Prosody and gesture constrain the interpretation

of double negation[*]

Abstract

The phenomenon of double negation (DN), by which two negative elements negate each other in such a way that a positive interpretation is obtained, has traditionally been considered in terms of its syntactic and semantic grammatical properties. Yet, correlated prosodic and gestural features exist, such as specific pitch contours and gestures which potentially affect listeners in the speech act comprehension process. This study investigates the extent to which prosodic and gestural patterns affect the interpretation of DN in two Negative Concord languages, Catalan and Spanish. Participants of these languages were presented with audio and video files producing two target negative words, namely Catalan *ningú* and Spanish *nadie* 'nobody', with two different prosodic and gestural patterns that correlate with single negation or DN interpretations. Participants were asked about their preferred interpretation of the target negative word as meaning either 'nobody' or 'everybody'. Responses were obtained for an auditory-only (AO) condition, a video-only (VO) condition, and an audiovisual condition (AV) with congruent and incongruent multimodal matches. Faced with AO and VO conditions, participants of both languages preferred DN readings when the negative

word was accompanied with a contradictory intonational contour and with specific denial gestures respectively. In the AV condition, DN readings were picked up when prosody and gesture converged on the DN interpretation, otherwise single negation was preferred, with an increase in reaction times. These results demonstrate that prosodic and gestural patterns play an important role in linguistic comprehension processes and specifically in the interpretation of double negation.

1. Introduction

Double negation (henceforth DN) refers to a phenomenon of semantic composition by which two negative items negate each other's meaning and yield a positive interpretation (cf. Law of Double Negation; Horn, 1989). In the linguistics field, this phenomenon has traditionally been investigated in terms of its syntactic and semantic grammatical properties. As is well known, some languages encode the DN meaning within the limits of a single clause by combining two negative operators and/or quantifiers (e.g., Standard English *Nobody wants to do nothing* 'Everybody wants to do something')[1]. This is the expected interpretation in Double Negative languages such as English and Dutch. In these languages, negative operators and quantifiers co-occurring within the clause negate each other and imply a positive reading.

Some other languages, i.e., the so-called Negative Concord (henceforth NC) languages, typically allow for the combination of two or more negative items within the clause to express a single negation with no cancellation (e.g., Italian *Non ho visto nessuno* lit. not have seen nobody 'I haven't seen anybody'). These languages are claimed to encode DN only out of the limits of a single clause, when a negative operator in the subordinate clause cancels the meaning of a negative operator in the main clause

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[1] Unlike Standard English, which is a DN language, most dialects of English allow negative readings for sentences with multiple negative items. A sentence such as *Nobody wants to do nothing* can therefore be interpreted as ''Nobody wants to do anything' in these dialects.

(e.g., Spanish *No quiero que no venga* lit. not want that not come = I don't want him/her not to come', so 'I want him/her to come'). As is known from the literature, this is the expected interpretation in Romance languages such as Italian, Romanian, Catalan, and Spanish (e.g., Labov, 1972; Horn, 1989; Zanuttini, 1991, 1997; de Swart & Sag, 2002; Giannakidou, 2000, 2006; Zeijlstra, 2004; Tubau, 2008).

However, a number of studies have shown that DN interpretations can be felicitous both in Strict NC languages (such as Romanian; Falaus, 2007) and in Non-Strict NC languages (such as Catalan; Tubau & Espinal, 2012) when the sentence introduces two negative operators, one of them being non-overt.[2] Other studies have shown that the possibility of obtaining DN readings in NC languages is dependent on the fact that adequate formal and conversational conditions are met. Contrastive focus, stress, prosodic phrasing, and intonation have been highlighted as conditions that can favor DN readings crosslinguistically (see Corblin, 1995, 1996, and Vinet, 1998, for French; Corblin & Tovena, 2003, for French and Italian; Molnár, 1998, and Puskás, 2006, 2012, for Hungarian; Zanuttini, 1991, 1997, Godard & Marandin, 2007, and Penka, 2007, for Italian; Falaus, 2007, for Romanian; Huddlestone, 2010; Biberauer & Zeijlstra, 2012, for Afrikaans; Espinal & Prieto, 2011, for Catalan).

It should be noted that instances of DN in NC languages have been claimed to be marked and rare in spontaneous speech (Horn, 1989; Zeijlstra, 2004; de Swart, 2010), since they yield a marginal interpretation. The real problem, however, is that they correspond to a phenomenon of which we still ignore the set of interacting conditions required for their licensing. DN in these languages is semantically marked because, in

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[2] See Giannakidou (1998) for the distinction between two types of NC languages, namely Strict NC vs. Non-strict NC languages (Romanian versus Spanish or Catalan, for example), based on the fact that the first group of languages require an overt negative marker in preverbal position independently of the position of an overt n-word in the clause. This distinction has been correlated with the phenomenon of DN, and it has been proposed that Strict NC languages do not allow DN readings (Giannakidou, 2006).

spite of being logically equivalent to an affirmative sentence, it is conceptually more complex, since it requires processing the negation of a negative item or sentence against a negative proposition that might not be explicit in the linguistic context. Among its conversational conditions, some authors have pointed out that in order to license a DN interpretation, it is important that discourse context provides access to a denial of an accessible negative proposition (Espinal & Prieto, 2011), either a piece of information explicit in the preceding discourse, an inference warranted by preceding text, or a piece of information stored in the common ground (cf. Dryer, 1996; Prince, 1992). Taking this requirement of a denial of a negative proposition or presupposition into account (Geurts, 1998), it is not surprising that DN readings can be inferred not only from full sentences but also from isolated n(egative)-words (Laka, 1990) that constitute isolated answers (Corblin, 1994, 1995, 1996, for French; Espinal & Prieto, 2011, for Catalan).

 Suppose the following two situations:

(1) A. Your office is in chaos, so you call the IT technician to come and fix all the computers. When he arrives he asks:

What isn't working?

  B. An IT technician is called to another office to repair their computers, but he comes to your office instead. When he arrives he asks:

What isn't working?

With respect to the first context a reply such as Catalan *res* 'nothing' will be interpreted as implying that no computer is working in the office. However, with respect to the second context, we have noticed that the same n-word, pronounced in a certain way, can imply that every computer is working in that office, thus denying the negative presupposition of the IT technician.

The question still to be addressed is what the linguistic cues that guide the hearer at the time of interpreting an isolated n-word in a NC language as either implying single negation or DN are. In a recent paper, Espinal & Prieto (2011) investigated DN interpretations in isolated n-words such as *ningú* 'nobody' and *res* 'nothing' in Catalan. The results of these perception experiments showed that the presence of a contradictory intonation contour in the target n-word was a sufficient condition to trigger a positive interpretation for the n-word: that is, intonation, not focus, is the prime factor that conveys DN in the interpretation of Question – Answer dialogues. In line with Fretheim's (1996) and Escandell's (1998) proposals on the role of intonation in inferential processing, Espinal & Prieto (2011) claim that prosody is able to constrain meaning by guiding the hearer/listener at the time of interpreting an n-word in context. Importantly, different intonation contours encode different constraints on the communicated proposition, and can reverse the negative meaning of n-words to a positive meaning, in accordance with the available contextual setting. Thus, prosody is being used to link the utterance with an epistemic state of the interlocutor and allow listeners to identify the speakers' contradictory statement with respect to a discourse-activated assumption. And this is the crucial pragmatic effect of DN interpretations in NC languages: it corresponds to a presupposition denial (Geurts, 1998).

