From a perceptual point of view, is there prosodic continuity between languages in contact?

Running title: Prosodic continuity between languages in contact

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Abstract

This paper contains the results of a set of perception tests that aimed at measuring perceived prosodic distances between different Romance languages (Italian, Friulian, Sardinian, Catalan, and Spanish). Data were collected within the framework of the

AMPER project. The results were obtained by means of discrimination and identification tasks where the judges were 31 native speakers of Catalan form Barcelona and the stimuli were broad focus statements and yes-no questions in the above-mentioned languages. The perceived distances are then compared with the results of a dialectometric analysis of acoustic data. This comparison shows that the perceived distances are related to acoustic differences.

1. Introduction

1.1. Perception of prosody and intonation

Until not very long ago, there were few acoustic studies on prosody in general or on intonation in particular. This has now changed thanks to the advent of new technologies and a growing interest in these topics. Perceptively, however, there continues to be little work done around intonation. The majority of research done in the field of perception is in the domain of tonal languages, where the main focus is to investigate the limits between tones through the use of synthesized manipulations based on natural stimuli; but this type of study about intonational languages is scarce.

The results that we obtain within the framework of the Multimedia Prosodic Atlas of the Romance Domain (*Atlas Multimedia de Prosodia del Espacio Románico* or AMPER), together with those obtained by other work groups, provide us with a rather suitable description of several geoprosodic varieties of Catalan and Spanish from the acoustic perspective. This is also true of other languages.

We are aware that not all acoustic differences are linked to perceptive ones, although it is evident that a relevant, significant, or pertinent contrast should imply a perceptive

correlation. In this respect, Caravedo Barrios (2012) argues that linguistic varieties exist only insofar as they are perceived, since the perception process implies continuous reworkings and interpretations of sensory information that assume the activation of inference mechanisms. It is known that even in the early stages of people's lives, it is possible to make linguistic discriminations based on prosodic parameters (Mehler et al. 1988). But there are few studies that focus on this aspect in adults (Vicenik & Sundara 2013).

Regarding intonation in adults, Ladd (1981) specifically identifies two viewpoints: 1) the Strong Universalist Hypothesis, according to which a rising pitch suggests a question, and a falling pitch indicates a declarative sentence; and 2) the Nuclear Tone Hypothesis, according to which the distribution of contours and their relation with sentence functions is arbitrary and depends on the language. Bolinger (1978) and Liberman (1967) also speak about the universality issue. It is obvious that from these two hypotheses, the second one appears to be more explanatory because, as we know from acoustic studies, there are linguistic varieties where there is a rise in statements (for example, in Gradisca d'Isonzo and Beivars, in Friulian) or a fall in interrogatives (for example in Villanova Monteleone, Porto Torres, or Alghero – respectively Sardinian, Italian, and Catalan, the three languages of the island of Sardinia). In addition, each language may present different patterns depending on the pragmatic function of utterances, but this becomes evident when the listener is familiar with the language or the patterns are similar to those in his or her language.

Gussenhoven & Chen (2000) postulate that the universal and specific effects of languages derive from two different components of language: one is the intonational lexicon (morphemes have an intonational meaning) and the other one is the phonetic implementation module, which can differ considerably from the phonological

component because phonetic implementation is not universal. The authors think that higher peaks aligned with the stressed syllables or peaks at the end of a sentence cause the utterances to be interpreted as interrogatives, and they believe that these are universal signs based on results with Dutch, Chinese, and Hungarian listeners (three languages that signal interrogation differently). Nevertheless, they acknowledge that the language-specific experience of each listener is an active component in the interpretation of strategies and it conditions perception.

In any case, studies that explore the possibility of calculating linguistic distances based on the perception of intonation, as has been done based on acoustic parameters (Fernández Planas et al. 2011, 2015, Moutinho et al. 2011 and Roseano et al. 2015a), are in short supply. The concept *distance* between linguistic varieties, based on intonation, might be intuitively easy to notice, but difficult to quantify and explain. It is a concept inevitably linked to that of *likeness* and they keep a necessary inverse relation: if two elements are more alike, they are less distant of each other than two elements that are more unlike each other. However, we will not discuss here whether likeness and distance should be opposite in the same scale or not (Hayward 2000 and Sullivan 2011).

In this paper, we will reflect on our data to see whether perceptive data can lead us to trace prosodic distances and whether it is possible to find prosodic continuity between languages in contact from a perceptive point of view as we have done from the acoustic one (Fernández Planas et al. 2013). Our starting point is the following questions: can an ordinary speaker who lacks specific knowledge about the topic understand and detect geoprosodic differences? Preston (1989) includes this question within the macrolinguistic dimension of perceptive dialectology. In particular, and taking it step by step, our research questions are the following: are speakers (of central Catalan) capable of identifying sentence type (information-seeking yes/no questions vs.

broad-focus statements) in other Romance varieties?, are speakers (of central Catalan) capable of perceiving prosodic similarities/differences between Romance varieties?, are these similarities/differences perceived by the subjects parallel to those that can be detected through an acoustic study?, do the data license a contribution to the Strong Universalist Hypothesis vs. Nuclear Tone Hypothesis discussion (Gussenhoven & Chen 2000)?

