success of these contexts in eliciting the intended interpretations was not controlled for.

[7] This measure--not standard for intonation studies—delivered only a partial picture of the facts.

Consequently, some of the variability in their results could well have arisen from a mismatch between the context and the speakers' actual interpretation that went unnoticed.

3 Research questions and Experimental design

The preceding sections observed that the prosody of acknowledged ambiguous French multiple negative sentences, has not yet been experimentally investigated. Moreover, at the outset of previous studies, whether and how distinctive acoustic or prosodic cues could be reliably identified or characterized for each reading remains inconclusive. The perception stimuli or the production realizations were rarely analyzed acoustically. Espinal & Prieto (2011) investigated prosodically marked question-answer pairs (as opposed to simple propositions) with fragment answers, which are unambiguous in French (Corblin, 1994; 1995). When disambiguation contexts were used, a description of their discourse characteristics was not provided, nor was their influence on interpretation verified. Our experimental design sought to address and avoid these potential issues which may have impacted these previous studies. In this section, we lay out the precise research questions our study means to answer, and the design of our production experiment intended to investigate them. Our central research questions were the following:

1. In French ambiguous sequences of NCI like (1), can the two possible readings—NC and DN—be distinguished acoustically and prosodically?

If so:

2. How do the two readings differ? More specifically,
    a. What are the acoustic/prosodic properties that characterize the NC reading?
    b. What are the acoustic/prosodic properties that characterize the DN reading?
3. What do the acoustic profiles reveal about the prosodic structure and its interactions with the syntax, the semantics, or the pragmatics of these ambiguous sentences?

To address these questions, we designed a carefully controlled production experiment in which participants were recorded reading aloud simple ambiguous transitive sentences featuring two NCIs—*personne* and *rien*—respectively in subject and object positions. The sentences were embedded in contexts manipulated to elicit the distinct interpretations.

3.1 Elicitation paradigm: Context-guided production

Thirty-two experimental context-target pairs were created with eight items in each of four experimental conditions (DN, NC, NegSub, NegOb), the latter two serving as prosodic and semantic baselines:

1. NC: transitive sentences with two NCIs presented in a negative concord targeted context
2. DN: transitive sentences with two NCIs presented in a double negative targeted context
3. NegSub: transitive sentences with one NCI in subject position, and a non-negative object
4. NegOb: transitive sentences with one NCI in object position, and a non-negative subject

An additional eight fillers were included to serve as behavioral controls that did not feature any NCIs (see appendix for the complete list of stimuli). In the DN and NC conditions, the target sentences were constructed to be maximally ambiguous by featuring two pronominal NCIs with simple highly frequent transitive predicates. Their ambiguity was previously confirmed in a picture choice task (Déprez et al., 2013) showing that sentences with two pronominal NCIs mapped to DN and NC interpretations almost evenly, while sentences with more complex NCI DPs (e.g.: *aucun enfant* – no child), favored DN, and were avoided in this experiment. Identical target sentences were used in both the DN and NC conditions to maximize comparability at the phonetic and acoustic level, with only minor changes to sentence-final prepositional phrases.

To ensure that participants accessed the interpretation directed by a given context, we introduced a meaning control task. Each experimental item was followed by a verification statement that participants judged as true or false. They served to verify the speaker's interpretation and corresponding produced prosody. They also evaluated the extent to which the contexts were successful in guiding the interpretation.

To illustrate, consider the NC context in (12a). Here, if the interpretation of the target sentence (12c) matches the NC context intention (12a), the verification statement (13) “they don’t drink alcohol” is expected to be true, since everyone in the family is allergic to alcohol. By contrast, judging (13) as false would signal a DN interpretation (“no one fails to drink at parties”) of the target sentence (12c) as expected in the context (12b) which states that the consumption of alcohol among the youth has reached frightening levels.

(12)
(a) NC context:

Dans notre famille, on est tous allergique à l'alcool
My whole family is allergic to alcohol

(b) DN Context:

Chez les jeunes, la consommation d'alcool est effrayante
Among young people, alcohol consumption is alarming

(c) Target sentence:

Personne ne boit rien dans les soirées
Nobody drinks nothing/anything in parties

For both 12(a) and 12(b), the verification statement was 13.

(13) Ils ne boivent pas d'alcool
They don't drink alcohol

In the NegSub (14a) and NegOb (14b) conditions, the verification statement kept task homogeneity and controlled for participants' interpretations of unambiguous sentences. These conditions further provided a baseline to compare the prosody of NCIs in a single negative condition against the potentially more complex multiple negative NC and DN conditions. True and false responses were counterbalanced within each condition.

(14) NegSub Condition

(a) Dans ce bar, il y a de l'ambiance et on consomme beaucoup d'alcool :
In this bar, the atmosphere is vibrant, and people drink a lot of alcohol
Personne ne boit d'eau ici.
No one drinks water here.

NegOb Condition

(b) Quand on sort, il faut un chauffeur sobre :
When we are going out, we need a sober driver
Raoul ne boit rien aujourd'hui.
Raoul drinks nothing today.

3.2 The Verbal stimuli: prosodic properties

In all the critical, baseline conditions and fillers, the target sentence featured at least seven syllables: two for the subject, one for the pre-verbal *ne* particle, one for the verb, one for the object, and between two and five syllables for a sentence-final prepositional phrase. This sentence-final PP was included to keep the object NCI tone separate from the sentence final boundary tone to avoid masking other relevant prosodic signals. Wherever possible, sonorant use was maximized to facilitate F0 measurements. The same eight high-frequency monosyllabic verbs were used in the present tense across all four experimental conditions to maintain canonical SVO word order.

In the NegSub baseline-condition, the subject was the same pronominal NCI as in the DN and NC conditions and the object was a non-negative monosyllabic DP (e.g.: *l'eau* – water) or pronoun (e.g.: *ça* – this) to keep syllable count constant across conditions. In the NegOb baseline-condition, all subjects were bisyllabic DPs to maintain syllable count for comparison across conditions.

3.3 Context design

While the contexts in the NegSub and NegOb conditions simply set up a situation where the target sentences were natural continuations, the contexts in the DN and NC conditions were manipulated to guide the interpretation of the ambiguous target.

As previously observed (Horn, 1985; Puskás, 2012; Larrivée, 2016), DN readings are notably facilitated in contexts that trigger the contradiction or denial of a previous negative utterance or presupposition. Moreover, such facilitation effects obtain in DN languages like English or Dutch, as well as in NC languages like Hungarian, Spanish, Catalan or French (Horn, 1991; Puskás, 2012; Szabolcsi, 2018; Déprez et al., 2015; Larrivée, 2016) spanning across the classic DN and NC language divide. Due to their crosslinguistic effects then, contradictory contexts do not offer very useful grounds to help understand the potential contribution of morpho-syntax or semantics in allowing access to DN readings. We hence chose to steer away from pragmatic contradiction in designing our DN elicitation contexts to avoid potentially confounding effects. Our DN contexts did not use any negative propositions, or presuppositions that could lead speakers to interpret the target sentences as corrective or contradictory with this negation. They presented assertive statements describing situations that offered contingent generalizations that would come to be reinforced by a DN reading of our target sentences. Consider (15):

(15) a. Dans notre école, les profs veulent tous donner leurs avis.
At our school, the teachers all want to express their opinions
b. Personne ne dit rien pendant les réunions.
Nobody says nothing/anything during meetings

In this example, the context states a generalization about the teachers of a given school, asserting that they are highly opiniated people eager to express their viewpoint. This sets up a situation where they are unlikely to remain silent. The question under discussion (QUD) which following (Tian, 2014) negation is a cue for is for (15b): 'Who says what during meetings?'. Coherence with the context's generalization guides an interpretation that discourages alternatives in which teachers remains silent, i.e.: say nothing. (15b) under a DN reading

526 strengthens this by asserting that no teachers do. In contrast, (15b) under a single negative NC
527 reading (asserting people were silent) clashes with the generalization set up in this DN context.
528 Our DN contexts were all designed in this way, with the particular goal of gauging whether
529 French speakers could access DN readings without the help of the peculiar pragmatic
530 facilitation that a contradictory or corrective reading sets up[8]. The absence of contradictions
531 also allows us to examine whether a DN prosodic contour could differ from the contradiction
532 contour discussed in previous literature (Liberman & Sag (1974), Ladd (1979, p. 150),
533 Pierrehumbert & Hirschberg (1990)), in particular for metalinguistic negation (Puskás, 2012;
534 Portes & Reyle, 2014).

535 ## 3.4 Recording procedure

536 Recordings took place in a quiet office at the Institute for Cognitive Sciences at the University
537 of Lyon, France. Participants received a written informed consent approved by the Institutional
538 Review Board of Rutgers University and were seated comfortably in front of a computer
539 monitor wearing an Asus Orion PRO gaming headset with a noise filtering microphone.

540 Participants were instructed to first read silently the context and target sentences to ensure good
541 understanding of their meaning (Figure 2, A). Then, they pressed the space bar to begin
542 recording the items read aloud, with a lively and naturalistic rendering (B). Once satisfied with
543 their recording, the participant pressed the space bar to stop (C) and proceed to the verification
544 statement judged by pressing either the V or F key (French for Vrai (true) or Faux (false)).
545 Their response triggered the next trial. Participants received two practice trials, to familiarize
546 themselves with the paradigm, followed by the 40 experimental items. The items were
547 pseudorandomized in blocks with a different list order for each participant. In the blocks, no
548 two items from the same condition could appear consecutively, and the contrastive DN/NC
549 pair for a given target sentence (as in 14(a) and 14(b)) were never part of the same block. All
550 participants saw all 40 items. Finally, they filled out a short demographic questionnaire and
551 were debriefed. The whole session lasted about 20 minutes.

[8]Following Tian (2014) we take negation to trigger a positive QUD. In (15b) the DN interpretation updates the discourse by eliminating alternatives of the positive QUD 'who said what' that are incongruent with the context .This produces a reinforcement of the context statement. For further discussion of negation as trigger of a positive QUD see Tian (2014).

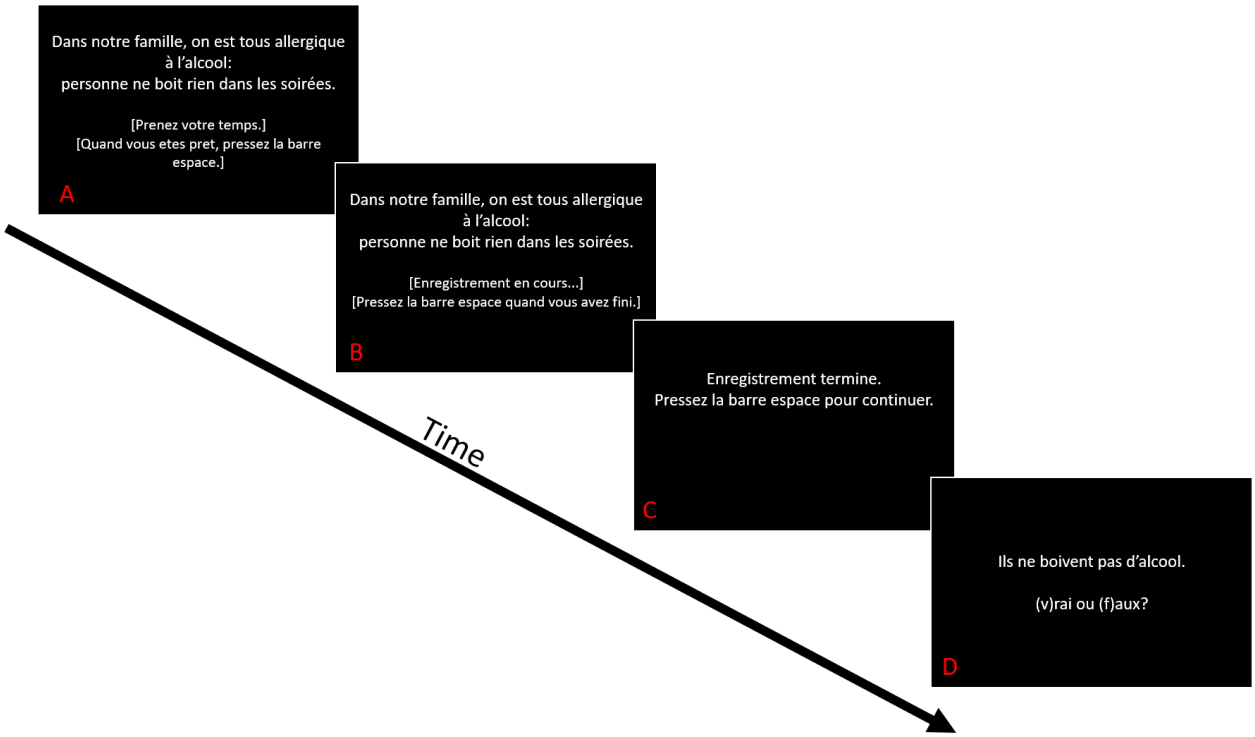


Figure 2. Single trial schematic for production experiment. A) Participants read the context and target silently, then pressed the space bar to begin recording. B) Participant recorded context and target read aloud and C) pressed the space bar to end recording.