Although some prosodic aspects of DN have been investigated, to date no attention has been paid to the multimodal aspects of DN interpretation across languages and, in fact, very little is known about the interactions between the prosodic and gestural aspects of speech that are candidates for triggering DN interpretations. Recent investigations have shown that visual and gestural input provides crucial information for online linguistic interpretation (see McNeill, 1992; among many others), but no attention has been paid to the multimodal aspects of DN interpretation across languages

and to the potential interactions between prosody and gesture. Audiovisual speech studies have revealed that the visual component plays an important role in various aspects of communication typically associated with verbal prosody. The gestural correlates of prominence and focus —such as eyebrow flashes, head nods, and beat gestures— (Krahmer & Swerts, 2007; Swerts & Krahmer, 2008; Dohen & Loevenbruck, 2009), as well as echoic question intonation (Srinivasan & Massaro, 2003; Borràs-Comes & Prieto, 2011), uncertainty (Swerts & Krahmer, 2005), and even the expression of null subjects (see Jouitteau 2004 for French), have been successfully investigated. With respect to negation, Harrison (2009), in a recent study on the multimodal expression of negation, investigated the gestural patterns found in negative speech acts in English spontaneous speech. The results showed that speakers temporally synchronize and integrate verbal and gestural expressions of negation. However, it should be noted that none of these studies have addressed the associations between both the prosodic and gestural aspects of sequences that are optimal candidates for conveying DN interpretations.

Multisensory effects have been investigated for speech prosody and gestures at a linguistic level, like in perceiving emphasis or in identifying an interrogative utterance. Swerts & Krahmer's (2008) study showed that conflicting visual and auditory prosodic information can affect the location of prominence/emphasis prosodic features. Borràs-Comes & Prieto (2011) showed that when Catalan listeners are presented with conflicting visual and prosodic information when trying to identify counterexpectational questions, they rely more heavily on gestural cues. Even though prosody and gesture are treated as distinct and separate modules with little or no interaction, it has become increasingly clear that gestures are used to express pragmatic discourse meanings and that gesture-prosody interactions contribute to multimodally specific percepts. Related

to these topics new interesting questions should also be raised, such as: which part of prosody interacts with gesture, and whether all prosodic information can be read off from syntactic structure.

Within this line of research, it becomes relevant to investigate the potential semantic interactions between prosody, gesture, and the linguistic expressions used. One of the goals of this study is to make a step in this direction and to explore the extent to which non-verbal cues (i.e., prosodic intonation patterns and gestural patterns) affect the interpretation of very basic linguistic units, so called n-words, as either expressing single negation or DN. To our knowledge, this will be the first experimental study on how negation-related prosodic and gestural patterns influence the interpretation of the overall message. We will test the relevance of not only intonation but also gestures, as well as their matched and mismatched combinations in two different NC languages. To test these effects, two interpretation experiments were conducted involving a single n-word in isolated contexts in two Romance languages, Catalan and Spanish (Cat. *ningú* and Sp. *nadie* 'nobody').[3] Participants were presented with audio and video files comprising these n-words with prosodic and gestural features associated with negative and DN readings, and were asked about their preferred interpretation of the target n-word as conveying either a 'nobody' or an 'everybody' interpretation. The claim we make is that, even though these n-words are not lexically ambiguous, they may convey two completely distinct interpretations in context.

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[3] For the purposes of this study, we assume that n-words are negative indefinites that incorporate a zero numeral meaning (Déprez 1997) and that are underspecified for quantificational force (Wouden & Zwarts 1993, Rooryck 1994, Martins 2000, and Espinal 2000), which makes n-words vague rather than ambiguous (contra Herburger 2001). See, among others, Bosque (1980) and Laka (1990) for an analysis of n-words as NPIs; Zeijlstra (2004) and Penka (2007, 2010) for an account of n-words as indefinites that are syntactically specified for negation; Zanuttini (1991), Haegeman & Zanuttini (1991), and Haegeman (1995) for an analysis of n-words as negative quantifiers; de Swart & Sag (2002) for a polyadic negative quantifier analysis; and Herburger (2001) for an account of n-words as lexically ambiguous between NPIs and negative quantifiers.

The data were presented in three conditions according to modality of presentation, namely, an auditory-only (AO) condition, a video-only (VO) condition, and an audiovisual condition (AV). Within the AV condition, in some cases prosody and gestures were congruent (prosody: "nobody-DN"; gesture: "nobody-DN"), and in other cases they were incongruent.

Among Romance languages, Catalan and Spanish are both Non-Strict NC languages in the sense mentioned above. Still, Catalan differs slightly from Spanish in the fact that it is more flexible in allowing n-words and negative markers to co-occur in preverbal position to infer a negative meaning (e.g., Cat. *Ningú (no) vindrà* vs. Sp. *Nadie (*no) vendrá* 'Nobody will come'; see, e.g., Bosque, 1980; Sánchez, 1999; Solà, 1973; Espinal, 2000, 2002, 2007; Tubau, 2008), and in isolated answers (e.g., Catalan *No gens* lit. not nothing 'nothing'; Spanish *No nada lit. not nothing). In our view, it is especially relevant to test the potential effects of prosody and gesture with listeners of two NC languages (with Catalan leaning a bit more towards a Strict Negative Concord language), which in theory should display a general resistance to obtaining DN readings. (See note 9 below)

In this study, we will assess experimentally the hypothesis that prosodic and visual features significantly contribute to online DN inference. We will test not only the relevance of intonation but also of gestures, as well as their matched and mismatched combinations in two different types of NC languages. It is hypothesized that DN interpretations for isolated n-words can be obtained in NC languages when specific prosodic and gestural information is available; and, furthermore, that prosodic and gestural information will interact with and constrain linguistically encoded information.

2. Methodology

With the aim of testing the effects of prosodic and gestural cues and their interaction in the identification of DN interpretations for isolated n-words, we ran a set of decision tasks with native speakers of Catalan and Spanish. In all of the tasks, participants had to rate the negative answers/stimuli (Cat. *ningú* / Span. *nadie* 'nobody') as conveying either 'nobody', the default meaning, or 'everybody', the marked DN interpretation.

In Section 2.1 we present the participants that took part in the experiment, in Section 2.2 we explain how the audiovisual recordings and materials were prepared, and in Section 2.3 we describe the procedure followed at the time of running the experiments. Section 2.4 gives information about the model used for measuring the results.