1.2. State of affairs with acoustic data. The Autosegmental-Metrical (AM) model and the 1.5-semitone psychoacoustic threshold

The main interest of the global AMPER project is descriptive; however, some of the studies carried out within the scope of the group AMPERCAT give the results an additional more theoretical reading. At this level, we focus on the Autosegmental-Metrical (AM) framework, initiated by Pierrehumbert (1980) in his doctoral thesis, and surely one of the most followed and best-known models to date. This theoretical framework for the study of the modulations of F0 takes the melodic curve as a succession of two high (H) and low (L) tones related to the metrically stressed positions, even though these might be de-stressed and other unstressed syllables might in turn show tonal peaks because of focal reasons or information structure reasons.

In general, the AM theory is considered more phonological than phonetic (Hualde 2003 and Ladd 1996), but the limits are admittedly blurred. The notation systems proposed for each language are known as ToBI (Tones and Breaks Indices) systems.

Our studies largely follow the proposed notation for CAT_ToBI by Prieto et al. (2009), somewhat adapted to our work in the phonetics laboratory (Fernánez Planas & Martínez Celdrán 2003, Martínez Celdrán & Fernández Planas 2003) because we

consider the psychoacoustic threshold established at 1.5 semitones (Pamies et al. 2002) as a rigorous starting criterion to determine if the perceptive difference between two tones associated to the two relevant syllables in each measurement is valid or negligible. This is all done within the scope of AMPER and its prescribed methodological aspects. The difference is usually measured between adjacent syllables (pretonic-tonic and tonic-posttonic), but not exclusively in these cases. In terms of the final juncture, if the sentence ends in a proparoxitonic word, for instance, it is also convenient to consider the final value of the last vowel, which is not the posttonic adjacent to the tonic one of the corresponding lexical stress. In our system, we perform two types of labeling: the first one presents a clearly phonetic, or superficial, point of view based on the empirical data obtained and it takes the established psychoacoustic threshold into account; the second one, carried out from the first one, is closer to a phonological perspective. One difference between them, therefore, is that the first one allows for the possibility of finding tritonal structures, whereas these would be impossible in the second system. Additionally, in our system, we are working towards an automatic labeling system (Elvira-García accepted, Roseano et al. 2015a, Roseano & Fernández Planas 2013).

In the sphere of Romance languages, both within the AMPER framework and outside it, there are studies that deal with the interference of languages in contact (Romera et al. 2008, 2012, Roseano et al. 2015a, Romera & Elordieta 2013) as well as with the analysis of the continuity between different but geographically close languages (Fernández Planas et al. 2012, 2013), from the acoustic perspective. These studies also apply the AM theory. In this study, we will reflect on this possible continuity based on perceptive data.

1.3. Dialectometry based on acoustic data

Dialectometry (Goebl 1981, 349), originated in the late 20th Century, represents a methodological alliance between geolinguistics and numerical taxonomy as a mathematical discipline. Unlike traditional dialectology and its atlases that compile nominal data based on which qualitative statistical analyses can be done, dialectometry attempts to establish groupings from the mass of empirical data obtained through research, which provide an idea of the knowledge and distribution of these data. Therefore, it bases its dialectal classification and delimitation methods on quantitative data. This has attracted criticism from traditional dialectology since it does not take into account that some linguistic differences are qualitatively more relevant than others (Clua 1999) but, on the other hand, in makes it possible to handle vast amounts of data, which would otherwise be unworkable.