3.5 Participants

28 monolingual native speakers of continental French—from various regions but residing in Lyon—participated in the experiment (18F, aged 18-45). They were compensated 10 EUR for their time.

3.6 Exclusion Criteria for the prosodic analysis

To accurately characterize the prosodic features of the DN and NC readings, we needed to be certain that a) the productions reflected the contextually intended meaning, and b) the participants had access to both the DN and NC interpretations, as participants unable to access both are unlikely to produce a distinguishing prosody.

For a), assessment of T/F responses to verification sentences revealed that contexts were quite successful in guiding the DN/NC interpretation. Context-congruent responses were given in 79.9% of DN & NC trials (see Figure 3), confirming the strong ambiguity of these sentences for French speakers. The influence of context was slightly higher in the NC condition (mean=87.05%, t=10.439, df=27, p=5.608e-11) than in the DN one (mean=72.77%, t=4.0083, df=27, p=0.0004329), but was significantly above chance in both cases.

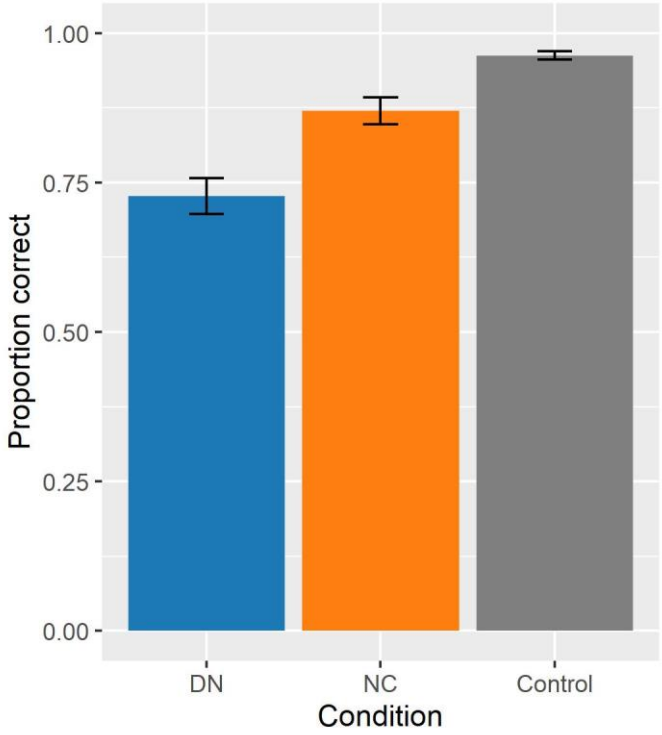


Figure 3. Percent context-matching responses by condition. Participants performed at ceiling for the single negative controls and filler items. Error bars represent 95% confidence interval.

We used the results of these verification statement responses to select participants regularly accessing both readings. Eight participants who did not were excluded from our acoustic analysis (see supplementary materials for details on the exclusion procedure). From the productions of the remaining 20 participants, our acoustic analysis included only items with context-matching interpretations (excluded n=65; see Table 1 for a breakdown). The acoustic analysis hence included 277 and 298 recordings in the critical and control conditions respectively, for a total of 575 productions.

Table 1. Number of items per condition used in prosodic analyses. The numbers here are each out of a possible 160 (20 participants × 8 items per condition).

Condition	**Structure**	**Abbreviation**	**n**
Double Negation	NCI-NCI	DN	137
Negative Concord	NCI-NCI	NC	140
Subtotal Criticals			277
Single Negative Object	DP-NCI	NegOb	149
Single Negative Subject	NCI-DP	NegSub	149
Total			575

4 Analyses

4.1 Acoustic analysis

The target sentences were excised from the context using Audacity 2.0.6 and time-aligned, matching phonemes and syllables to the waveform in Praat (Boersma & Weenink, 2009) using EasyAlign (Goldman, 2011). The Praat plugin ProsodyPro (Xu, 2013) was then used to extract fundamental frequency (F0) values, and syllable duration.

4.2 F0 contour analysis

For each syllable, ten time-normalized (i.e., uniformly sampled over the duration of the syllable) F0 values (in Hertz, Hz) were extracted. We took the mean and standard deviation (SD) for each participant and used these to exclude outliers greater than 3 standard deviations away from that participant's mean. Because the sentence-final PP varied in length between two and five syllables depending on the item, we could not compare the entire utterance as a whole. We thus consider these data in two windows: 1) the first six syllables and 2) the last two syllables of the target sentence. Window 1 comprised the bulk of the sentence and included the subject (2 syllables), the French *ne* particle (one syllable), the verb (one syllable), the object (one syllable), and the first syllable of the sentence-final prepositional phrase (PP1). Window 2 comprised the final two syllables[9] which would capture the sentence final tune.

We fit a Generalized Additive Mixed Model (GAMM) to characterize the F0 contour of each condition based on the time-normalized F0 data (Wood, 2004). Generalized Additive Models allow us to estimate an overall contour across the utterances from both conditions, then examine how our variables of interest (i.e.: condition and syllable) impact the F0 (Wood, 2011). Using a mixed model allows us to further account for individual variation in participants and items. We therefore fit a GAMM to the F0 data from window 1 (the first six syllables), using F0 as the dependent variable, normalized time as a smooth term, and condition and syllable as crossed fixed effects to see how F0 differed between our two critical conditions at each syllable. We included participants and items as random effects, which was the maximal random-effects structure that converged. In other words, we fit a single contour for F0 over time for both conditions (the smooth term), then examined how condition and syllable impacted that contour. We fit another GAMM on the data from window 2 (the last two syllables), using the same

[9] In some items (n = 3), the first syllable of the PP was also the penultimate syllable, and therefore would appear in both windows of interest.

structure. We report estimates (b), standard errors (SE), and t-values, where |t|>1.96 is considered meaningful. The first syllable of the NC condition was used as the reference.

4.3 Syllable-level analysis

We also measured maximum and minimum F0 values (in Hz) for each syllable. Syllable maximum and minimum F0 values were z-scored relative to the mean and SD from each participant's time-normalized F0 data for that syllable. In other words, for the first syllable of the sentence, the mean and SD were taken from all of the time-normalized points in the first syllable of any utterance from that participant, and then this mean would be subtracted from the max F0 value for the first syllable before dividing by the SD. Differences between syllables were not the focus of our interest because we are primarily interested in differences between conditions. Thus, max and min F0 values are considered relative to the F0 for that syllable only. To remove outliers, we excluded absolute z-values of 3 or higher. We analyzed the data from all four conditions for the first six syllables of the sentence.

We also measured the duration of each syllable in milliseconds, and z-scored this by participant. We excluded syllable duration values 3 or more SD from each participant's mean and analyzed the data from all four conditions for the first six syllables of the sentence.

We used Linear Mixed-Effects (LME) regression to compare the maximum and minimum F0 for each syllable for the DN and NC conditions. LME models are a form of linear regression which can better account for individual- and item-level variance (Barr et al., 2013). Separate models were fit for maximum F0, minimum F0, and duration. Each included a fixed effect for syllable, as well as a syllable×condition interaction term. All LME models had random intercepts for participant and item. We report estimates (b), standard errors (SE), degrees of freedom (df), and t-values, where |t|>1.96 is considered meaningful. Results are reported using the first syllable in the NC condition as the reference unless otherwise specified.

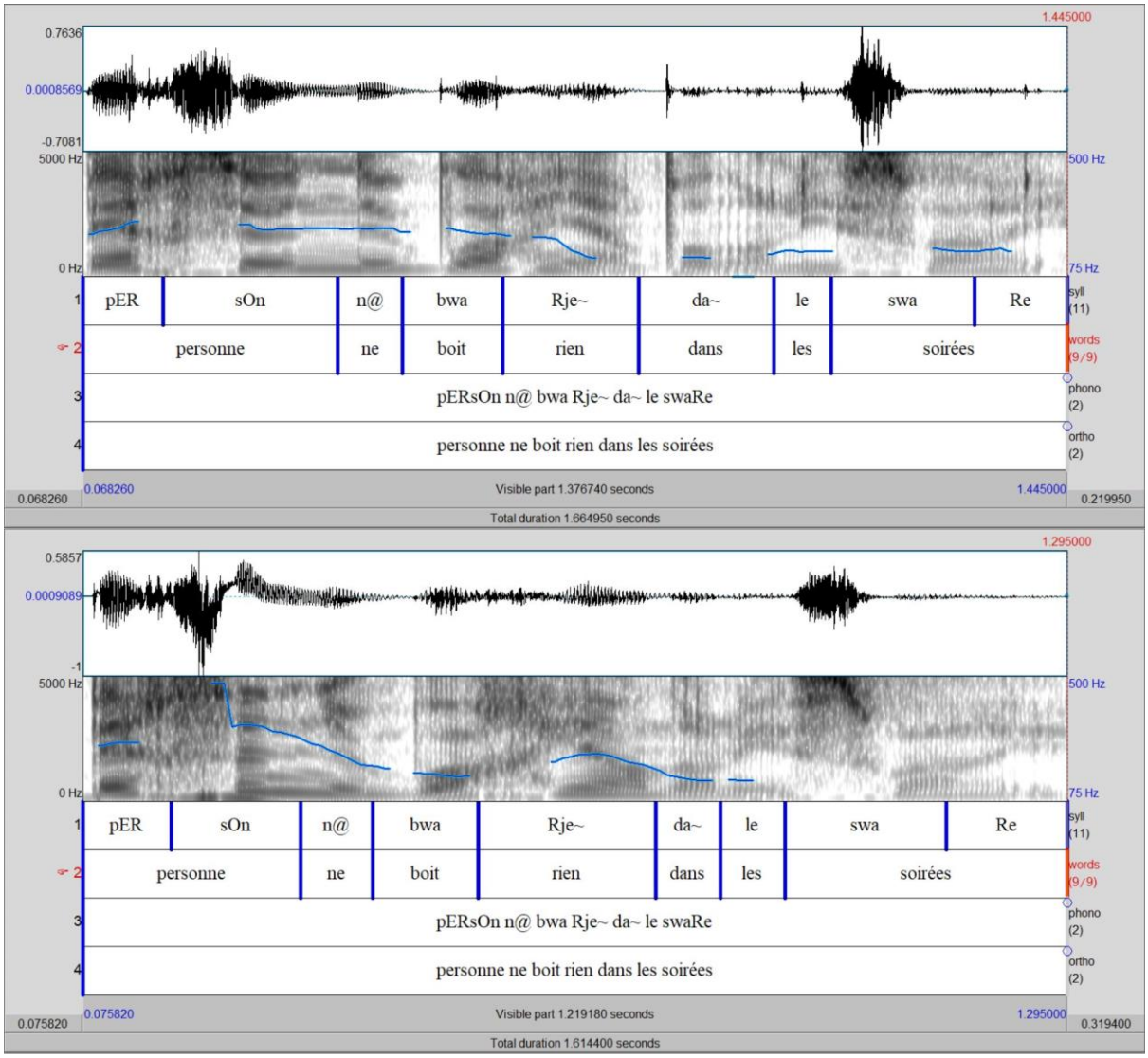
5 Results

The goal of our experiment is to uncover whether acoustic and prosodic cues are consistently employed to distinguish between our experimental conditions, most critically DN and NC. This section first describes and compares the F0 contours that characterize the DN and NC conditions across the whole sentence (cf. Section 4.2). Next, the regions where our statistical analysis revealed significant differences between DN and NC are discussed, followed by a

644 more detailed analysis mostly on duration. Finally, the DN and NC conditions are compared to
645 the NegSub and NegOb control conditions.