2.1. Participants

A total of 30 Central Catalan speakers (21 women and 9 men; mean age = 27.17; stdev = 9.735) from the Barcelona area (mainly students of the Universitat Autònoma de Barcelona and the Universitat Pompeu Fabra) and 30 Peninsular Spanish speakers (22 women and 8 men; mean age = 23.07; stdev = 4.948) from the Madrid area (mainly students of the Universidad Autónoma de Madrid) participated in the experiment. For the Catalan participants, Catalan dominance was 86.67% (stdev = 15.884), according to their own reports of the amount of time per day in which they speak Catalan. Spanish participants were monolingual.

2.2. Audiovisual recordings and materials

In order to investigate which gestural and intonation patterns are representative of the target utterances with negative and DN interpretations, a production study was first run

with four native speakers of Catalan and four native speakers of Spanish.[4] A set of productions of the target words *ningú* 'Cat. nobody' and *nadie* 'Sp. nobody' were videotaped after they were presented with a target discourse context and question displayed in (2). Such a question, containing an explicit sentential negative marker in both languages, involves a negative presupposition (i.e., *Somebody did not eat dessert*). Speakers were asked to reply to this negative question providing either a simple negative answer *Nobody ate dessert* or an answer that would contradict the negative presupposition. That is, with one of the two target answers, namely the one where the n-word is associated with the marked prosodic pattern and gesture associated to DN, the speaker who answers the question corrects the questioner's presupposition and denies it, i.e. *It is not the case that somebody did not eat dessert*, which results in the conversational implicature *Everybody ate dessert.*

(2) DISCOURSE SETTING

CATALAN: Una mare entra al menjador quan els altres tres membres de la família estan entaulats. Mira la fruitera i demana…

— Qui no ha menjat postres?

SPANISH: Una madre entra en el comedor cuando los otros tres miembros de la familia están sentados en la mesa. Mira el frutero y pregunta…

— ¿Quién no ha comido postre?

'A mother enters the dining room while the three other members of the family are sitting around the table. She looks at the fruit bowl and asks…'

'Who did not eat dessert?'

Please note that in the perception experiment (Section 3) we tested exactly this context, with the two negative questions and the target subject n-words: Cat. *ningú /Span. nadie '*nobody'.
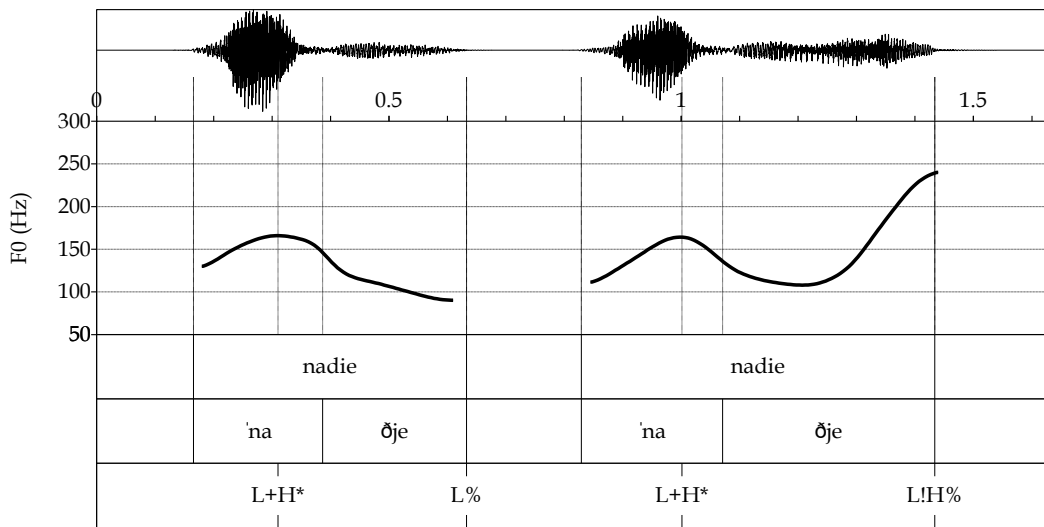
For the audiovisual recording of the specific target negative words, each of the eight speakers was asked to pronounce the two instances of the target n-word *ningú / nadie* in a particular way, i.e., one clearly expressing a negative meaning (that corresponds to the lexically encoded meaning 'nobody' of the n-words) and the other one conveying a positive interpretation (that contradicts the negative presupposition, and yields DN, that is, 'everybody'). Even though no specific instructions were given to speakers about how to perform the positive and negative answers, we asked them to do it in an expressive and convincing way.

The recordings were performed in a quiet room at the Universitat Autònoma de Barcelona using a professional digital video camera (Panasonic AG-HMC41). The speakers were videotaped against a uniform white background, facing the camera. The head and upper part of the body were recorded, based on the hypothesis that manual gestures were important in the expression of negation and double negation. The video recordings were digitized at 25 frames per second, with a resolution of 720×576 pixels. The sample rate of the sound was 44,100 Hz using 16-bit quantization. A total of 32 utterances were produced (4 speakers × 2 meanings × 2 repetitions × 2 languages) and submitted to prosodic and gestural analysis.

The prosodic characteristics of the target utterances (durations and prosodic transcription according to the Cat_ToBI and Sp_ToBI systems[5]) were coded with Praat (Boersma & Weenink, 2008). As expected, the majority of utterances in the two

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[5] For more details on the Cat_ToBI and Sp_ToBI systems for Catalan and Spanish intonation, see Prieto, (in press) for Catalan and Beckman et al. (2002) and Estebas-Vilaplana & Prieto (2010) for Spanish.

languages were produced with the two target intonation contours described in the literature.[6] Figure 1 shows a schematic representation of the intonation contour produced for the single negation renditions (left) and the intonation contour produced for the double negative renditions (right). The negative intonation contour corresponds to a typical broad focus tune in both languages, which has been labeled as L+H* L% in the Cat_ToBI and Sp_ToBI systems, i.e., a rising pitch associated with the stressed syllable followed by a falling tone associated with the posttonic syllable(s)). The DN intonation contour corresponds to the so-called contradictory intonation contour and is represented as L+H* L!H% (i.e., a rising pitch associated with the stressed syllable followed by a complex falling-rising tonal movement aligned with the posttonic syllable(s)).

Single negation (NC)	Double negation (DN)

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[6] See Espinal & Prieto (2011) for a formal and semantic description of the contradictory intonation contour L+H* L!H% in Catalan.
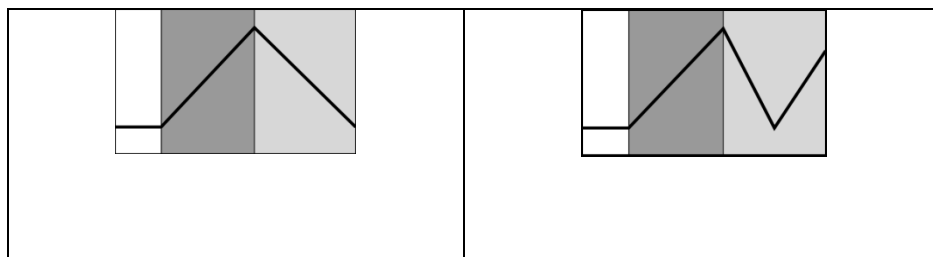
Figure 1. The upper part of the figure shows the spectrogram and F0 contours of the Spanish *nadie* utterances, with a negative (left) and a double negative meaning (right). The bottom part shows representative schematic intonation contours. Stressed syllables are represented with dark gray and posttonic syllables with light gray.