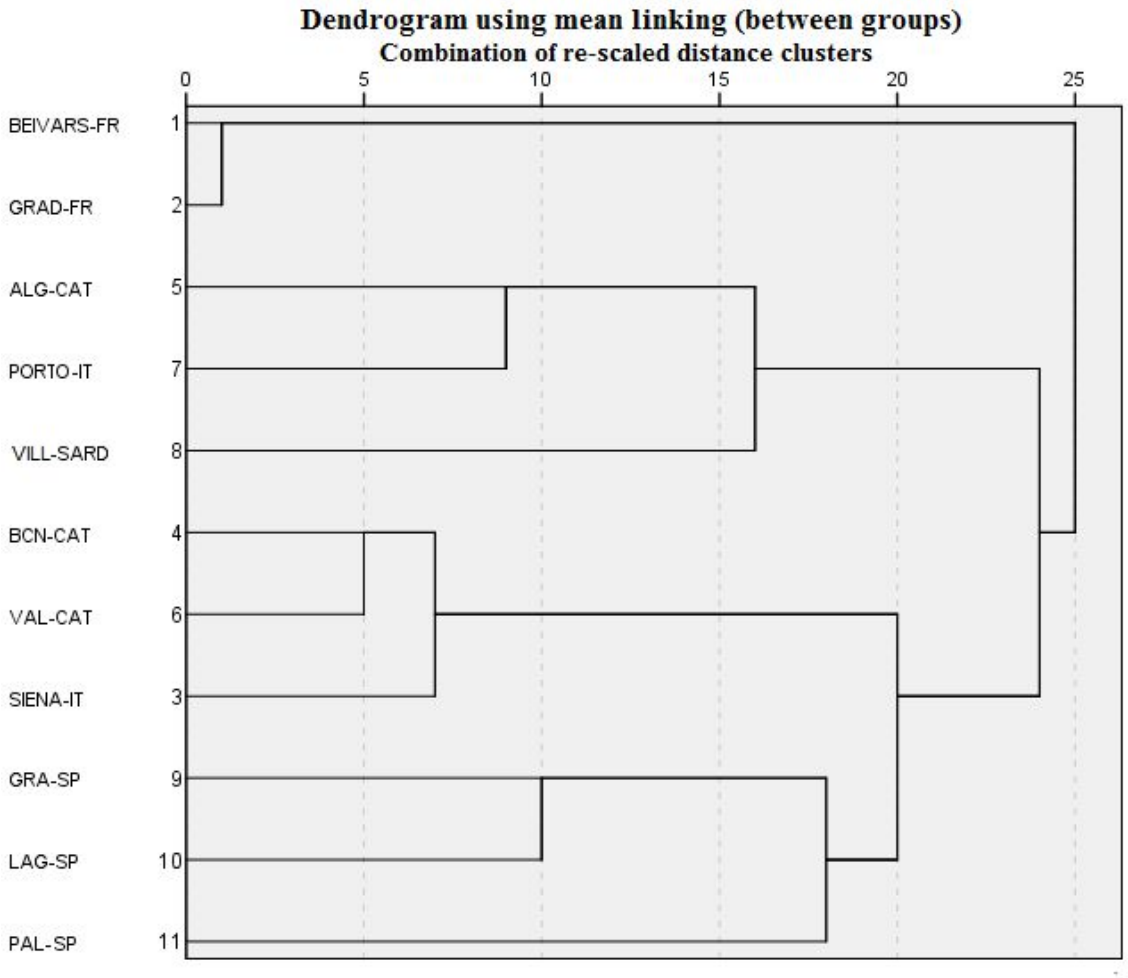
The application of the fairly recent dialectometry to prosodic data in the world of phonetics is something new. The AMPER framework has pioneered this and constitutes an optimal field for its application since out of the four corpora it studies, the fixed corpus has set guidelines that are the same across all the languages and dialectal varieties that are being described, which also licenses multiple comparisons between them.

Figure 1 shows the dialectometric classification of clusters obtained from the acoustic data of the eleven survey points considered in this study (see the methodology section) presented in the form of a dendrogram[1], taking into account both interrogative

[1] Another convenient way of representing the data is by creating a virtual two- or three-dimensional space obtained from the statistical technique of multidimensional scaling (MDS). This method attempts to construct a metric space with as few dimensions as possible so as to represent the proximity or preferences between objects with utmost fidelity. The proximity (or similarity) tables are put together from the numeric properties of a set of objects, which are ultimately transferred onto a space or object map (Matas 2006).

and declarative sentences together. The groupings that appear coincide with the acoustic characterization of the melodies and their melodic labels. In this study, as mentioned before, the main objective is to evaluate whether these groups remain unchanged from a perceptive standpoint. Specifically, the graph presented was created using the CalcuDista system, proposed by the *Laboratori de Fonètica* of the *Universitat de Barcelona* (Roseano et al. submitted).

Figure 1. Dendrogram obtained with the acoustic parameter of F0 for the relevant phrases in the selected survey points of the study. The names of the survey points whose sentences were included in the statistical study followed by a hyphen and the linguistic domain to which each belongs appear on the vertical axis.



2. Methodology

2.1. Informants, survey points and corpus of stimuli

The acoustic data used in the perception tasks proceed from women who share the same sociolinguistic profile (aged between 25 and 55, without higher education, native of the survey point they represent, and daughters of people that share the same characteristics).