646 ## 5.1 Overall F0 contour: Comparison between DN & NC

647 A representative sample rendering of two distinct productions of the same sentence by the same
648 speaker, one with a DN interpretation and the other in an NC interpretation is given in Figure
649 4.



650

651 *Figure 4.Praat images of representative NC (top) and DN (bottom) productions by the same*
652 *speaker. Note the blue curve plotted over the spectrogram indicating F0.*

653 DN and NC present essentially the same overall melodic contour characterized by two peaks
654 on the final syllable of each of the NCIs and a low tone after each, with an overall falling final
655 contour (L%) and a general falling baseline. Characteristically, in the DN rendering, the two

peaks appear far more pronounced and higher. These distinctions and overall melodic curve are confirmed when an averaged contour is computed over the entire set of speakers' productions included in this acoustic analysis (Figure 5).

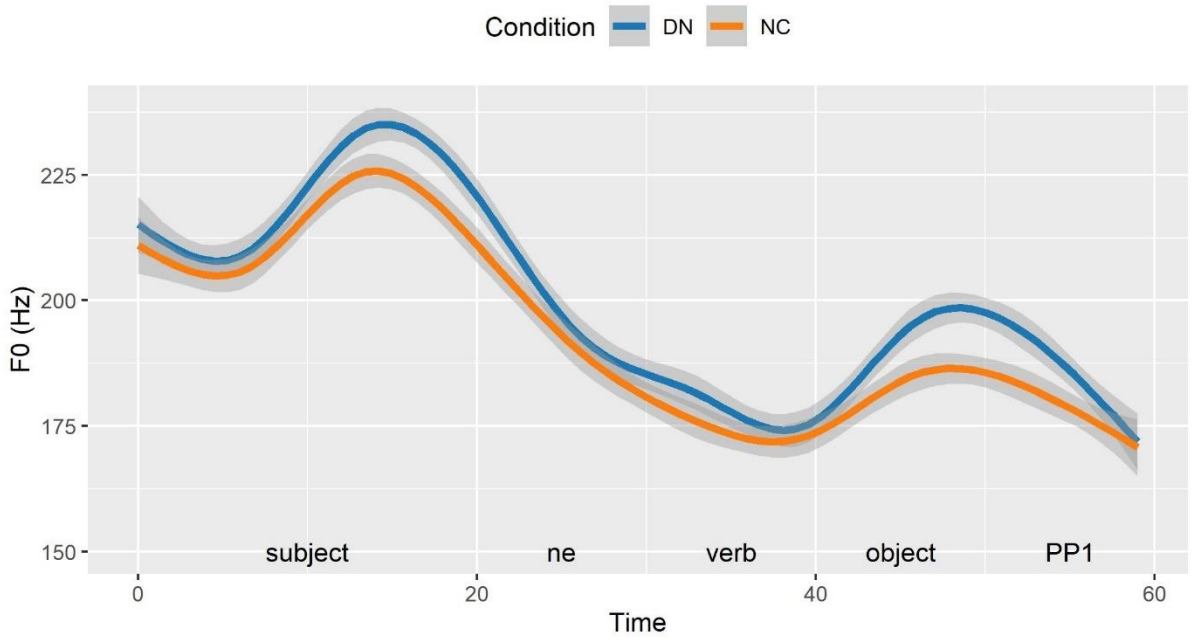


Figure 5. Smoothed prosodic contours in the critical conditions. The x-axis is in normalized time points (10 per syllable).

This averaged contour shows that both the DN and NC conditions follow largely the same melodic form: an overall falling contour with two strong peaks—the first on the second syllable of the subject NCI and the second on the main syllable of the object NCI—with the second lower than the first due to downstep. As this melodic shape parallels that of our single negative control sentences, as well as the contour of simple transitive affirmative statements as schematized in Vaissière and Michaud (2006) reproduced in Figure 6, it is insufficient to distinctively characterize our ambiguous multiple negative sentences.

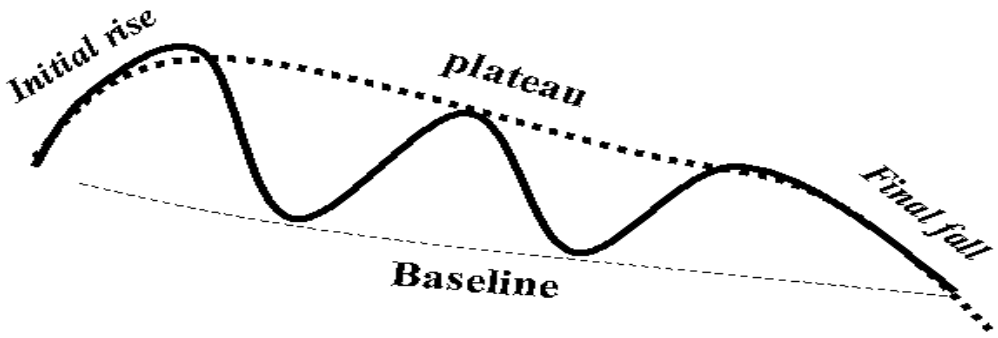
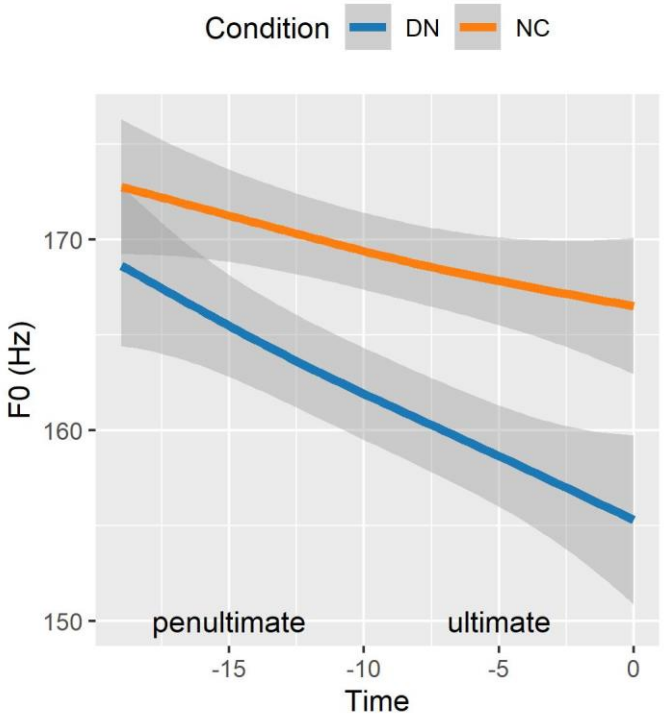


Figure 6. French sentence contour schematization reproduced with permission from Vaissière et al (2006).

Our GAMM analysis comparing the DN and NC conditions on the first six syllables found significant differences on the second syllable of the subject NCI (per-*sonne*; b=5.66, SE=1.30, t=4.344), on the following *ne* particle (b=3.16, SE=1.34, t=2.35), on the object NCI *rien* (b=4.79, SE=1.29, t=3.71), and the following first syllable of the PP (b=4.03, SE=1.29, t=3.12). In all these cases, DN is realized at a higher F0 than NC. We thus have significant F0 effects on both the subject and object NCIs, and the syllable that follows each. In both cases, the effect size on the NCI is larger than on the following syllable, suggesting a carry-over effect from the NCI.

5.2 Comparison between DN & NC – Sentence-final F0 contour

The GAMM analysis on the sentence-final F0 contour found no significant differences between the DN and NC conditions (all $|t|<1$). Both conditions follow the same falling contour (Figure 7). This result contrasts with previous experimental work on the prosody of DN and NC in Catalan and Spanish (Espinal & Prieto, 2011) for which the DN interpretation was characterized by a contradictory contour. A final fall-rise tone, typical of a contradictory contour is not observed in our data.



687

688 *Figure 7. F0 contour on the last two syllables.*

689 ## 5.3 Comparison between DN & NC – Other F0 measures

690 In our LME analysis of the syllable-wise maximum F0 data, we found several points where the
691 NC and DN conditions differed. On the second syllable of the subject NCI, we found a marginal
692 difference between the two, with a higher maximum F0 in the DN condition (b=0.25, SE=0.14,
693 df=102.66, t=1.80). We further found significant differences on the object NCI (b=0.35,
694 SE=0.13, df=85.32, t=2.59) and on the first syllable of the PP (b=0.43, SE=0.13, df=85.05,
695 t=3.18). In both of these cases as well, the maximum F0 in the DN condition was higher than
696 in NC. We did not find a significant difference between DN and NC in minimum F0 on any
697 syllable.

698 ## 5.4 Comparison between DN & NC – Duration

699 In our analysis of syllable duration in the DN and NC conditions, we found a marginal
700 difference on the object NCI (b=0.14, SE=0.08, df=67.87, t=1.68), and a significant difference
701 on the first syllable of the PP (b=0.47, SE=0.08, df=67.87, t=5.73). For both of these syllables,
702 the DN condition was realized with a longer duration than the NC one (Figure 8).

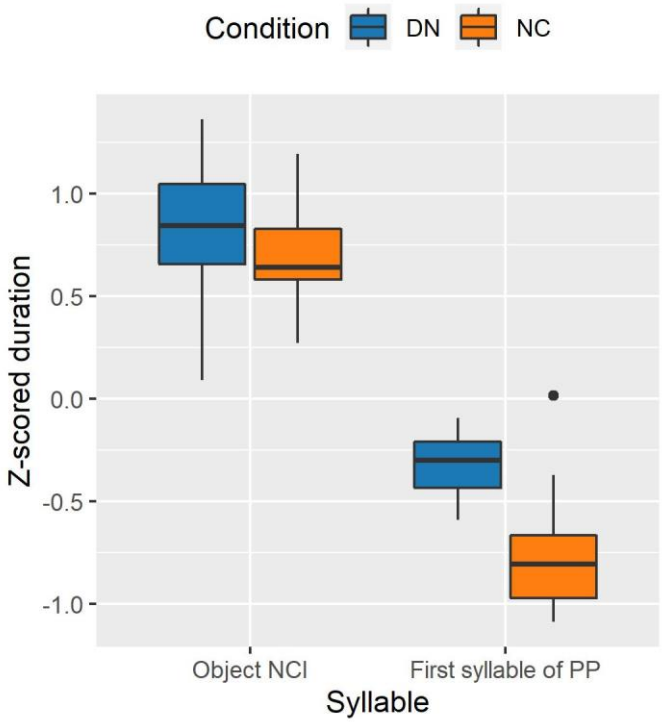


Figure 8. Syllable duration by condition on the object NCI and first syllable of PP. Duration is higher in the DN condition in both cases.

5.5 Comparison of DN and NC readings to single-negative controls NegSub, NegOb

Following our examination of the DN and NC conditions, we enlarged the comparison to the single-negative controls. Regarding F0 contour, we first observed that the non-negative DP-subjects in the NegOb condition, manifested a lower and more delayed peak than the NCI-subjects in all the other conditions (Figure 9A). This is consistent with NCI-subjects being focused, not just in the DN condition, but also when they occur in the NC or NegSub conditions (Figure 9B). Examining the object position, we noted that the melodic curve of the NCI-objects in the DN condition closely paralleled that of the NegOb condition (Figure 9C). In contrast, the melodic curve of the NCI-objects in the NC condition appeared qualitatively more similar to that of the non-negative-DP objects in the NegSub condition (Figure 9D).

Because the LME models that we fit above included the data from all four conditions, we can examine how the single negative controls compared to the DN and NC conditions for the same variables. The same models were fit with different conditions as a reference in order to facilitate pairwise comparisons. We focused here on the points where the DN and NC conditions differ.