With the help of the interface program ELAN (see Lausberg & Sloetjes, 2009 for a reference on this program), the target utterances were also submitted to independent gestural analysis. Gesture form was coded according to guidelines published by McNeill (1992). As for head gestures, not included in McNeill's guidelines, we followed Alwood et al. (2009). Some examples of the coding procedure are explained below.

Table 1 illustrates the variation in gesture types found in the target 32 productions produced by the eight speakers (8 participants × 2 meanings × 2 repetitions) of *Ningú/Nadie* 'Nobody' in the N (Negative) and DN (Double Negative) interpretations. Since we did not observe variation between the renderings of Catalan and Spanish speakers, we collapsed the results of the two languages. The results show some predominant patterns which are shown in bold type. First, shoulder shrugging was only found in the DN renderings. As for head movements, there is a predominant use of head shake in both N and DN renderings. Some head nods were also found, especially in the DN context, and three out of the 7 cases were produced in conjunction with a head shake. An additional head gesture found was head tilt, with only a case in the DN interpretation. As for manual gestures, three manual configurations appeared in our

production task. The first manual gesture consists of the two palms down describing an horizontal movement across the body, from the center of the body to its periphery; this manual gesture was only found in N interpretations (see the top panel in Figure 2). The second manual gesture consisted of the two palms up moving outwards from lower center to left and right periphery; this manual gesture was mainly found in DN interpretations (see the bottom panel in Figure 2). Though these two manual gestures were the most frequent in our production task, an additional manual gesture was found only for DN interpretations, consisting of moving only up the right palm, orientated towards the center of the body, from center of the body to its upper periphery, at the height of the head. Standard labels of these three manual gestures (according to McNeill, 1992: 78-89, 377-387) are provided at the bottom of Table 1.

Interpretation		
Gesture	**N**	**DN**
Shoulder shrug	0	**13**
Head shake	**16**	**11**
Head nod	1	**7**
Head tilt	0	1
Manual PTD*	**10**	0
Manual PTU**	1	**13**
Manual PTC***	0	2

*Manual PTD = 2SH (the two hands performing the same gesture) # B (palm open) # PTD (palms towards down) # moving outwards horizontally from center to left/right periphery

**Manual PTU = 2SH (the two hands performing the same gesture) # B (palm open) # PTU (palms towards up) # moving outwards from lower center to left/right periphery

***Manual PTC = RH (the right hand) # B (palm open) # PTC (palm towards center) # moving up from center to upper periphery

Table 1. Gesture types found in the target 32 productions of *Ningú/Nadie* 'Nobody' in the N (Negative) and DN (Double Negative) interpretations, in the two languages.

Figure 2 offers an example of the combinations of manual and non-manual gestures that were most commonly associated with each meaning, and which were chosen as

items for the experimental materials. As we can see in the top panel, for the expression of negation, speakers displayed a head gesture consisting of a headshake together with a gesture consisting of two palms down across the body in a horizontal movement. According to McNeill (1992: 78-89, 377-387), these can be described as 'hand = 2SH, shape = B, palm orientation = PTD, motion shape and place = moving outwards horizontally from center to left and right periphery'). As for the expression of DN, our speakers displayed an open palm/open arm gesture (hand = 2SH, shape = B, palm orientation = PTU, motion shape and place = moving outwards from lower center to left and right periphery), accompanied by a head nod and/or headshake gesture, which corresponds to a general meaning of contradiction and denial/challenging of a discourse assumption.

NEGATION

SHOULDERS: relaxed

HAND/ARM: 2SH B PTD moving outwards horizontally from center to left/right

periphery

HEAD: headshake

DOUBLE NEGATION

SHOULDERS: shrugging

HAND/ARM: 2SH B PTU moving outwards from lower center to left/right periphery

HEAD: head nod and/or headshake

Figure 2. Stills of the representative gestures produced with a negative meaning (top; Catalan actress 3) and a DN meaning (bottom; Spanish actor 2).

The gestural patterns found for denial gestures in our data are comparable to the ones found by Harrison (2009) in English. He found three types of palm down gestures, six vertical palm gestures, and headshakes and head nods, which play an important role in the gestural expression of negation. As for the gestural patterns associated with the meaning of contradiction (i.e., the palms up gesture/ headshake), they have also been documented in previous investigations in other languages. We explain the occurrence of a headshake in this context because of the fact that those DN responses are in fact 'negating' the presupposition contained in the negative wh-question, namely, the DN response is negating the assumption that someone did not eat dessert on the part of the speaker (thus implicating that everyone did). Regarding the palms up gesture, even though Kendon (2004) points out that it is used in contexts where the speaker is offering, giving or showing something or requesting the reception of something, it is clear that the palms up gesture has an unusually wide range of possible meanings. Recently, in a study of three open-palm hand gestures in French, Ferré (2011) claims that: (1) open-palm gestures play a role at different levels of the verbal interaction as they are multi-functional; (2) one of the functions of the palm up gesture is the one of reinforcing "a secondary judgmental modality to the utterance" (in many cases a negative judgment) or reinforce epistemicity".[7]

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[7] Ferré (2011) gives the following example to illustrate the point that the palms up gesture is related to a meaning of negative judgment and/or modality (p. 14): "In the first example (Figure 6a), two speakers are talking about expecting a baby. The wife of one of the speakers is pregnant at the time of the recording,

For the target materials of the perception experiment, we selected the most representative audiovisual recordings from each speaker, i.e., two instances of each n-word (associated with two interpretations: single negation and DN) for each actor, for a total of 16 utterances (4 speakers × 2 meanings × 2 languages). The files were segmented into several audio files and movies each lasting second using Adobe Premiere CS3.

As for the incongruent video clips, they were created using Sony Sound Forge 10 by replacing the sound in the two target video clips, and generating new mpeg video files. With respect to AV binding, we aligned the new acoustic information by taking the boundary between the two syllables of *ningú* [niŋ.'gu] and *nadie* ['na.ðje] as an anchor point. By doing this, we kept the suprasegmental-to-speech alignment properties of our acoustic stimuli. Two separate raters evaluated the mismatched AV target stimuli and reported that AV synchrony was perceived to be totally natural to allow our participants to integrate auditory and visual information (see, e.g., Bischoff et al., 2007, on audiovisual binding and the ventriloquist effect). Finally, half the AV files were termed 'congruent', where the gestural and prosodic features matched, and half of them were termed 'incongruent', where the gestural and prosodic features were mismatched.