The phrases used in the perceptive tasks are broad-focus statements and information-seeking yes/no questions with SVO syntactic structure, composed of three lexical stresses, all of them paroxitonic. The first set of sentences are expository, presenting information without evaluating it, that is, without expressing surprise, doubt, disagreement, or insistence, thus they can be considered neutral. The second set of sentences consists of polar questions because they require and expect the receiver to answer yes or no, that is, in the affirmative or the negative. Both sets of sentences correspond to the so-called fixed corpus without expansion in AMPER, and they all have the same number or syllables. These sentences, both declarative and interrogative, proceed from the following lexical combinations: *el copista no porta la caputxa* (Peninsular Catalan), *lo copista no porta la caputxa* (Alghero Catalan), *la guitarra se toca con paciencia* (Spanish), *la bambina mangiava la banana* (Italian), *sa madrina pregontat sa banana* (Logudorese Sardinian), *la ghitare si sune cun dolcece* (Friulian).

In any case, the stimuli were presented to the listeners resynthesized from their unaltered prosodic features, but without lexical, syntactic, semantic, pragmatic, or contextual content. Given the lack of segmental information, the listeners could not

identify the language of each stimulus, and we can be certain that any judgment will proceed from prosodic information, intonational in particular.

The survey points used in these perceptive tests are Palencia, Granada, and La Laguna (Tenerife) (Spanish; the first two, peninsular; the latter, insular); Barcelona, Valencia, and Alghero (Catalan; peninsular the first two—oriental and occidental, respectively—; insular the latter –Sardinia); Siena and Porto Torres (Italian, peninsular and insular –Sardinia—respectively); Villanova Monteleone (Sardinian); and Beivars and Gradisca d'Isonzo (Friulian). All of them were considered in the first three tests. For the last two, a selection was made to reduce the complexity and duration of the tests to prevent the judges' attention from becoming fatigued, because this would have negatively affected the results. In these tests the samples that were used were from Barcelona (peninsular Catalan), Alghero (insular Catalan from Sardinia), Porto Torres (insular Italian from Sardinia), and Villanova Monteleone (Logudorese Sardinian).

2.2. The perceptive tests: general characteristics and profile of the judges, SPSS evaluation

The participants in the study took five perceptive tests after filling out a personal information form that included sociolinguistic data. In the end, we had 31 perceptive judges, all first-year students of the Faculty of Philology of the UB. They were all Catalan-Spanish bilinguals (specifically, 22 self-proclaimed Catalan-dominant and 9 Spanish-dominant).

The tests were carried out in the PRAAT environment (MFC6 -Multiple Forced Choice6-). We created a script that automatically collected the personal information of

the judges, concatenated the experiment sequence in which the order of the stimuli was randomized each time, and saved the responses in a database in a set order.

The stimuli were always resynthesized –without lexical-semantic content—from natural sentences that could be declarative or interrogative of SVO form, composed of paroxitonic words pronounced by speakers of several survey points, as has been stated in the previous section. These sentences were part of the original fixed corpus of AMPER (Fernández Planas 2005). The number of stimuli varied depending on the specific test.

Each perceptive judge took the tests individually, wearing headphones, on a PC running Windows. Each judge had the option of listening to each stimulus a second time and to correct his or her response once only. In the longer tests, there was a chance to take a break every 25 items. Taking advantage of another feature of the Praat program, the tests also measured the reaction time of the responses. Although we agree that this is not the optimal way of collecting this datum, and without going into extensive details, we think that considering it can, roughly, offer some orientation about the trend the results have in this sense. In this system, reaction time is measured from the beginning of the stimulus (or the first stimulus) until one of the possible keys is pressed.

Some tests, as will be seen, presented the items in pairs or triads of stimuli. In this case, the ISI was of 800 ms.

The total duration of the tests plus the filling out of the personal information form was approximately 1 hour (the exact duration depended on each judge's pace), including a short initial training to prevent a potential surprise at the synthetic stimuli.

The statistical analysis of the results was done on SPSS v.20. Distance matrices were created based on the confusion matrices obtained. Several clusters analyses were

carried out based on these Euclidean distances, and the results were graphically rendered in dendrograms and virtual bidimensional space (MDS) representations.

2.3. Experiment 1. Identification test

The first experiment contained 22 stimuli, 11 declarative and 11 interrogative, which were doubled (resulting in the 44 stimuli that constituted the test) to corroborate that the responses obtained were not random. The stimuli were presented one at a time. The question to answer was "What sentence-type is it?" [*¿A qué tipo de frase corresponde lo que oyes?*]. The possible responses to choose from were "Statement" [*Enunciativa*] and "Question" [*Interrogativa*], which made it a forced choice test. There was no option to take a break between stimuli in this sentence type identification test.

The advantage of this type of test is that it is very simple to explain, and it assumes that the judges are familiar *a priori* with the labels for the identifying categories, which means that there is no need to explain, in this case, what a declarative or an interrogative sentence is.