Maximum F0

On the subject NCI, where the DN and NC conditions had a marginal difference in maximum F0, we found that the NegSub condition was slightly but significantly lower than DN (b=-0.36, SE=0.14, df=95.79, t=-2.59), but did not differ from NC. The non-NCI subject in the NegOb condition significantly differed from all three other conditions (all |t|>3) in being much lower. On the object NCI where DN and NC differed significantly, we found that the NegOb condition was significantly higher than the NC condition (b=0.41, SE=0.13, df=81.76, t=3.09) but that the NegSub where the object is a DP did not differ from NC condition (|t|<1). On the other hand, the object NCI in the DN condition was significantly higher than the non-NCI object in the NegSub condition (b=-0.43, SE=0.13, df=84.65, t=-3.19), but did not differ from the NCI object in the NegOb condition (|t|<1). We found a similar pattern on the first syllable of the PP where the DN condition was significantly higher than the NegSub condition (b=-0.55, SE=0.13, df=82.69, t=-4.13), but not different from the NegOb condition (|t|<1). In the first syllable of the PP in the NC condition, however, we found a significantly lower maximum F0 compared to the NegOb condition (b=0.47, SE=0.13, df=80.05, t=3.59), but no difference from the NegSub condition.

Duration

The duration of the second syllable of the subject was the same in all conditions with a subject NCI (DN,NC,NegSub) and differed from the shorter non-NCI subject of the NegOb condition. On the object where the DN and NC conditions differed marginally, we found that the NCI in the NegOb condition was significantly longer than in NC (b=0.17, SE=0.08, df=65.42, t=2.13), but not significantly longer than DN. The DP object in the NegSub condition was significantly shorter than both NC (b=-0.70, SE=0.08, df=65.42, t=-8.58), and DN (b=-0.84, SE=0.08, df=66.13, t=-10.24). The first syllable of the PP, which was longer in DN than NC, was also longer in DN than in both the NegSub (b=-0.55, SE=0.08, df=66.13, t=-6.65) and NegOb (b=-0.59, SE=0.08, df=66.12, t=-7.13) baseline conditions, but was not significantly different in NC from either.

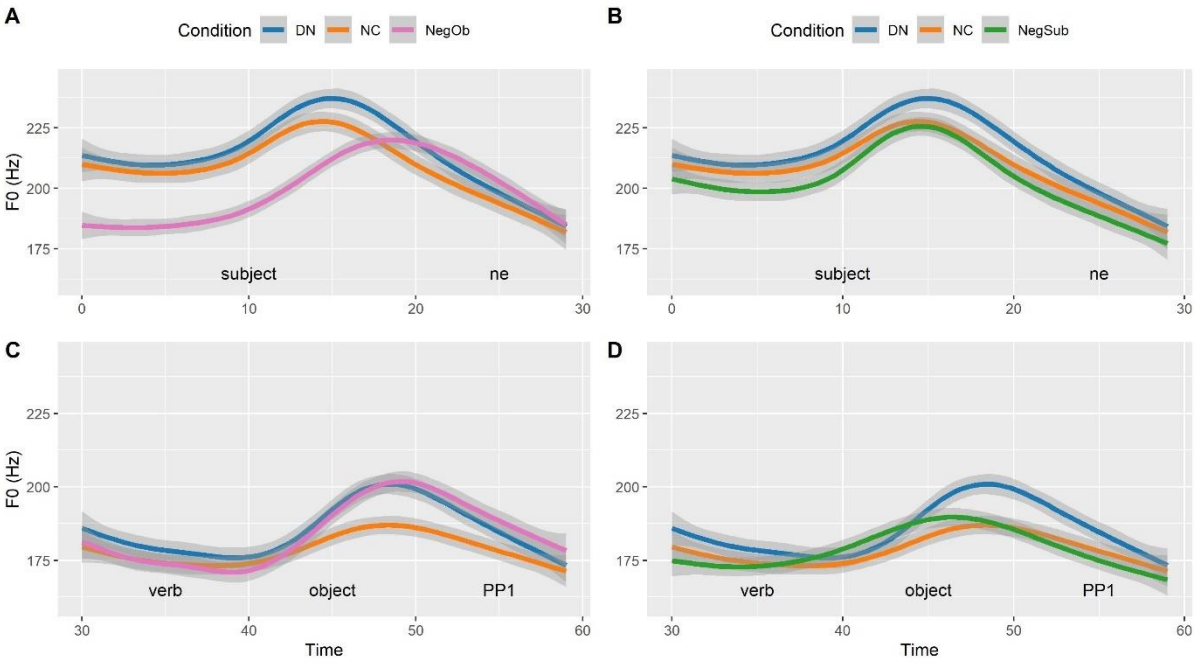


Figure 9. Critical (DN & NC) conditions compared to NegOb (A,C) and NegSub (B,D) conditions during the first part of the utterance (onset to just before the verb—A,B), and latter part of the utterance (verb to the onset of the PP—C,D).

These data are compatible with the view that NCI objects are focused in the DN condition and in the NegOb condition but melodically more compressed in the NC condition and phrased with the verb, essentially like non-negative objects.

5.6 Summary of results

Based on the acoustic data, we found that the DN and NC recordings were distinguished in two ways. First, they differed significantly in F0 on the NCIs (both in overall contour and maximum F0), with the DN reading being realized higher than the NC one around both NCIs. Second, syllable duration was longer on the object NCI and the on the first following syllable (PP1) in the DN readings. When we added the single-NCI control conditions to the comparison, we found that in F0, NCI subjects in all conditions were realized significantly higher than the DP subject in the NegOb condition. For the object, on the other hand the NCIs in the DN and NegOb conditions were realized higher than in the NC condition and the non-negative DP object in the NegSub condition, which in turn did not differ from one another. Thus, while we observe a 3vs1 pattern with the subjects, with all NCI manifesting a higher tone than a DP subject, we see a 2vs2 pattern on the object with NCIs in the DN and NegOb condition realized with a comparatively higher tone than in the NC condition where the NC did not differ from the DP object in the NegSub condition. For duration, we found the same 3vs1 pattern for the

second syllable of the subject, with all three NCI subjects being longer than the DP subject in the NegOb condition, and some version of the 2vs2 pattern on the object+PP1—with DN and NegOb tending to be longer, while NC and the DP object in the NegSub condition tended to be shorter. Finally, we found that in the sentence-final window the DN and NC conditions do not significantly differ in F0, meaning that the sentence final contour does not distinguish between the conditions.

6 Discussion

6.1 Characterizing the prosody of French ambiguous multiple negative statements

In this section, we consider our results in terms of what they reveal about the prosodic analysis of French multiple negative sequences. Following a brief recap of the core features of French prosody, we return to our research questions and, based on our quantitative results, offer a prosodic characterization of each of our four conditions.

The autosegmental-metrical (AM) framework, which frames our discussion here, conceives of intonational tune as composed of a structured sequence of underlying H and L tones, with some tones associating with metrically prominent syllables to form pitch accents, and others marking the edges of prosodic constituents. What distinctly characterizes French prosody is that accents are defined at the phrasal level, not lexically as in Italian or English. In French, three levels of prosodic constituents are commonly distinguished: the Accentual phrase (AP) which has a tonal pattern (L (H L)H*) with a final H* tone that has a demarcative function[10]; the intermediate phrase (iP), distinguished by phrasal tones coded T-; and the larger intonational phrase (IP), marked with a final boundary tone coded T% (Jun & Fougeron, 2000). Two phonetic cues are well-known to distinguish among AP, ip, and IP boundaries, namely F0 peak height, and vowel duration (Michelas & German, 2020). So, besides pitch, the final accented syllable of a French rhythmic group is characterized by a significantly longer duration than the syllable preceding it (Jun & Fougeron, 2002). An AP-final H*, however is preempted by a higher level (IP) boundary tone and is generally realized as a L% in declarative statements. How focus is marked in French remains controversial. For some authors, focus is manifested by a large, sharp rise and fall in pitch contour and an increased duration on the focused element (Rossi, 1985; Touati, 1989; Di Cristo & Hirst, 1993; Clech-

[10] In APs with fewer than four syllables, either the H tone, the following L tone, or both fail to be realized, leaving a single rising tonal pattern LH*. This is what is seen here, with the bi-syllabic subjects (personne) in our experimental stimuli.

Darbon, Rebuschi, & Rialland, 1999; Di Cristo, 1998). Material following the focus presents a reduced melodic register and is described as "flat", "deaccented" or "dephrased" (Touati, 1989; Di Cristo, 1998; Clech-Darbon et al., 1999), though as Jun and Fourgeron (2000) have argued, a post-focus sequence while deaccented or melodically compressed, is not always dephrased, as duration of AP-final syllables is often maintained. For Féry (2001) phrasing, rather than pitch accent, is what characterizes French focus. She argues that a focused constituent forms its own phrase, with its own tonal structure, and sometimes short breaks before and/or after the phrase boundaries. She provides experimental evidence that after a focused subject, the remainder of a sentence is realized with a low intonation and no correlates of phrasing, and when an object is focused, it is phrased separately, and the following (but not the preceding) material is dephrased. In recent work, Michelas and German (2020) observe yet another possible effect of focus marking in French. They provide evidence that when a prosodic AP boundary coincides with the right edge of a focus constituent, it can be raised to the next structural level up in the prosodic hierarchy (compared to what it would otherwise be under broad focus). Finally, as Avanzi et al (2014) have shown, monosyllabic French verbs can sometimes be independently phrased and sometimes dephrased, depending on their prosodic weight.

With this brief summary of French prosody and our acoustic results we now return to answer our original research questions concerning the prosody of multiples negative sentences, repeated here below:

1. In ambiguous sequences of NCI like (1) in French, can the two possible readings—NC and DN—be distinguished phonetically, acoustically, and prosodically?

If so:

2. How do the two readings differ? More specifically,
    a. What are the phonetic/acoustic properties that characterize the NC reading?
    b. What are the phonetic/acoustic properties that characterize the DN reading?
3. What do these prosodic profiles reveal about the prosodic structure and its interactions with the syntax, the semantics, or the pragmatics of these ambiguous sentences?

Our acoustic results allow us to answer our first research question positively. It is clear that when uttering ambiguous sentences with multiple NCIs, speakers produce characteristic acoustic distinctions when conveying the DN vs. the NC interpretation. The DN and NC readings differed in the F0 domain, where our analysis identified two main regions of

831 statistically significant contrast: the first on the second syllable of the subject NCI, and the
832 second on the end of the object NCI. On the subject NCI, that there is a significant distinction
833 in F0 in the height of the peak on the second syllable of '*personne*', spilling over the negative
834 'ne'. On the object NCI, there is a significant distinction both on the height of the peaks as well
835 as on the duration, with some spilling over onto the first syllable of the PP. What characterizes
836 the NC reading acoustically then, is a slightly lower earlier[11] peak on the NCI subject, and a
837 distinctively lower peak on the object NCI. By contrast, the DN reading is characterized by a
838 slightly offset, more pronounced peak on the subject and a significantly higher peak on the
839 object, as well as by a significant lengthening of the last syllable of the object NCIs and the
840 first syllable following it.
841 Although statistically significant, these differentiating measures do not constitute a prosodic
842 analysis for these readings, since such an analysis must be based on rhythmic structure assumed
843 to be perceivable by speakers. The question of perception will be addressed in a forthcoming
844 companion paper presenting a perception experiment. Here we endeavor to offer a prosodic
845 characterization of the two readings in the following section.

846 ### 6.2 Framing acoustic results within current prosodic models

847 We turn now to a discussion of how our acoustic results can be analyzed within a current AM
848 prosodic model to characterize the prosodic contour of each of our conditions. The fact that the
849 NCIs in the subject position in the DN, NC, and NegSub conditions present a heightened F0
850 and increased duration as do the NCI in object position in the DN and NegOb condition is
851 consistent with the view that they are focused. This provides evidence that NCI in French are
852 systematically associated with focus when they are semantically interpreted as negative. We
853 further suggest that the NC and DN readings are characterized by a potential phrasing
854 difference, consistent with Féry's view that focus in French can be expressed through phrasing,
855 but perhaps more with Michelas and German's (2020) boundary promotion hypothesis. We
856 now consider the prosodic profile of each reading in more detail.
857 For NC, the prosodic analysis we propose is represented in (16). We suggest that the subject
858 NCI *personne* is focused, forming its own accentual phrase with a low tone on the first syllable,
859 and a high boundary tone marking the subject accentual phrase on the second syllable. The
860 object NCI, on the other hand, though bearing the phrasal tone of the VP, manifests a lower
861 H* tone with respect to the second NCI in the DN condition and in the NegOb control
862 condition. It is essentially equivalent in F0 to a regular non-focused DP object. We note that

[11] It is possible that the slight distinction in the peak on the first NCI in the NC vs DN condition is influenced by the duration distinction. Duration being significantly longer in DN, the peak occurs slightly later.

this clearly indicates that the object NCI in the NC condition, in contrast to all other NCI in the other conditions, is not under focus. We take this to be consistent with the NCI being under a post-focal pitch compression in the NC reading (Di Cristo 1998; Jun & Fougeron 2000; Féry 2001; Dohen & Loevenbruck 2004). Now, as our data show, the object NCI in the NC condition is essentially equivalent to a regular DP object in a transitive sentence. That is, it appears to form a phrase with the Verb and to carry the naturally downstepped H* tone of the VP AP. Why then consider it as post-focally compressed? Note that we have evidence that in the single negation conditions (NegSub and NegOb), NCIs always associate with focus manifested by a combination of heightened F0 and increased duration. This is also true in the DN condition. It is only in the NC condition that the association between NCI and focus fails on the object NCI, so that comparatively, the object NCI is melodically 'compressed' in the NC condition when it is not associated with a negative interpretation.