2.3. Procedure

The 60 participants were tested individually in their target language. In the experiment that we ran to Catalan hearers, they listened to the context recorded in Catalan, the

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and the second speaker, who already has a little boy, is talking about his own experience. At this point in the recording, he makes a short joke about the fact that his partner went into labor while they were watching a TV series that he likes, an activity which was interrupted by their having to rush to the hospital. The other speaker elaborates on the joke with the feedback "putain, elle aurait pu attendre la mi-temps quand-même" (jeez, she could really have waited till half-time). Just before he begins his utterance, he starts producing a flip of his left hand which he holds palm upwards until the end of the utterance. With this gesture, he reinforces the negative judgment which is also present in speech in the exclamation "putain" (jeez) and the discourse marker "quand même" (really). The gesture can therefore be considered as carrying a judgmental modality which participates in the conveying of humor."
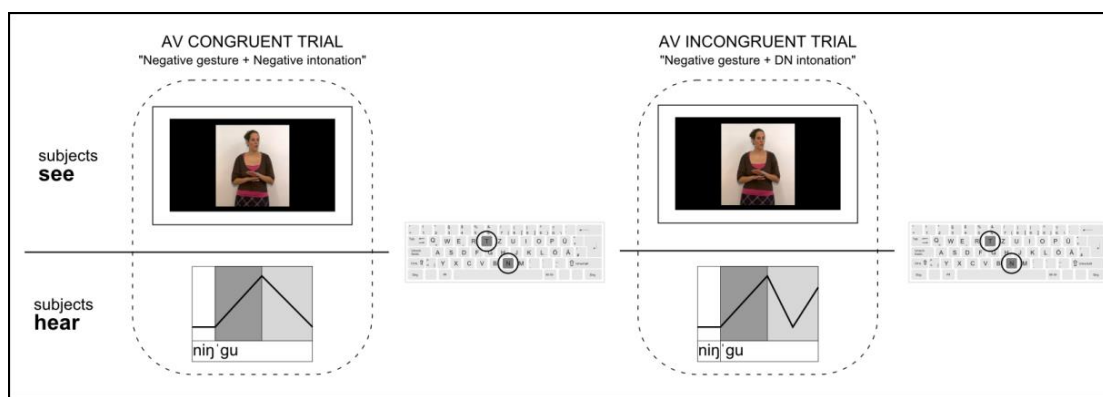
17

question *Qui no ha menjat postres?* in (2), and the target answer *ningú.* In the experiment that we ran to Spanish hearers, they listened to the context recorded in Spanish, the question *¿Quién no ha comido postre?* in (2), and the target answer *nadie.*

The test experiment was divided into three tasks, one for each modality: auditory-only (AO), visual-only (VO), and audiovisual (AV). The presentation of the tasks was fully balanced across participants in the following way. The AO and VO tasks were run first, and their order was counterbalanced in two groups of participants. The AV task was run after presenting all participants with the AO and VO tasks. In the three tasks, participants were first presented with the aims of the experiment and then were presented with the target communicative context in (2) above, followed by the negative question in (2), which triggered access to a negative presupposition, namely *Somebody did not eat dessert.* Preparing participants for this specific pragmatic condition in the discourse context guaranteed that listeners could felicitously associate the n-word with either a negative or a DN meaning. Participants were told that they would listen to or see speakers pronouncing the target n-word (Catalan *ningú* and Spanish *nadie*) as an answer to a Question-Answer pair. The participants were asked to indicate whether the Answer containing the n-word in isolation was interpreted as 'Nobody ate dessert' (single negation) or, rather, as 'Everybody ate dessert' (DN).

Presentation was controlled by means of E-Prime 2.0 (Psychology Software Tools Inc., 2009), which makes it possible to record response frequencies and reaction times automatically. Subjects were instructed to pay attention to the auditory stimuli and decide which interpretation was more likely for each stimulus by pressing the corresponding computer key, either "N" for the single negation interpretation (corresponding to the initial letter of Cat. *ningú* and Span. *nadie*), and "T" for the DN

interpretation (corresponding to the initial letter of Cat. *tothom* 'everybody' and in Sp. *todos* 'everybody'). The experiment lasted approximately 15 minutes.

Each task was composed of 6 blocks of repetition in which the full set of stimuli was presented to the subjects in a randomized order. A brief training session was conducted prior to the task in order to get subjects accustomed to the stimuli and task. For the first two (unimodal) conditions,[8] a total of 48 tokens were presented to each participant (2 intonational/gestural conditions × 4 speakers × 6 blocks). For the AV condition, in order to test the relative weight of prosodic and gestural cues in the rating task, congruent and incongruent audiovisual combinations were included, for a total of 96 tokens (2 intonational conditions × 2 gestural conditions × 4 speakers × 6 blocks). An example of the congruent and incongruent AV trials is illustrated in Figure 3. Subjects heard congruent and incongruent combinations of the stimuli of the negative word 'ningú/nadie' and had to decide on the two interpretations by pressing one of the two keys, namely "N" for the single negation interpretation or "T" for the double negation interpretation.

Figure 3. Representative examples of audio and video trials in two of the AV conditions, a congruent combination of negative audiovisual signals (left panel), and an incongruent combination of a negative visual signal plus a DN auditory signal (right panel).

We obtained a total of 5,760 responses for the AO and VO tasks (2 stimuli NEG/DN × 4 speakers × 6 blocks × 30 subjects × 2 languages x 2 tasks), and 5,760 for the congruent and incongruent AV tasks (2 intonation patterns × 2 gestural patterns × 4 speakers × 6 blocks × 30 subjects × 2 languages).

2.4. Measures and analyses

The response measures (perceived DN) and reaction time (RT) measures in the different conditions (AO, VO, AV) were analyzed using a Generalized Linear Mixed Model (GLMM) using IBM SPSS Statistics 19.0 (IBM Corporation, 2010). In all GLMM analyses, both subject and items were set as crossed random factors.

3. Results

In this section we present the results obtained from the 30 Catalan speakers and 30 Spanish speakers that participated in the experiments described in Section 2. The following two subsections present the analyses of the unimodal tasks (AO and VO; section 3.1) and the bimodal task (AV; section 3.2). The data were first checked for the occurrence of possible outliers on the basis of reaction time. These cases were those where the reaction times were at a distance of at least three standard deviations from the overall mean (Ratcliff, 1993): 255 cases in the AO condition ($\geq$ 3085 ms), 236 cases in the VO condition ($\geq$ 4191 ms), and 391 cases in the AV condition ($\geq$ 3929 ms). These cases were excluded from the analysis.