2.4. Experiments 2 and 3. AX discrimination tests

Experiment 2 works with declarative sentences while experiment 3 with polar interrogative sentences, but they both follow the same approach and structure. Each experiment dealt with 11 stimuli that were presented two by two in all possible combinations, including pairing each stimulus with itself. Each of these combinations where presented twice, like in experiment 1. Each of the tests included, therefore, 242 items. The question the judges had to answer was *"Can both of the sentences you hear*

correspond to the same dialect?" [*¿Las dos frases que escuchas pueden corresponder al mismo dialecto?*]. The possible answers available were, "Yes" [*Sí*] and "No" [*No*], presenting again a forced choice. Like the previous text, these tasks are easy to explain and understand. There is no need to categorize in this case, responding that the two sentences could correspond to the same dialect or not based on each individual's perception of the data is enough.

2.5 Experiments 4 and 5. ABX discrimination tests

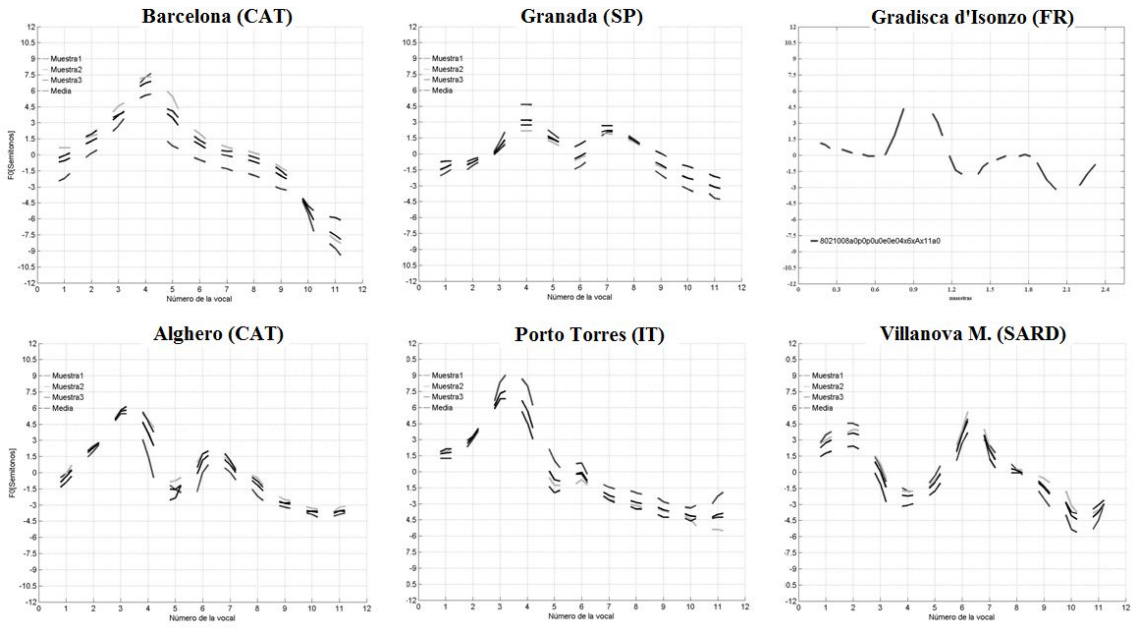
Experiment 4 uses declarative sentences while experiment 5 uses polar interrogative ones. In each of them, the stimuli considered were five. We used only those that correspond to the varieties of Sardinia (Catalan, Sardinian, and Italian) plus one sample of peninsular Catalan (Barcelona) and one sample of peninsular Italian (Siena). In this case, the stimuli were presented in triads and in all possible combinations (including those where one of the initial items was repeated), all of which were again duplicated to prevent the possibility of considering random responses. The resulting items for each test were 100 and, as in the previous two experiments, the judges could take a break every 25 items. As stated above, the interstimulus interval (ISI) was of 800 ms and the intertrial interval (ITI) was not taken into consideration because it depended on the response pacing of each judge; a new item would not appear until a response had been given for the current one. Once again, these are forced-choice tests. The question presented on the screen was "Which is more like the third?" [*¿A cuál se parece más tercera?*]. The response options were only two: "The first" [*A la primera*] and "The second" [*A la segunda*].

The structure followed to pose these tests was the ABX scheme, where the combinatory possibilities were ABA, ABB, or ABC. The disadvantages that this design of the ABX model presents are relative to the temporal order in which the stimuli are presented, because there might be a slight memory effect that might cause a bias towards B in the responses. On the other hand, the advantages of this model dwell in that the explanatory task is simple: there is no need to explain to the subject what it means for two stimuli to be more or less like one another, and there is no need to categorize, discriminating is enough.