(16) NC: Focus on *personne*; *rien* post-focally compressed and phrased as part of VP

L H_f* L L H- L-L%

(([$_{DP}$Personne]$_{AP}$) ([$_{VP}$ne Verb rien]$_{AP}$)..([$_{PP}$…PP…]$_{AP}$)$_{IP}$)

Although F0 on the subject NCI is slightly lower for the NC interpretation than for DN, its rather elevated height resembles the subject NCIs in the single negative condition and differs from that of a non-negative DP subject (Fig. 8A & 8B). Furthermore, the syllable duration of the NCI subject does not differ in NC from the DN condition, nor does it differ from the NCI subject in the single negation condition, and all are significantly longer than a non-negative bi-syllabic DP subject. These findings support the view that the subject NCI is under focus. Furthermore, the fact that in the NC condition, the NCI-object *rien* is i) realized with a peak lower than the NCI object of a single negative condition, i.e., NegOb, and ii) turns out to be essentially comparable to a monosyllabic non-negative object in the NegSub condition is expected, if as we propose, the object NCI is under-post focal pitch compression on this reading as a consequence of the focus on the subject NCI. Although signs of post-focal melodic compression on the object are present (flatter melody in our acoustic analysis, cf. Figure 5), phrasing does not seem to be affected[12]. The NCI object in the NC condition appears

[12] Our interpretation of pitch compression is here relative to what occurs with a single NCI object in a regular transitive sentence, i.e here the NegOb condition.

phrased with the monosyllabic verb forming a VP phrase and it continues to manifest the increased duration characteristic of an AP boundary (Michelas & German, 2020). Although shorter than the NCI object in the DN and NegOb condition, the NCI-object in the NC condition is longer than a monosyllabic non-negative object. This observation appears to support the Jun and Fougeron (2000) proposal that material after a focused phrase in French can be melodically compressed, without being dephrased.

Turning now to the DN interpretation, the prosodic analysis we propose in (17) below differs characteristically from that of the NC condition. While, as in NC, we take the subject NCI to be focused in the DN condition, given the amplified height of its peak which significantly differ from NC and spills over to the next syllable of 'ne', which though under an L is higher in DN than NC, as well as the increased duration of its second syllable, we suggest that it may additionally form an iP. As argued in German and Michelas (2020) one available strategy for conveying additional prominence in French can involve promoting the level of the boundary from what would normally occur in an all-focus context here a subject AP, to a prosodic higher structural level, here an iP. This analysis remains tentative here, because our subject is only bisyllabic so that the difference in prosodic boundary level is only marked with pitch range. Further verification with NCI that have a more complex prosodic structure would be needed to confirm this potential distinction between the NCI subject in the NC condition, which though under focus is hypothesized to remain an AP, and the NCI subject in the DN condition, for which the significant distinction in F0 and duration can support the raising to an iP level as a way to mark focus, following Michelas and German (2020) hypothesis that focus can produce a raise in the hierarchy of a boundary tones.

This could also explain why in this condition, the object is not affected. Indeed, the core distinction of the DN prosodic profile is that there is strong evidence that the object NCI is also focused, carrying on its one syllable a L+H* or rising phrasal boundary tone. The low tone is often observed on the glide of *rien*, which appears sometimes almost syllabified (ri.jE) and the H* occurs on the nasal vowel. This is supported both by the height of the peak on the object NCI *rien* being the highest in comparison to all other conditions and duration consideration. Although the length of the monosyllabic *rien* does not significantly surpass that of other conditions, especially that of the NegOb condition, for which the object NCI also appears focused, lengthening in the DN condition is much more evident when the first syllable of the subsequent PP is taken into account. Because the DN condition exceeds all other conditions on both F0 and duration measures, this suggests that the focused object forms the core of its own

phonological phrase and that the verb which in turn, is squeezed between two foci, may be deaccented and possibly dephrased (Avanzi et al. 2014) on the DN interpretation as does the final PP, which is generally marked with low tones up to the final boundary tone L%.

(17) DN: Focus on *personne* which forms *iP;* V is "dephrased" (Avanzi et al. 2014); Focus on *rien* which forms the core of its phonological phrase.

L H_f- L L H_f*- L-L%

((([$_{DP}$Personne]$_{AP}$)$_{iP}$ [$_{VP}$ne Verb ([$_{DP}$rien]$_{AP}$)] ([..PP..]$_{AP}$)$_{IP}$)

Nobody Neg Verb nothing

When we consider our two baseline conditions (NegSub and NegOb), there is evidence that the NCI subject and the NCI object are also focused in these single negative conditions. For the NegSub condition, we observe that the subject NCI is essentially equivalent in height to the NC condition and distinct from the non-negative subject NP in the NegOb condition. Duration of its second syllable is also comparable to that of the NC condition and significantly distinct from that of a non-NCI subject in the NegOb condition. These two acoustic measures both support the view that in the NegSub condition, the NCI subject is focused and forms its own accentual phrase, essentially paralleling the subject in the NC condition. For the NegOb condition in contrast, tonal evidence and duration support an analysis of focus on the NCI object since it manifests a prosodic profile comparable to that of the object in the DN condition. (Fig 8C, D). Here as well, the object forms the core of its accentual phrase, while the pre-focus monosyllabic verb is deaccented and possibly dephrased (Avanzi et al., 2014) and the post-focus PP is melodically compressed. The prosodic analysis we offer for these single negation conditions are depicted in (18) and (19) for NegSub and NegOb respectively.

(18) NegSub: Focus on the subject NCI. No focus on the object.

L H_f* L L H- L-L%

((([$_{DP}$Personne]$_{AP}$)$_{iP}$ ([$_{VP}$ne Verb DP]$_{AP}$) ([..PP..]$_{AP}$)$_{IP}$)

(19) NegOb: Focus on the object NCI.

L H* L L H_f* L-L%

((([$_{DP}$ DP]$_{AP}$)$_{iP}$ ne Verb ([$_{DP}$ rien]$_{AP}$) ([..PP..]$_{AP}$)$_{IP}$)

We can summarize our prosodic analyses as follows. In the NC condition, the subject NCI is focused while the object NCI is under post-focal pitch reduction though not dephrased but rather phrased along with the verb as in a regular transitive statement. In the DN condition,

961 both the subject and the object NCI are focused and may form their own independent
962 prosodic phrases, while the verb and final PP are deaccented (and possibly dephrased). Given
963 that our NCI subject and object are both rather short, the full expansion of the phrasing
964 differences we propose, although experimentally consistent with our data, may nevertheless
965 turn out be rather subtle to perceive. Pitch reduction on the second NCI in the NC reading is
966 not accompanied by dephrasing, which may impede perception. In contrast, the second focus
967 on the second NCI in the DN reading makes for a more marked double focus prosodic
968 structure that could facilitate perception. In each of the single negative conditions, the NCIs
969 are focused, and the post-focus areas melodically compressed. These prosodic and acoustic
970 analyses support the conclusion that when the NCIs in French are negatively interpreted--in
971 the sense that they associate with a semantically negative denotation and sentential scope--
972 they appear to be systematically focused. In contrast, the non-negatively interpreted object
973 NCI in the NC condition appears to be under post-focal pitch compression[13].
974
975 As noted above, and as observed in our four experimental conditions, the final boundary tone
976 in the production of our negative sentences, multiple or single, is generally a falling tone F%.
977 This is not particularly surprising for our single negation or NC sentences since these are all
978 negative statements, expected, like positive ones, to simply offer a speaker's update to the
979 discourse context. This may be less expected in the case of the DN readings of our multiple
980 negative sentences, however. Recall that in previous investigations of the ambiguity of multiple
981 negative prosody in other NC languages, reviewed above in Section 2.3, the DN interpretation
982 was regularly associated with a contradiction contour[14]. This contour, in particular the end,

[13] An interesting question that our findings raise is why should negative interpretation and prosodic focus be linked. One possible avenue is suggested in recent work on the pragmatics of negation by Tian (2014) and Tian and Breheny (2016). For Krifka 2007:20"focus indicates the presence of alternatives that are relevant for the interpretation of linguistic expressions". Within the framework of dynamic semantics, Tian & Breheny propose that 'negation is a cue to recovering a prominent QUD' through accommodation and that in this respect it has a function that closely parallels that of focus. As they note, their proposal clearly raises the question of whether negation triggered QUD accommodation could be unified with prosodic focus triggered QUD accommodation. In a negative sentence ~p such as 'the door is not opened', the truth of the proposition is what is at isssue and hence the QUD that is most prominent is 'whether p'. But if focus is on 'the door' or on 'open' then the QUD changes, becoming either What isn't open or The door isn't what? In the cases under consideration here, when focus and negation are associated on an NCI, it would seem that the corresponding QUD must range on this argument with negation eliminating all the possible alternatives introduced. For instance, in a sentence with a single negative such as 'Personne n'est parti' (nobody left), the corresponding QUD would be ' Who left' with negation then eliminating all the alternatives introduced, i.e., ~ john left, ~Paul left etc. for all alternatives considered. Further exploration of this complex link, though certainly needed, lies outside the scope of this particular paper.

[14] A related contour with a rise-fall pattern termed "implication contour" is also discussed for French by Portes et Reyles (2014). As they note, however, the "implication" contour is not the only rising-falling movement of

appears to share some similarities across the different languages studied, culminating in a fall-rise and especially a final H% boundary tone. A similar description for a contradiction contour in English is discussed in Goodhue & Wagner (2018). They provide a picture (reproduced as Figure 10) of a characteristic rendering of the contradiction example (20) below:

(20)A: You are not a friend of Jenny's

B: No, I am a friend of Jenny's

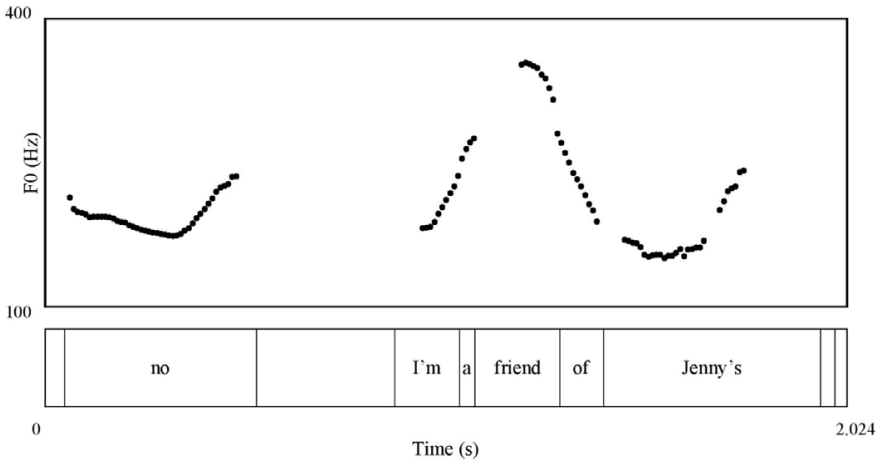


Figure 10. The characteristic contradiction contour reproduced from Goodhue & Wagner (2018).