3.1. Unimodal tasks

The four graphs in Figure 4 show the mean perceived Double Negation (y axis) obtained in the two unimodal tasks (AO and VO), for the two languages tested (Catalan and Spanish). The x-axis represents the stimuli used, i.e., the target intonation patterns used in the case of the AO task and the target video clips used in the VO task. They are coded as follows: in the AO condition, "N" represents the intonation contour L+H* L% and "DN" represents the intonation contour L+H* L!H%; in the VO condition, "N" represents the video trials involving the negation gestures, and "DN" the video trials involving the double negation gestures. The graph shows that in both unimodal conditions (AO and VO), the stimuli properly convey their intended meaning, that is, DN inputs were interpreted as DN readings by both Catalan and Spanish listeners. Specifically, the presence in the AO condition of the so-called contradiction intonation pattern in Catalan and Spanish (described as L+H* L!H% in autosegmental-metrical terms) and the presence in the VO condition of distinct contradiction gestures (i.e., palms up and open hand gestures, combined with rising shoulders) led to a clear activation of the DN readings. Combining the AO and VO responses, DN inputs obtain a mean of 82% of DN responses in Catalan and a mean of 77% of DN responses in Spanish. By contrast, for the Negative inputs only obtain a mean of 2% of DN responses for Catalan and a mean of 11% of DN responses in Spanish.
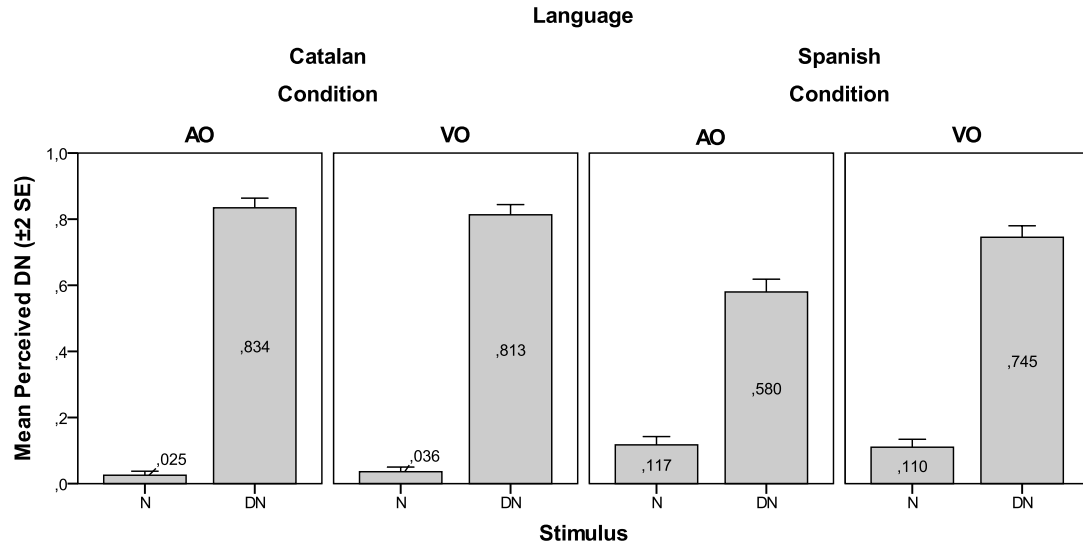
Figure 4. Mean perceived DN ratings in the two unimodal conditions AO (left) and VO (right) in the two languages: Catalan (left) and Spanish (right). The x-axis represents the intonation/gestural conditions, while the y-axis represents the perceived meaning: 0 for N and 1 for DN.

A GLMM analysis was run, with the perceived DN as the dependent variable. The fixed factors were CONDITION (AO, VO), STIMULUS (N, DN), LANGUAGE (Catalan, Spanish), and all their possible interactions. SUBJECT and SPEAKER were set as random factors. A main effect of STIMULUS was found ($F_{1, 5261} = 1322.864$, $p < .001$), and also a main effect of CONDITION ($F_{1, 5261} = 3.850$, $p = .050$), but no main effect of LANGUAGE ($F_{1, 10} = 0.422$, p = .531). Post-hoc analyses revealed that: (a) there is an expected main effect of Stimulus (that is N vs. DN stimuli) on the participants' responses, in the sense that DN stimuli triggered significantly more DN responses than N stimuli; (b) the main effect of condition is due to the fact that the VO condition triggered more DN readings than AO.

With respect to interactions, LANGUAGE × STIMULUS was significant ($F_{1, 5261} = 125.863$, $p < .001$), but not CONDITION × LANGUAGE ($F_{1, 5261} = 2.911$, $p = .088$) nor CONDITION × STIMULUS ($F_{1, 5261} = 0.373$, $p = .542$). The interaction LANGUAGE ×

STIMULUS is due to the fact that both N and DN stimuli triggered more N and DN responses respectively in Catalan than in Spanish (see Figure 4).

The triple interaction CONDITION × LANGUAGE × STIMULUS was also significant ($F_{1, 5261}$ = 15.148, $p < .001$). This result can be traced back to the fact that the effect of stimulus on DN ratings was lower when Spanish participants rated the AO materials than when they rated the AV materials, and that this was not the case for Catalan ratings (see Figure 4). In line with this, post-hoc tests also revealed that the effect of condition (AO vs. VO) was significant for Spanish ($F_{1, 5261}$ = 12.591, $p < .001$) but not for Catalan ($F_{1, 5261}$ = 0.022, $p = .881$).

It is important to note that even though there is no significant effect of language, Catalan utterances triggered higher DN responses in the AO task, and to a lesser extent in the VO task, than Spanish utterances. Qualitative prosodic and gestural analysis of the target stimulus materials (see section 2.2) revealed that Spanish DN pitch contours were produced with more compressed pitch range and shorter durations than Catalan pitch contours, which we interpret as the main cause for the lower DN ratings provided by Spanish listeners in the AO conditions. Correlation analyses between DN ratings and pitch range measures (i.e., pitch accent range, and boundary tone range) revealed a significant negative correlation between DN ratings and pitch range measures, i.e., less expressive contours were correlated with significantly lower DN ratings. Pearson correlation coefficients between perceived DN and pitch accent range equaled .354 (at $p < .001$; df = 1437) and between perceived DN and boundary tone range equaled .404 (at $p < .001$; df = 1437).