3. Acoustic description of the melodies

Before moving on to the perceptive results as such, it is convenient to bear in mind the most pronounced variations among the stimuli that were tested in the experiments. Even though there are differences between the melodies of all the survey points (see the samples in Martínez Celdrán & Fernández Planas 2003-2012), some are more pronounced than others, and this causes the differences to be grouped in blocks, as can be seen in figure 1. This leaves four major groups of differences that coincide with the following distinctions: a) the peninsular Catalan and Italian survey points; b) the Spanish survey points; c) the Friulian survey points; and d) the three languages of the northwest of the island of Sardinia.

Figure 2. Some of the chosen declarative melodies. In the row above, a sample of the first three blocks of data and, in the row below, a sample of each of the three languages of the northwest of the island of Sardinia.

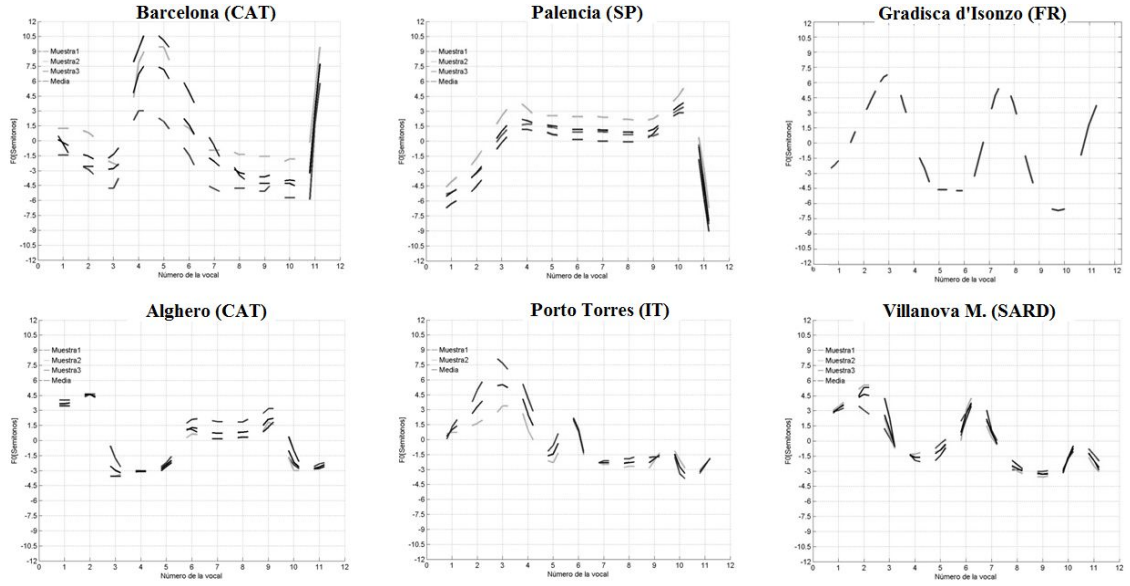


In the case of the declarative sentences, the majority of the survey points studied present a falling nucleus or nuclear configuration (L%), although in the Sardinian survey points, the last posttonic syllable can be kept suspended in relation to the previous tonic syllable, or even slightly rising in the Logudorese Sardinian of Villanova, just as it does in the Friulian of Gradisca d'Isonzo or Beivars, where the final juncture tone rises a little, as can be seen in figure 2. In the pre-nucleus (all pre-nuclear pitch accents), the differences between survey points are focused on presenting one or two peaks, their magnitude, and the presence of such peaks on the tonic, pretonic, or posttonic syllables of the pitch accents.

In the interrogatives, once again all the contours are different, but there are some coincidences among them: most notably, a difference present between Barcelona, Valencia, Granada, Siena, Beivars, and Gradisca d'Isonzo with a rising final juncture on one side (H+L* H% in the Friulian survey points and Siena, L* H% in Barcelona, Valencia, or Granada) and, on the other side, Alghero, Porto Torres, Villanova, San

Cristóbal de la Laguna, and Palencia, with a falling nucleus (¡H+L* L% in the survey points of the island of Sardinia; ¡H* L% in Palencia, L+¡H* L% in the Tenerife). Siena and Porto Torres coincide with the first peak on the tonic syllable that in Alghero and Villanova coincide with the pretonic syllable. In Porto Torres, the first two peaks coincide with the tonic syllables of the lexical accents, while in Villanova they coincide with the last two. Among the varieties of Spanish, Granada cannot be unequivocally told apart from other points that show a rising nucleus, while Palencia and San Cristóbal de la Laguna present a falling nucleus; however, the difference between them is clear because the Canarian variety shows the typical circumflex ending that has been pointed out in the literature (Dorta 1999, 2008, 2013, Dorta & Hernández 2004, Dorta et al. 2008, among the most recent works). Palencia from the first posttonic syllable leaves the intonation of the sentence on a *plateau* from where it rises slightly on the last tonic syllable to sharply fall on the posttonic syllable. Beivars, in the body of the sentence, presents as the highest peak the one associated with the second pitch accent, not the first, as in the rest of the survey points with rising nucleus. Some of these differences can be seen in figure 3.