Our experimental data do not support the view that a contradiction contour (or context) is involved in fostering access to a DN interpretation here. Since the final boundary tone of our DN utterances is usually L%, this tone tends to signal an agreement with the interlocutor as well as a commitment by the speaker to the truth of the proposition stated, not a disagreement or correction (Beyssade & Marandin, 2007; Ward & Hirschberg, 1985). Recall that our multiple negative stimuli were designed as statements meant to reinforce the situation described in the context, for both the NC and the DN readings. The final low boundary tone observed in our data serves as evidence that this was indeed how speakers interpreted the target propositions. Our results, hence, provide solid evidence that neither a contradiction context, nor a contradiction contour is needed for speakers to access DN readings in French. The most common pattern for DN readings obtained here involves focusing of both NCIs and a final L% boundary tone signifying speaker consent and readiness for update rather than the denial of a previous statement or presupposition. In this respect, double negation readings in French

French intonational inventory. It is sometimes confounded (but should not be) with the rise-fall of the AP which has a high f0 target localized on the penultimate syllable, while with the implication contour, it occurs on the final (full) syllable. This implication contour is not in evidence in our data.

cannot be taken to always involve a non-compositional metalinguistic negation[15] but can be understood as supporting a compositional semantics compatible with the grammar of the language. Such a compositional analysis in turn supports the conclusion that French NCIs can be semantically negative expressions.

6.3 Theoretical Implications

In this final section, we discuss what the distinct prosodic profiles we uncovered reveal about the interaction of prosody with the syntax/semantics and pragmatics for the French ambiguous negative sentences considered. The goal of this section is to outline some broad implications from our experimental findings on the intonation of French multiple negative sentences for the different theoretical models in the literature. We refrain from outlining a specific analysis within a particular model, both for space and because of the nature of our prosodic findings remain exploratory.

Our brief review of the theoretical landscape in Section 2.2 distinguished three main types of approaches to negative concord dependencies, 1) the agreement approach, 2) the resumptive quantification approach and 3) the ambiguity approach that lead to differing predictions concerning conditions on the accessibility of NC and DN readings for speakers and the contribution of grammar to these possibilities. Here we consider broad implications that our empirical findings support with respect to these theoretical approaches. Our discussion will stay clear of detailed aspects of particular theoretical accounts to aim at general consequences for the treatment of these negative dependencies.

In current multiple Agree approaches (Ladusaw, 1992; Zeijlstra, 2004; Penka, 2011; Giannakidou, 2006) negative concord is derived compositionally on the assumption that all NCIs in a concordant sequence are non-negative expressions licensed syntactically and semantically under agreement with a c-commanding negative operator (Zeijlstra, 2004 and following). On this view, all NCIs in a sequence have the same non-negative interpretation and entertain the same dependency with negation; they are hence expected to behave alike[16]. Such a predicted parallelism, however, is not supported in our data which reveal, on the contrary, a distinctive asymmetry. For the NC reading, our study provides evidence that while the subject NCI is focused, the object NCI manifests post-focal pitch reduction. That is, we show that in a concordant sequence with a single negative reading, one NCI is clearly realized with more prosodic prominence than the other. At best, then, these findings raise unexpected

[15] Contradiction can of course also be a triggering factor for a DN in French. See Larrivée (2016) for a discussion.
[16] See Haegeman and Londhal (2010) for similar theoretical conclusions on multiple Agree models of NC to which they bring their own challenges.

questions for multiple Agree models, as they show that concordant NCIs have asymmetric prosodic effects on one another. Concerning the DN reading, given the parametric distinctions that Agree models posit, as Puskas (Puskás, 2012, p. 628) puts it "we expect DN to be impossible" in NC languages like French, a pronouncement that does not square well with its confirmed availability in our results and the demonstrated success of context in influencing the availability of DN readings for French speakers (Figure 3). Within this framework, however, Puskás (2012) articulates an interesting account of how DN readings obtain in Hungarian, where she argues, NCIs are non-negative expressions. She proposes that DN readings can be licensed if one [uNeg] NCI moves to a focus position that houses the negative version of a Verum Focus operator, while the other is licensed as usual in this model, i.e., under agreement with the regular negative operator. For Puskás, it is the conjoined semantic presence of the two negative operators (i.e.: the regular sentential negation and the negative verum focus operator) that builds DN readings with semantically non-negative NCIs. Prosodically, Puskas describes the Hungarian DN reading with different intonation patterns for the two NCIs involved: the post-verbal NCI is uttered with a flat deaccented prosody, while the preverbal one bears a heavy primary stress H*L, marking association with focus in Hungarian[17]. Pragmatically, DN readings in Hungarian are said to have a corrective import akin to denial or metalinguistic negation, which unlike regular negation is used not to reverse the truth value of a proposition but rather to object "to a previous utterance, on any grounds whatsoever" (Horn, 1989, p. 362). Although Puskás' proposal succeeds in allowing DN with non-negative NCIs, it does not align well with our prosodic findings for French. The tonal pattern she discusses of one NCI being focused and the second NCI deaccented or melodically compressed indeed resembles one we observe in our data. But in French, it links quite solidly with the NC reading rather than with the DN one. Furthermore, since the negative Verum Focus operator of Puskás' account is meant to encode the corrective import of a DN reading, the prediction--presumably correct for Hungarian--is that DN readings should not occur in the absence of corrective import. But as we observed, a corrective import and a correlative contradiction prosody do not come into play to elicit DN readings in French in our results[18]. Hence the problem of how DN could arise in French in the absence of such a Verum focus operator in a framework with only non-negative NCIs remains open.

[17] Puskás' prosodic description is based on intuition, not experimental findings.

[18] The French presentative cleft construction in (7) above (Lambrecht, 1994) which involves, a syntactically focused NCI, a favored DN reading, and a corrective function seems to present more similarities to the Hungarian DN constructions Puskas discusses than the simple transitive sentences considered in this paper.

We now consider the implications of our findings for the resumptive quantification model (May, 1990; Déprez, 2000; de Swart & Sag, 2002; de Swart, 2009; Fălăuș, 2007; Iordachioaia, 2009) which takes NCIs to be negative quantifiers that can be interpreted either with relative scope -- leading to a compositional DN reading–or as forming a single negative polyadic quantifier leading to the single negation NC interpretation. Clearly, the demonstrated highly ambiguous nature of French multiple negative sentences, confirmed here experimentally (Fig 3) is consistent with the built-in constructional ambiguity of the resumptive quantification approach. These results, in contrast, clash with the parametric distinction between NC and DN characterizing the agreement approach for which contextual DN/NC ambiguity for individual speakers is unexpected. Our results furthermore show that French NCIs when interpreted negatively appear to systematically associate with prosodic focus. This is evident both in our critical (NC and DN) conditions and in the unambiguous control single-negation conditions (NegSub, NegOb) where NCIs in subject or object positions manifest heightened peaks and longer duration compared to non-negative DPs. In contrast, the object NCIs in the NC condition whose pitch is reduced and comparable to that of a regular noun phrase possibly as a consequence of post-focal melodic compression fail to manifest an independent negative meaning. The relationship between focus and negative interpretation has been commonly underscored in the literature as, for instance, in Watanabe's (2004) analysis of NC, based on the premise that NCIs are inherently negative expressions when they associate with a possibly morphologically realized focus feature or in Giannakidou's distinction between emphatic NCIs and non-emphatic NPIs in Greek. Recent work by Giannollo (2020) further provides evidence of this link in the historical evolution of NPIs to NCIs, suggesting quite fittingly with our results that, in NCIs, association with focus can come to be grammaticalized (Gianollo, 2020). Our findings here provide prosodic evidence of the link between focus and negative interpretation for French NCIs. Evidence that both NCIs are focused in the double negation interpretation and that, as we suggest, they may form their own prosodic phrase fits well with the view that they are each independently focused and negatively interpreted to lead a compositional DN reading. Furthermore, within a resumptive quantification approach, our observation that in the NC reading, the subject NCI is focused while the object NCI is post-focally relatively compressed as a consequence suggests that there could be a prosodic constraint on the formation of the polyadic negative quantifier responsible for a single negation meaning in the NC condition. Instead of the parallelism constraint on resumptive quantification proposed in

(May, 1990)[19]and critically assessed in Déprez et al. (2015), which suggests that the resumptive quantifier formation is facilitated with NCIs that are morpho-syntactically or semantically parallel, our results suggest that the formation of a polyadic quantifier could instead be facilitated or conditioned by prosodic restrictions as follows:

(20) The members a of (negative) quantifier sequence [No(x)... No (y) R (x,y..)] can be interpreted as a n-ary polyadic quantifier $NO_{<x,y..>}$ R <x,y..> when they belong to the same enlarged prosodic domain, delimited on one end by a prosodically prominent/focused quantifier, and on the other end by (a) post-focally compressed one(s).

The prosodic constraint in (20) echoes Richards (2010) intonational proposal on wh-in situ licensing[20], and could bring new light on some of the locality restrictions which famously limit NC readings, with limitations ranging on how far pitch compression could affect post-focal material in particular languages, a topic still poorly understood at present. This prosodic constraint on polyadic quantification formation may also clarify why the morphosyntactic nature of the NCI as pronominal vs full DP matters for the interpretation of multiple NCI sequences in French and other languages[21]. Due to their smaller prosodic weight, pronouns like *rien* or *personne* may more easily fit within the dependent prosodic domain of a focused subject than full-fledged DPs like [aucun enfants] (no children) that are more likely to form accentual phrases in French. On a resumptive quantification analysis of NC, such a prosodic constraint, consistent with our experimental results, opens rich consequences that raise sufficiently intriguing new questions to warrant further investigations whose scope, however, is beyond the current study.

Let's finally turn to our third type of NC model, namely the contextual ambiguity approach pioneered in (Longobardi, 1987) and Herburger (2001). In both of these works, NCIs were assumed to be lexically ambiguous, but since then, a number of other quite diverse

[19] As Déprez et al (2013; 2015) showed although parallel pronominal NCIs sequences do indeed favor NC interpretations and, hence, the formation of a resumptive quantifier on May's view, parallel full DP sequences do not. This raises difficulties for a definition of parallelism in morpho-syntactic or semantic terms.

[20] Our formulation of the condition in (20) is clearly preliminary and needs further elaboration, which our current exploratory results do not allow us to pursue. For instance, like Richards (2010) proposal, it may need a restriction condition that no prosodic boundary intervenes between a focalized NCI and its 'dependent'. Such a more extended condition may explain why sequences like "persone ne dit jamais rien à persone' preferably lead to NC readings.

[21] Similar distinctions have also been noted in other languages. See Déprez et al (2015) for Spanish and Catalan, Iacoponi and Déprez (2017) and Acquaviva (1999)for Italian, Haegeman and Zanutini (1991; 1996) for West Flemish among others.

approaches grouped here under the same umbrella for brevity have been developed that attribute ambiguity to differences in the morphosyntactic feature composition of NCIs (Espinal and Tubau 2016b), the internal structure they may have (Déprez, 2000 and following) or a combination of NCI-internal negative features and the syntactic operations in which these features may take part (Collins & Postal, 2014; Déprez, 2018). As noted in Section 6.2, what our results suggest is that French NCIs are interpreted negatively only when they associate with focus and not when they are under post-focal compression[22]. It could be that this prosodic distinction supports a contextual ambiguity for NCIs. That is, the findings we report here are consistent with the view that NCI could be ambiguous between two different (lexical featural or structural) make ups: one that leads to a negative interpretation when the NCI comes with focus and one that leads to a non-negative interpretation when the NCI is not focused. Note however, that a pure ambiguity approach distinguishing a negative [+focus NCI] from a [-focus NCI] one (however this is achieved in given ambiguity models) must be supplemented by proper constrains to explain their contextually restricted distribution. Our results that NCIs fail to be interpreted negatively only when under post-focal compression, implies a dependency to the focused element that caused the compression in the first place. Yet this prosodic dependency is surely not a sufficient condition. A pitch compressed [-focus NCI] needs at least to have the properties of a strong NPI that requires negative licensing as it can only be licensed by a subject that is semantically negative. For French, furthermore a caveat is needed that the sentential marker *pas* must eschew this licensing since its co-presence with an NCI in the standard dialect always leads to a DN reading as in (2). Whether this effect of *pas* could relate to the prosodic properties of the standard French negation, is an interesting speculation, if for instance the presence of *pas* could be shown to play an intervention role that blocks post-focal compression. Though interesting, a verification of such speculations extend beyond the scope

[22] A reviewer asks what it could mean to have NCIs being both negative or non-negative. In some models, such as for instance Collins and Postal (2014), the distinction is achieved with featural make up. Some negative expressions are assumed to have one negative feature, some two. In the later, when both features remain within the same nominal domain, they semantically cancel each other, which results in a non-negative expression. This could correspond to the non-focused NCIs. Focus could in turn be interpreted as forcing one Neg feature to move out and take sentential scope. In other models, such as Déprez (2000, 2011) the ambiguity depends on the internal structure of the NCI. To be interpreted at the sentential level, a negative feature must occur at the edge of an NCI, which for DP, implies a high position often proposed to coincide with DP internal focus movement. On this view then, connecting negative interpretation to internal DP focus seems rather straightforward. In contrast, an NCI in which DP internal focus has not taken place would fail to have its negative feature at the edge, resulting in a non-negative NCI, or more exactly, in an NCI whose negative feature is uninterpretable. See Déprez 2018, Déprez et als 2019 for a proposal connecting edge position with interpretability for Neg features. These are only some options. There are more in the literature that cannot be explored here for the sake of brevity.

of this paper, as does the development of a specific proposal of how a given ambiguity model could integrate our results to explain the proper distribution of ambiguous NCIs. The point to be noted at present is simply that our findings appear compatible with an ambiguity approach, because of the link they establish between focus and negative interpretation and post-focal compression and its absence even if by itself, this link clearly does not suffice to address the distributional constraints that any successful ambiguity approach must tackle.