3.2. Audiovisual task

The two graphs in Figure 5 show the mean perceived DN (y-axis) obtained in the bimodal AV condition for the two languages tested (Catalan and Spanish). The x-axis represents the different combinations of the congruent and incongruent AV stimuli, coded as follows: "int-N" = negative intonation; "int-DN" = double negative intonation; "ges-N" = negative gesture; "ges-DN" = double negative gesture. From the graph it can be seen that only congruent AV conditions, located at both extremes of the x-axis, lead to the most clear readings. This means that these two combinations (i.e., [int-N, ges-N] and [int-DN, ges-DN]) are perceived as optimal at the time of conveying a negative or a DN reading, respectively. On the other hand, the other combinations (i.e., [int-DN, ges-N] and [int-N, ges-DN]) are perceived as suboptimal and obtain ratings that have a bias towards a negative interpretation (i.e., below 0.5 in the graph). This bias towards the N interpretation can be explained because N readings are the unmarked interpretation and, generally speaking, we observe that the formal properties of n-words constrain a negative meaning, unless external stimuli (intonation and gesture) point congruently towards a reinterpretation of linguistic meaning (see Discussion below).
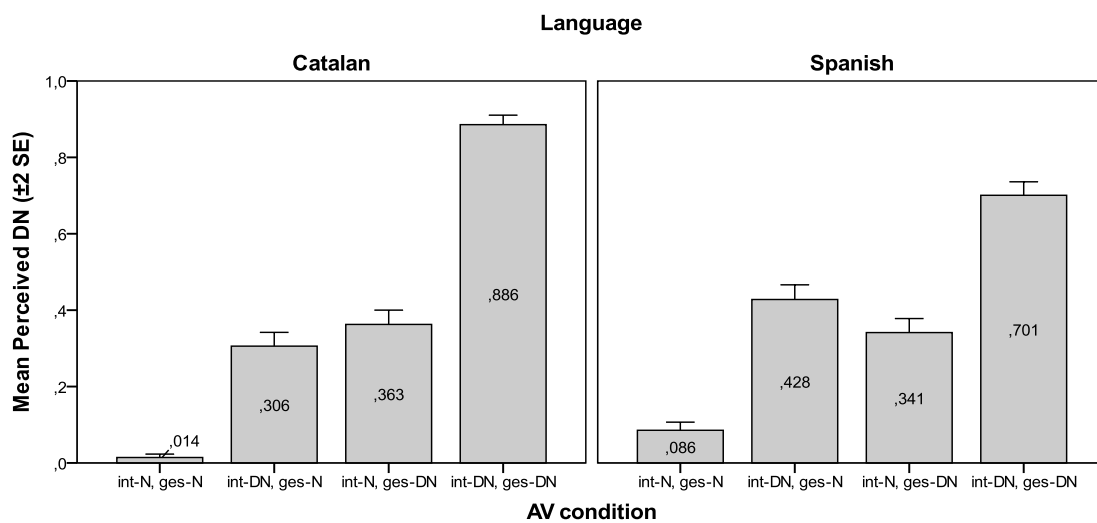

Figure 5. Mean DN ratings in the bimodal condition AV in Catalan (left panel) and Spanish (right panel). The x-axis represents the four possible combinations of the intonation condition with the gesture

condition, coded as follows: "int-N" = negative intonation; "int-DN" = double negative intonation; "ges-N" = negative gesture; "ges-DN" = double negative gesture. The y-axis represents the perceived meaning: 0 for N and 1 for DN.

To test the effects of intonation and gestural patterns in the AV condition, a GLMM analysis was conducted with the perceived DN as the dependent variable. The fixed independent variables were INTONATION (L+H* L% vs. L+H* L!H%), GESTURE (N gesture vs. DN gesture), LANGUAGE (Catalan, Spanish), and all their interactions. Again, both subject and speaker were set as random factors. Main effects were found for INTONATION ($F_{1, 5361} = 589.799$, $p < .001$) and GESTURE ($F_{1, 5361} = 559.304$, $p < .001$), but not for LANGUAGE ($F_{1, 8} = 0.409$, $p = .540$). All paired interactions were significant: INTONATION $\times$ LANGUAGE ($F_{1, 5361} = 32.980$, $p < .001$), GESTURE $\times$ LANGUAGE ($F_{1, 5361} = 80.271$, $p < .001$), and INTONATION $\times$ GESTURE ($F_{1, 5361} = 9.361$, $p = .002$). The triple interaction INTONATION $\times$ GESTURE $\times$ LANGUAGE was not significant ($F_{1, 5361} = 0.097$, $p = .756$). The statistically significant interaction between intonation and language is indicating that the effect of intonation on DN ratings was stronger in Catalan than in Spanish (see Figure 5). Similarly, the interaction between gesture and language shows that the gestural patterns triggered significantly more DN ratings in Catalan than in Spanish (see Figure 5). The interaction between intonation and gesture can be traced back to the fact that the four categories (int-DN, int-N, ges-DN, ges-N) do not have a systematic effect on listeners' responses, that is, their effects depend on how they are combined. Specifically, combinations such as [int-DN, ges-N] and [int-N, ges-DN] show a bias towards a negative interpretation.

Summarizing, the results of this section show evidence for the importance of the intonation and gestural patterns in the detection of DN interpretations (for the AO and AV conditions respectively). Moreover, when they are combined in 'congruent' and

'incongruent' gestural-prosodic combinations, the 'congruent' DN prosodic-gestural combinations are the ones that are most often interpreted as a DN utterance.

4. Discussion and conclusions

The results presented in this investigation show clear evidence that the semantic readings of the isolated n-words in Catalan *ningú* and Spanish *nadie* as either entailing a negative reading or implying a positive (DN) interpretation are strongly constrained by prosodic and gestural patterns. That is, prosodic and non-verbal cues (i.e., gestural patterns) crucially affect the interpretation of isolated n-words.

In the AO condition, it was found that the L+H* L!H% intonation contour (i.e., the so-called contradiction intonation pattern) consistently triggered a DN interpretation for isolated n-words. The results of this task corroborate recent claims in the literature which have highlighted the relevance of prosody in the interpretation of negation and DN across languages (e.g., Molnár, 1998 and Puskás, 2006, 2012, for Hungarian; Huddlestone, 2010, for Afrikaans; and Espinal & Prieto, 2011, for Catalan). In the VO condition, it was found that DN gesture patterns also triggered clear DN interpretations in both languages. In the specific case of DN interpretations, gesture also acts as a clear cue for the correction of a negative presupposition, hence overriding the lexical meaning of the n-word, as encoded by grammar. In fact, the results for the AO and VO conditions have acted as control conditions and support the claim that prosody and gesture can share a similar semantic function at the time of constraining the interpretation of DN. The present results thus advance our understanding of the impact of the perception of prosodic and visual information on the interpretation of DN. They are strongly significant and relevant for the debate surrounding negation and DN in a broader cognitive perspective, since they show that intonational contours and gesture

patterns have an immediate effect on the interpretation of linguistic expressions such as n-words.

Another novel result of the experiments is related to the interaction between prosody and gesture. In the AV condition, only "matching" or "congruent" prosodic and gestural patterns triggered clear negative or positive interpretations. DN interpretations associated with congruent audiovisual stimuli in the AV task thus provide evidence for a direct association between gestural and prosodic features linked with the detection of specific linguistic phenomena. It is informative to connect this result to the integrated-systems hypothesis (Kelly et al., 2011) and to research in other areas demonstrating bidirectional and obligatory interactions in multimodal communication (e.g., de Gelder & Vroomen, 2000; see also Calvert, Spence, & Stein, 2004). The results of the present experiment provide evidence for the claim that gesture, prosody, and grammar are tightly integrated (in an obligatory fashion) during language comprehension. Furthermore, even though the paper is focused on how people interpret DN utterances, it is worth pointing out that the production results obtained before the selection of the materials also point to this direction, namely that most instances of the N/DN renderings provide evidence for the integrated production of N/DN gestures and prosodic patterns.