Figure 3. Some of the chosen interrogative melodies. In the row above, a sample of the first three blocks of data and, in the row below, a sample of each of the three languages of the northwest of the island of Sardinia.



In a previous paper (Fernández Planas et al. 2013) about acoustic data, we had found a certain prosodic continuity across different points of Romance-speaking Europe, from east to west, considering one point of Friulian, one of peninsular Italian in Tuscany, two of peninsular Catalan, one of southern peninsular Spanish, and one of Canary Spanish for interrogatives. The novelty of said paper resided in that Alonso's (1943) idea of the *Romania Continua* had not been highlighted before for prosodic facts. This study will determine whether this continuity can be sustained from the perceptive point of view from the impressions of Catalan-speaking listeners from Barcelona.

4. Results

4.1. Concerning the initial personal information forms of the listeners

Before beginning the tests, the informants had to fill out a personal information form. Some of the information requested had open answer format, and some were established

multiple-choice options. In addition to their names and last names (for identification purposes, in case there were any issues with the tests), their age (to verify that they were all in the same age range), their sex (to evaluate possible perceptual differences associated with this parameter), and their employment status (to ensure that they were all undergraduate students at the *Universitat de Barcelona*), this form also asked them about linguistic and family aspects, such as mother tongue, language used in the family home, language used with friends, language used at work/for studies, educational level of the father, educational level of the mother, father's language, mother's language, as well as other personal aspects that might influence perception, for example, whether they had any hearing problems, whether they had received any theoretical musical training, whether they played a musical instrument (and if so, which one and how often).

After an exhaustive study of these factors, no relevant differences were identified. None obtained a $p<0.05$, because their personal characteristics were fairly similar, and therefore, the results obtained from each one in the tests are presented in this study globally, taking all the perceptive judges jointly into account.

4.2. Experiment 1. Identification test

We know that different dialects codify sentence function differently even if they belong to the same linguistic domain. Then, the first important question that presented itself was whether listeners could hear the difference between declarative and interrogative sentences correctly in data from different geoprosodic areas, in other words, to what extent do the acoustic indices affect categorization between the two groups, especially at the nucleus level. The error percentage obtained in this first test is shown in table 1.

Table 1. Percentage of errors in the identification of sentence type, from lower to higher mean of the two types, in percentages.

Language and survey point	Declarative	Interrogative	Mean
Catalan. Valencia	3	8	6
Italian. Siena	8	5	6
Spanish. Palencia	7	8	7
Catalan. Barcelona	15	2	8
Spanish. Granada	15	8	11
Friulian. Gradisca d'Isonzo	23	8	15
Friulian. Beivars	60	16	38
Spanish. La Laguna	42	39	40
Catalan. Alghero	26	66	46
Italian. Porto Torres	18	77	48
Sardinian. Villanova	7	95	51

It is important to keep in mind that we are working with the perception of synthesized stimuli without lexical content, which are unusual and difficult for people who are not accustomed to them, and that we are looking for distinctions that can be subtle. This notwithstanding, in many of the stimuli the percentage of errors is very low, as can be seen in table 1. The identification of declarative statements produces fewer errors than that of interrogatives. The only noteworthy data corresponds to Beivars (and partially to Gradisca d'Isonzo), La Laguna, and Alghero, because they are over 25%. All of these

survey points present a slightly rising or sustained ending from the last tonic syllable, that is, they do not clearly show falling intonation.

Regarding interrogatives, the results can be divided in two blocks, one that presents very few errors, composed of the majority of the survey points, and one that presents exceedingly high percentages of errors (from the Spanish of La Laguna (30.9%) to the Sardinian of Villanova (95%)). These survey points concur in not presenting clearly rising nucleus, as do those in the first block, where few errors are registered, nor clearly falling nucleus (as in the Canarian circumflex). At this point, we would like to clarify that the Palencian interrogative intonation has shown notably little confusion (8%), undoubtedly because the judges are Catalan-Spanish bilinguals from Barcelona, and the interrogative melody from Palencia (geographic point of Leonese Spanish) closely approximates the habitual echo questions of the central oriental variety of Catalan spoken in Barcelona (Borràs et al. 2014, Roseano et al. 2015b). Globally, the survey points that show the greatest number of errors correspond to the three studied enclaves of the northwest of the island of Sardinia. Somehow, the greater acoustic distance there is between the survey points and Barcelona (point of origin of the judges), the more difficult it is to interpret sentence type correctly, regardless of the language of the stimulus. In the northwest of the island of Sardinia, the three languages in contact present abundant concomitances amongst them that move them away from other varieties of some of those languages, particularly from peninsular Catalan and peninsular Italian (Roseano et al. 2015a).