To take stock, in this section we have sought to evaluate broad implications of our prosodic findings for a variety of accounts of negative concord in the literature. A strong interpretation of our findings indicates that French NCIs are associated with a negative interpretation when they are prosodically focused and that this meaning can be recruited to build a compositional semantics for DN readings. In French, triggers for DN readings cannot simply be assumed to result from the specific pragmatic conditions linked to denial. If so, the possibility of these readings needs to be an integral part of the syntax of these French negative dependencies. In sum, the fact that French multiple NCIs constructions are eminently ambiguous between an NC and a DN reading, and manifest characteristically distinct prosodic profiles that map to their distinct readings argues for a language-internal ambiguity that must be built on their syntax/semantics properties, and against the view that French could manifest a parametric choice for NC, with DN arising as a consequence of a general pragmatic process of denial independent of the syntax of the language. Moreover, the particular prosodic characterization we have uncovered for each of the readings appears most compatible with models that make room, at least as one alternative, for a characterization of French NCIs as semantically negative.

A further speculative perspective opened by the finding of this paper is that the possibility of either NC readings or DN readings may be subject to prosodic constrains. We have shown that DN readings require that both NCIs be focused. Besides markedness, since double foci constructions are not very common, this finding predicts, for French, that contexts or constructions in which double foci are impossible should disallow DN readings altogether. NC readings, on the other hand, involve the association of a focused NCI with a post-focally compressed one that depends on it. We speculated that this dependency may constitute a prosodic constraint on the building of polyadic quantification or flag a specific NCI makeup that could well be sensitive to language-internal or crosslinguistic distinctions to be further understood.

7. Conclusion

To our knowledge, the present work constitutes the first experimental investigation of the prosody of ambiguous multiple negative sentences in French. As such, its first goal was to determine whether prosody was used by speakers to distinguish the two readings that these sentences allow, and if so to characterize the acoustic and prosodic cues that were recruited for this purpose. A first result that our production experiment provides evidence for is that the two readings are indeed acoustically and prosodically distinguished. We further show that the NC reading maps with a prosodic profile in which the first NCI *personne* has distinctive prosodic prominence while the second appears, by comparison, melodically subdued and compressed. In the DN reading in contrast, both NCIs manifest prosodic prominence and are independently prosodically phrased, leading to a structure where the subject NCI separates from the rest of the sentence in its own intermediate phrase, while the object NCI possibly builds its own accentual phrases with a significantly heightened peak and an increased duration. We interpreted these results as showing that the NC reading is distinguished by a prosodic dependency that the second compressed NCI entertains with a first focused one. The DN reading, in contrast, features two independently prosodically prominent expressions. As such, these findings support the view that prosodic prominence on French NCIs is linked to negative meaning, a conclusion confirmed by our observation that NCIs in single negative sentences also manifest prosodic prominence consistent with focus. As discussed above, these finding are most compatible with theoretical models for French that integrate the possibility of negative NCIs in the syntax/semantic interface and envision NC and DN alternations as both allowed by the grammar, independently of any macro-parametric choice that would allow only NC and leave DN readings to the discourse level pragmatics of denial or contradiction. Our findings demonstrate that DN readings in French can be triggered in pragmatic settings that do not involve objecting to a negative statement or presupposition but include the possibility of reinforcing a generalization present in the context. Based on our results, we further speculated that NC readings may be subject to a prosodic constraint, requiring one prominent NCI to trigger a prosodic dependency on another such as pitch compression. Verifying whether comparable prosodic restrictions also constrain NC readings in languages where they can alternate with DN could offer an interesting new avenue of research.

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Supplementary Materials

List of stimuli

Type	Context	Crit	Question	Answer	Verb	ID
Critical1 NC	Dans cet hôtel, les clients ne sont pas contents du service :	personne n’aime rien ici.	Tout le monde aime quelque chose ici.	F	aimer	1
Critical1 NC	Dans notre famille on est tous allergique à l'alcool :	personne ne boit rien dans les soirées.	Ils ne boivent pas d’alcool.	V	boire	2
Critical1 NC	Tous les profs s’ennuient en conseil de classe :	personne ne dit rien pendant les réunions.	Ils restent tous silencieux.	V	dire	3
Critical1 NC	Il fait vraiment trop chaud aujourd'hui :	personne ne fait rien dehors.	Ils ont tous trop chaud pour faire quelque chose.	V	faire	4
Critical1 NC	Les profs se plaignent tous que les élèves n’étudient pas pendant les vacances :	personne ne lit rien en été.	Les élèves lisent tous quelque chose.	F	lire	5
Critical1 NC	Depuis toujours, cette cantine est absolument infecte :	personne ne mange rien ici.	Les gens ne mangent pas ici.	V	manger	6
Critical1 NC	Dans ce pays, la monnaie n’a plus aucune valeur :	personne ne met rien à la banque.	Les gens placent leur argent à la banque.	F	mettre	7
Critical1 NC	On vient de couper l’électricité et il fait tout noir ici :	personne ne voit rien dans la pièce.	Ils voient tous quelque chose.	F	voir	8
Critical2 DN	Dans ce restaurant on trouve toujours quelque chose de bon :	personne n’aime rien dans les plats proposés.	Ils aiment tous quelque chose.	V	aimer	9
Critical2 DN	Chez les jeunes, la consommation d’alcool est effrayante :	personne ne boit rien dans les soirées.	Ils ne boivent pas d’alcool.	F	boire	10
Critical2 DN	Chez nous, les profs veulent tous donner leur avis :	personne ne dit rien pendant les réunions.	Ils disent tous quelque chose.	V	dire	11
Critical2 DN	A l’approche des dates butoir, tout le monde travaille dur pour finir à temps :	personne ne fait rien ces jours-là.	Ils ne font pas de travail.	F	faire	12
Critical2 DN	Dans cette école exceptionnelle, absolument tous les élèves font leurs devoirs :	personne ne lit rien pour sa classe.	Les élèves lisent tous quelque chose.	V	lire	13
Critical2 DN	Même quand on fait un régime, il faut se nourrir :	personne ne mange rien pendant un mois.	Ils ne mangent pas pendant un mois.	F	manger	14
Critical2 DN	La plupart des gens amassent un tas de bricoles inutiles :	personne ne met rien dans son placard.	Les gens laissent les placards vides.	F	mettre	15
Critical2 DN	Les études cognitives nous montrent que même les aveugles ont une vision inconsciente :	personne ne voit rien du tout.	Tout le monde voit quelque chose.	V	voir	16
Critical3 NegOb	La rupture avec son copain l’a complètement déprimée :	Noëlle n’aime rien en ce moment.	Noelle déteste tout.	V	aimer	17
Critical3 NegOb	Quand on sort, il faut un chauffeur sobre :	Raoul ne boit rien aujourd’hui.	Il ne boit pas d’alcool.	V	boire	18
Critical3 NegOb	Parce qu’elle est très timide,	Aline ne dit rien pendant les cours.	Elle dit toujours quelque chose.	F	dire	19
Critical3 NegOb	Comme elle est très religieuse,	Marla ne fait rien le dimanche.	Marla fait toujours quelque chose le dimanche.	F	faire	20
Critical3 NegOb	Comme elle travaille comme relectrice toute la semaine,	Marie ne lit rien le week-end.	Marie lit quelque chose le week-end.	F	lire	21
Critical3 NegOb	Pour bien digerer,	les gens ne mangent rien le soir.	Les gens ne mangent pas le soir.	V	manger	22
Critical3 NegOb	Comme il est très dépensier,	Julien ne met rien de coté pour l'avenir.	Julien n’économise pas son argent.	V	mettre	23
Critical3 NegOb	Elle est très intelligente mais elle a la tête dans les nuages :	Lucie ne voit rien autour d’elle.	Lucie est très observatrice.	F	voir	24
Critical4 NegSub	Quand on s’amuse, on a pas toujours envie de rester sobre :	personne n’aime l’eau dans les fêtes.	Ils aiment tous l’alcool.	V	aimer	25
Critical4 NegSub	Dans ce bar, il y a de l’ambiance et on consomme beaucoup d'alcool :	personne ne boit d’eau ici.	Ils boivent tous de l’eau.	F	boire	26
Critical4 NegSub	Tout le monde fait très attention pendant ce cours :	personne ne dit mot pendant une heure.	Les étudiants restent silencieux.	V	dire	27
Critical4 NegSub	Beaucoup de gens se lèvent très tôt pendant la semaine,	personne ne fait ça le dimanche.	Ces gens font tous la grasse matinée le dimanche.	V	faire	28
Critical4 NegSub	Tous les meubles d’Ikea viennent avec des notices de montage :	personne ne lit ça en général.	Les gens ne lisent pas les notices.	V	lire	29
Critical4 NegSub	Les oeufs sont difficiles à digérer. On en mange plutôt le matin ou le midi :	personne ne mange ça le soir.	Tout le monde mange des oeufs le soir.	F	manger	30
Critical4 NegSub	Les mini-jupes sont super à la mode :	mais personne ne met ça à l’église.	Les femmes mettent toutes des mini jupes à l’eglise.	F	mettre	31
Critical4 NegSub	Dans la brousse, les gens se promènent tout nu :	personne ne voit ça ici.	On voit tous ça ici.	F	voir	32
Control	Il y a un match de foot cet après-midi :	tout le monde va au stade.	Les gens restent tous à la maison.	F	NA	33
Control	La leçon d'aujourd'hui n'était pas trop claire :	chaque élève avait des questions de clarification.	Les eleves n'ont pas compris la leçon.	V	NA	34
Control	Son ordi est cassé :	Alain va en acheter un nouveau.	Alain ne veut plus d'ordinateur.	F	NA	35
Control	Il fait vraiment très beau aujourd'hui :	tout le monde est dehors.	Les gens restent tous à l'intérieur.	F	NA	36
Control	Demain, c'est un long week-end :	tout le monde part à la campagne.	Les gens profitent de la nature.	V	NA	37
Control	Le printemps est arrivé :	tous les arbres sont en fleurs.	Il n'y a que des feuilles sur les arbres.	F	NA	38
Control	Aujourd'hui les gens ne se parlent plus face à face :	tout le monde utilise son téléphone portable.	Les gens n'ont pas de contact direct.	V	NA	39
Control	C'est une habitude chez nous après le diner :	tout le monde regarde la télévision.	Les gens regardent la télévision le soir.	V	NA	40

Participant exclusion protocol

We needed to ensure that participants understood the task, and that the contexts were generally successful in guiding participant interpretation. All participants performed effectively at ceiling for the fillers and single-negative controls (Figure S1A – same as Figure 3 in the text). For the critical items (DN & NC), responses to the verification questions were coded as being +/- contextually congruent, as well as +/- NC interpretation. For example, a contextually congruent DN response in the DN condition would be +congruent, -NC, and a contextually incongruent NC response to the same item would be -congruent, +NC, as a contextually incongruent response to a DN item would imply that the participant accessed an NC interpretation of the sentence.