Most theories of pragmatics take the verbal content of utterances as the basic unit of communication, and have neglected the fact that important information about the meaning of an utterance can be conveyed non-verbally. Within Relevance Theory (Sperber & Wilson 1986/1995), some authors have shown that prosody encodes procedural constraints on the addressee's inferential task. Extending Fretheim's (1996), Escandell's (1998), and Espinal & Prieto's (2011) proposals on the role of intonation in inferential processing, we have shown that both prosody and gesture constrain meaning by guiding the hearer/listener at the time of interpreting isolated n-words. Prosody and

gesture encode constraints on the communicated expression, and can thus reverse the 'preferred' negative meaning of n-words, as they are encoded by grammar, to a positive interpretation. In relevance-theoretic terms, lexically encoded information (i.e., the procedural information that n-words encode; Wilson & Sperber, 1993, Escandell et al., 2011) is highly integrated with prosodic information (i.e., the procedural instructions that different intonation contours encode) and gesture patterns. This interaction is also bidirectional (de Hoop et al., 2010) in the sense that a [int-DN, ges-DN] combination supports a DN interpretation, and [int-N, ges-N] supports a negative interpretation, whereas a marked DN interpretation of isolated n-words is favored by [int-DN, ges-DN], and an unmarked negative interpretation is preferably combined with [int-N, ges-N].

All in all, our results show that DN interpretations for isolated n-words are preferably obtained if specific prosodic and gestural information is available. This is an important finding, as it shows that prosodic and gestural features are not only important as a helping hand in the language understanding process, but also that they interact with each other during the interpretation of multimodal sentences and in the resolution of lexical semantic understanding. Our experiments show that during utterance interpretation, listeners are highly sensitive to prosodic and gestural patterns in online communication. Furthermore, they show that optimal combinations of intonation and gesture are those that match and yield either a negative or a DN interpretation; suboptimal combinations are those that do not match, for which a negative interpretation is preferred. In essence, the final interpretation of very basic semantic phenomena like negation, namely the interpretation associated with n-words, can interact with prosodic and non-verbal cues like gesture.

Regarding the potential language effects, our results reveal no significant differences between the Catalan and Spanish subject responses in none of the three conditions (AO, VO, AV), showing that results were comparable across the two languages. Thus, the hypothesis was confirmed that both languages, being NC languages, should display the same pattern of behavior. First, the results of the experiment showed that DN is a general linguistic phenomenon that can be obtained for isolated n-words in the two Non-Strict NC languages analyzed here when appropriate auditory and visual conditions are provided to the hearer. This result backs up recent linguistics literature on the topic which defends the notion that DN phenomena can be found in NC languages (see the Introduction). Second, as expected, results showed a general resistance to inferring DN readings. In this regard, it is of interest to highlight the asymmetry found between negation and DN interpretations in both unimodal and bimodal tasks: in all experiments, the negation ratings were clearer than the DN ratings, which ranged from 60% to 90%.

A related result from the bimodal task is the fact that when prosody and gesture did not match, results show that the interpretation tended to be negative. In other words, subjects needed strong (and congruent) prosodic and gestural cues in order to be able to attain a DN interpretation. This finding is of particular interest in relation to the claim that DN readings are hard to obtain in NC languages and that they correspond to marked interpretations (cf., Horn, 1989; de Swart, 2010). The resistance of both Catalan and Spanish hearers to obtaining DN interpretations in general, also in non-matching audiovisual stimuli, could be interpreted in two not necessarily conflicting ways. On the one hand, a possible explanation is that all negative expressions are inherently negative (as argued by Déprez, 1997, Espinal, 2000, and de Swart & Sag, 2002), but do not necessarily encode logical negation. Rather, in some languages n-words seem to simply

encode lexical negation, an approach which would explain why DN readings are difficult to obtain crosslinguistically. On the other hand, following up on the accepted generalization that DN readings are a marginal phenomenon in NC languages, it could well be that Catalan and Spanish hearers, being native speakers of NC languages, are displaying a greater resistance to DN interpretations. In order to test whether the pervasive presence of language-specific grammatical patterns should affect the processing of multimodal negative speech acts we plan to carry out a follow-up experiment comparing the behavioral responses of speakers of DN languages such as English or Dutch with those of speakers of NC languages (both Strict, such as Greek and Romanian, and Non-Strict NC languages, such as Catalan, Italian and Spanish).[9]

Crosslinguistically, it is well known that languages resort to different strategies to communicate certain types of meaning. Interrogativity marking is an interesting area where languages differ, generally marking polar questions with special prosody and syntactic order changes. Interestingly, some languages seem not to have clear marks of interrogativity and in this case visual and prosodic signals constitute common resources that help in the pragmatic inferencing process (see Levinson's 2010 analysis of interrogativity in the Papuan language Yélî Dnye). In the case of DN, some languages resort to overt verbal and grammatical marking (such as the presence of two negative quantifiers, or a negative quantifier in combination with a negative marker) to convey DN. Yet this strategy does not preclude that these languages may also use gestural and prosodic resources to help in the inferencing process. Based on this reasoning, it might well be that the outcome of the experiments would be very similar whether carried out

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[9] We leave for further research running similar experiments with speakers of Strict NC languages, such as Greek and Romanian, although informal interviews with native speakers of these languages seem to confirm the same results. By contrast, native speakers of standard varieties of DN languages, such as English, German, Dutch and Afrikaans, do not seem to rely on intonational contours in order to reverse the interpretation of negative expressions. It would also be interesting to look at non-standard varieties of the latter group of languages and see if they behave like NC languages or not.

for Greek, a language that has been argued to be extremely resistant to allowing DN interpretations at all (Giannakidou, 2006), or for English or Dutch. The initial prediction would be that those languages that lexically encode negative expressions as strong negative quantifiers will rely to a lesser extent on prosody and gesture at the time of conveying a DN interpretation than those languages that have n-words with a variable quantificational force (see note 3 above), as is the case in NC languages, mainly in the Non-Strict ones. With this in mind it is necessary to evaluate whether gestural and prosodic signals such as intonation contours constitute general resources that help in pragmatic inferencing processes in typologically different languages, and whether languages that lack linguistic encoding (whether lexical or supralexical) for certain interpretations tend to develop more diverse prosodic and gestural systems; yet this hypothesis remains to be tested.

To summarize, the findings presented in this paper are novel because in addition to highlighting mechanisms of gesture-prosody-speech integration in comprehension, they bolster linguistic theories that both verbal and non-verbal (i.e., gesture) components perforce comprise an integrated system in language comprehension. The interpretation of linguistic utterances is multimodal in nature, and prosodic and gesture patterns as well as their interactions need to be taken into account when studying how utterance interpretation is achieved. An important consequence of this study is that it highlights the possibility that semantic interpretation is not solely mediated by syntax but rather also constrained by cognitive areas, such as prosody and gesture, the latter being traditionally conceived to lie outside of linguistic theorizing.

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