For the DN & NC conditions, participants overall gave contextually congruent responses in 79.9% of trials. The influence of context was slightly higher in the NC condition (mean = 87.05%, t = 10.439, df = 27, p = 5.608e-11) than in the DN one (mean = 72.77%, t = 4.0083, df = 27, p = 0.0004329), but was significantly above chance in both cases. Participants were more likely to give contextually congruent responses for an NC item than a DN one (t = 2.1328, df = 45.298, p = 0.03839). This NC preference also appeared in an overall slight preference toward +NC responses ((+congruent) responses to NC items + (-congruent) responses to DN items) overall (mean NC = 57.14%, mean DN = 42.86%, t = 2.6212, df = 54, p = 0.01136, Figure 2B). For a more in-depth discussion of the contextual influence results and the effect of context on interpretation, see Déprez & Yeaton (2018).

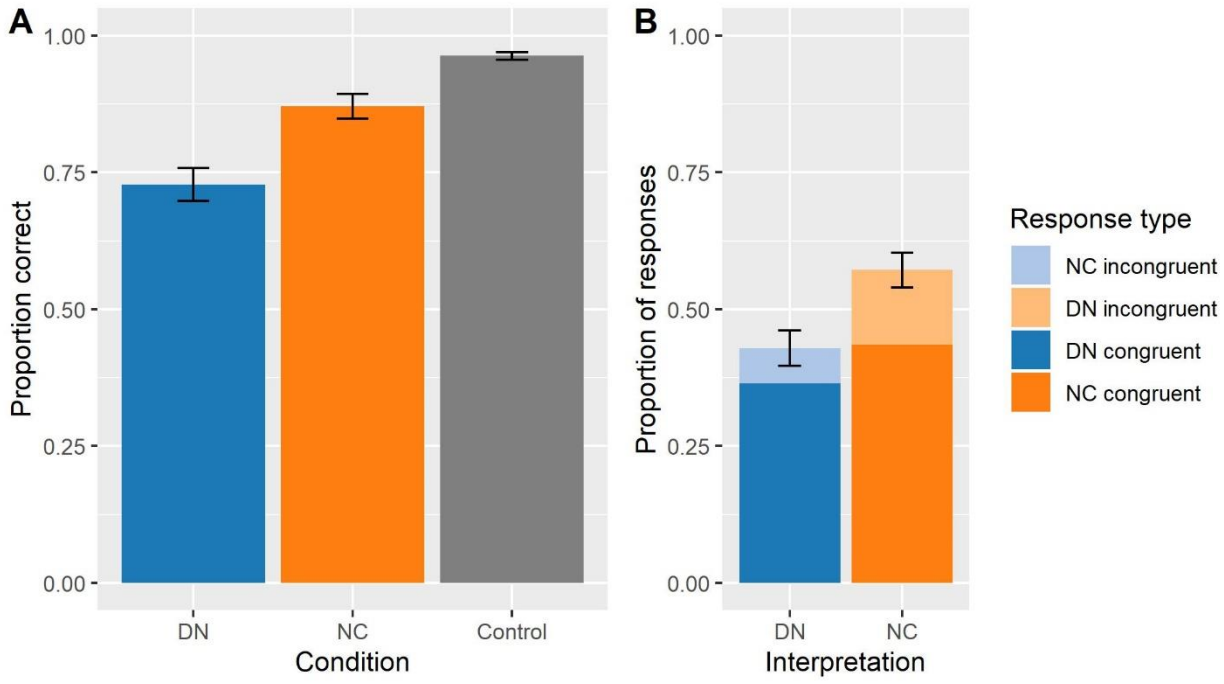

Figure S1: A (same as Figure 3 in the text): Percent context-matching responses by condition. Error bars represent 95% confidence interval. Participants performed at ceiling for the single negative controls and filler items. Overall context was very successful at guiding participant interpretation in the ambiguous DN and NC conditions, with contextually congruent responses significantly above chance in both conditions. B: Overall proportion of NC (NC congruent + DN incongruent) and DN (DN congruent + NC incongruent) responses to verification questions. There was an overall slight preference toward NC responses. Error bars represent 95% confidence interval.

Once we established that the contexts were overall successful in guiding interpretation, we wanted to include in our prosodic analysis only those participants who were susceptible of having a prosodic distinction between the two meanings, i.e.: the participants who readily accessed both interpretations. This was implemented by excluding from further analysis those participants who provided contextually incongruent responses to more than half of the items in either or both of the critical DN and NC conditions (n = 8). Once these participants were excluded, the productions of 20 participants (16F) remained included in the acoustic analysis. Participants' overall NC (NC congruent + DN incongruent) and DN (DN congruent + NC incongruent) responses are shown in Figure S2, with a single vertical bar representing each participant. The vertical black lines delineate the participants included in the acoustic analysis (between the black lines) from those excluded.

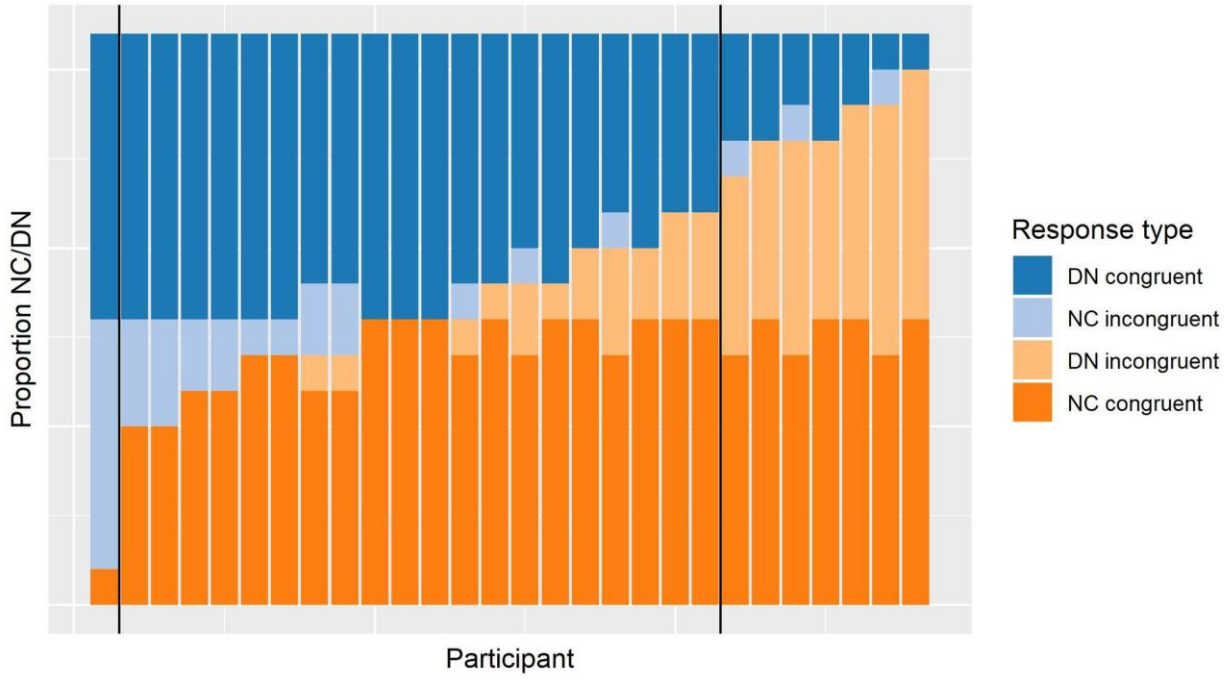

Figure S2. Overall DN and NC responses by participant. Participants' (one vertical bar per participant) overall NC (NC congruent + DN incongruent) and DN (DN congruent + NC incongruent). The vertical black lines delineate the participants included in the acoustic analysis (between the black lines) from those excluded.

Additional figures

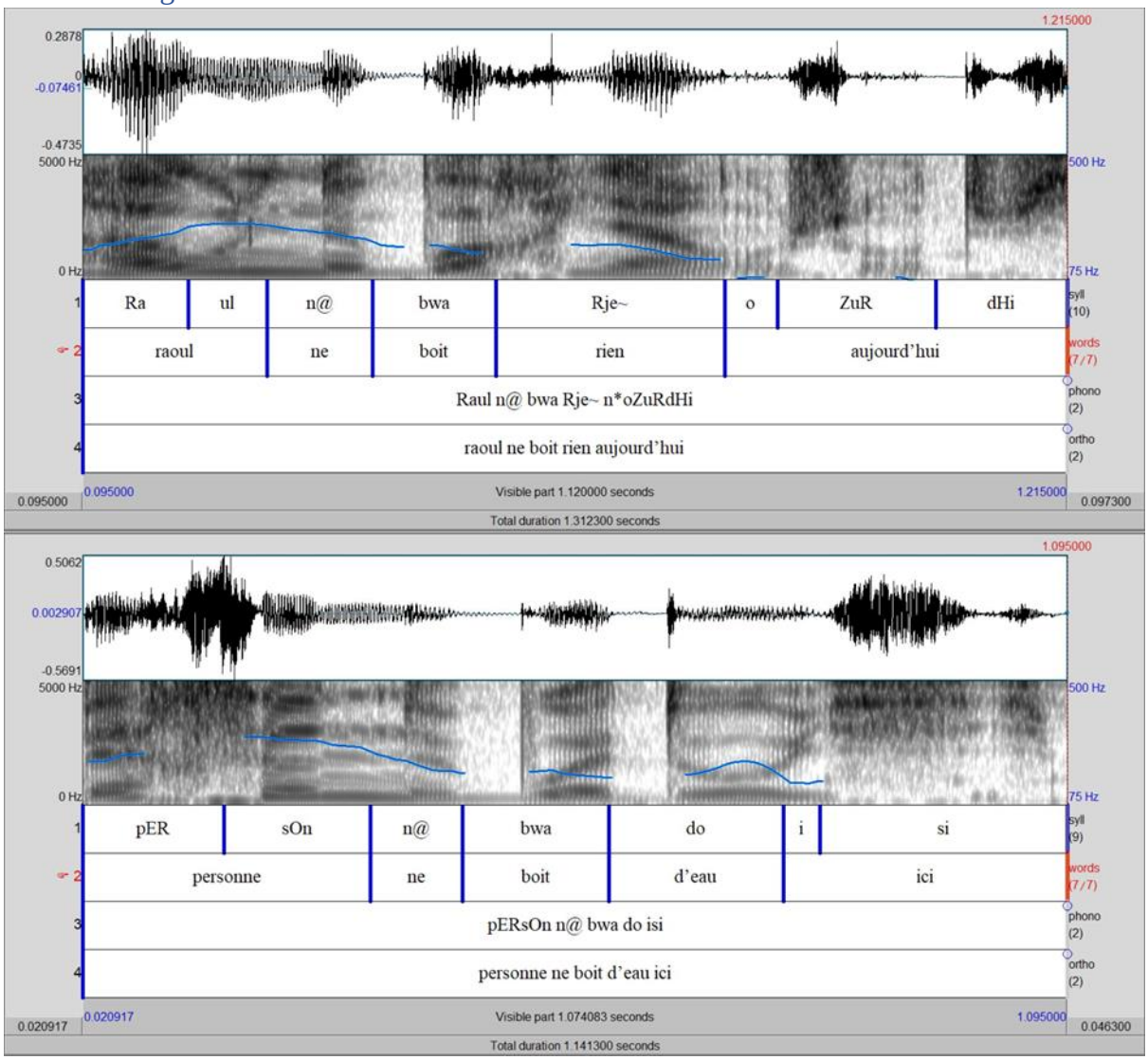

Figure S3. Praat images of representative NegOb (top) and NegSub (bottom) productions by the same speaker. Note the blue curve plotted over the spectrogram indicating f0.

Data and code availability statement

Stimuli were presented using the PyGame library (Shinners, 2011) in Python 2.7 (Van Rossum & Drake Jr, 1995) on an Asus laptop running Windows 7.

All data manipulation and statistics were conducted in R (R Core Team, 2019). GAMMs were fit using the mgcv package in R (Wood, 2004), and LMERs were fit using the lme4

package in R (Bates, Maechler, Bolker, & Walker, 2015). The dplyr (Wickham, François, Henry, & Müller, 2019) and tidyr (Wickham & Henry, 2019)packages were used heavily in the data preparation and organization. The ggplot2 (Wickham, 2016) library was used to produce the figures.

We have made the statistical analysis code and raw numerical data available via the OSF here: [Link to be added here after review]