Without going into too much detail, the reaction times are, in general, lower when identifying interrogatives than they are for declaratives (2.96 s. vs. 3.37 s.). For each sentence type, the ones requiring the shortest time for their identification are those that

present a rising nucleus amongst the interrogatives, while amongst the declaratives the opposite is true.

4.3. Test 2. AX discrimination in declaratives.

Test 2 consisted in a discrimination task between declarative sentences from the eleven survey points. In this case, as was stated in the methodology section, it was not necessary to categorize, or identify, the source of the sentences. The stimuli were presented in pairs, and the task required the judge to decide whether both sentences could belong to the same dialect or not. In other words, bearing in mind that the speakers whose utterances had been the source of the synthesized stimuli were different, and being aware, from their own experience as speakers, that there can be interpersonal variations in the same dialect and the same sociolect, the task consisted in evaluating the perceptive distance that might exist between different areas. If the listeners interpreted two melodies as potentially from the same dialect, this meant that they obviously considered that the distance between them, from a perceptive standpoint, was small. The objective, then, was to evaluate the perceptive distances between all the survey points considered, given that the test presented all possible combinations of the stimuli.

The results are presented in the confusion matrix on table 2. As can be seen, there is data in every box because this shows the order in which the stimuli were presented to the perceptive judges, and evidently, the results are not the same. For instance, in the Alghero-Barcelona pair, if the insular stimulus was presented first, the percentage of responses that stated that they could belong to the same dialect was 83.9%, but if the peninsular stimulus was presented first, the percentage dropped to 45.2%.

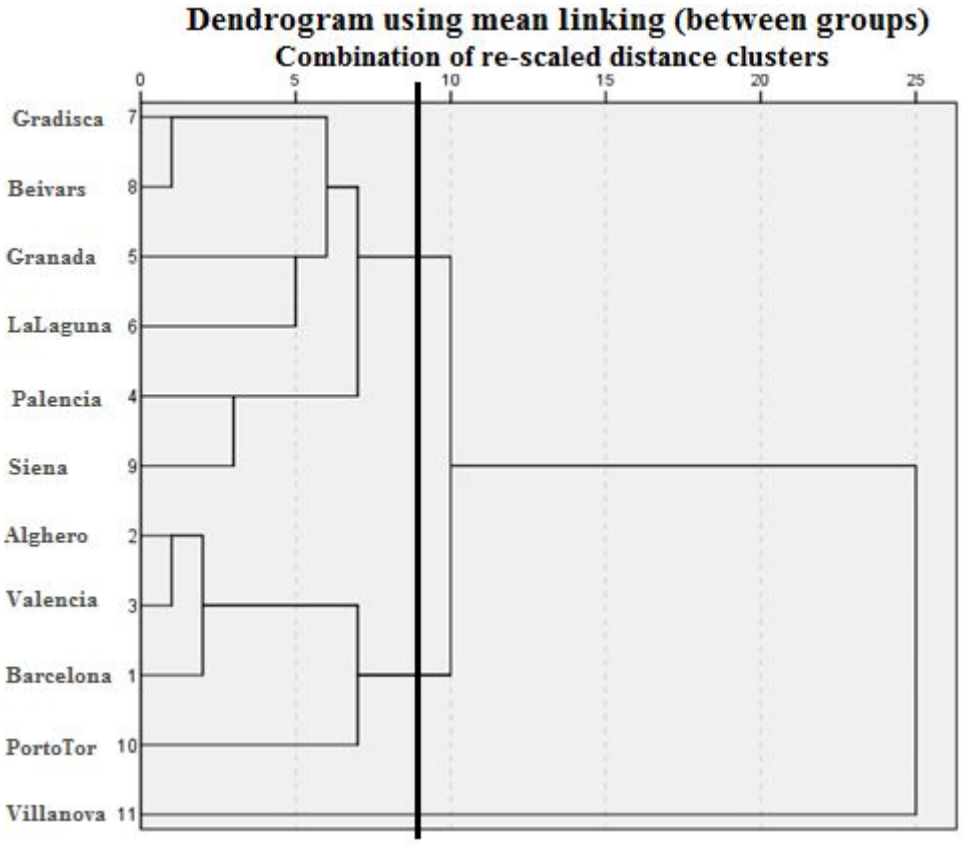
Table 2. Confusion matrix of declarative sentences, in percentages.

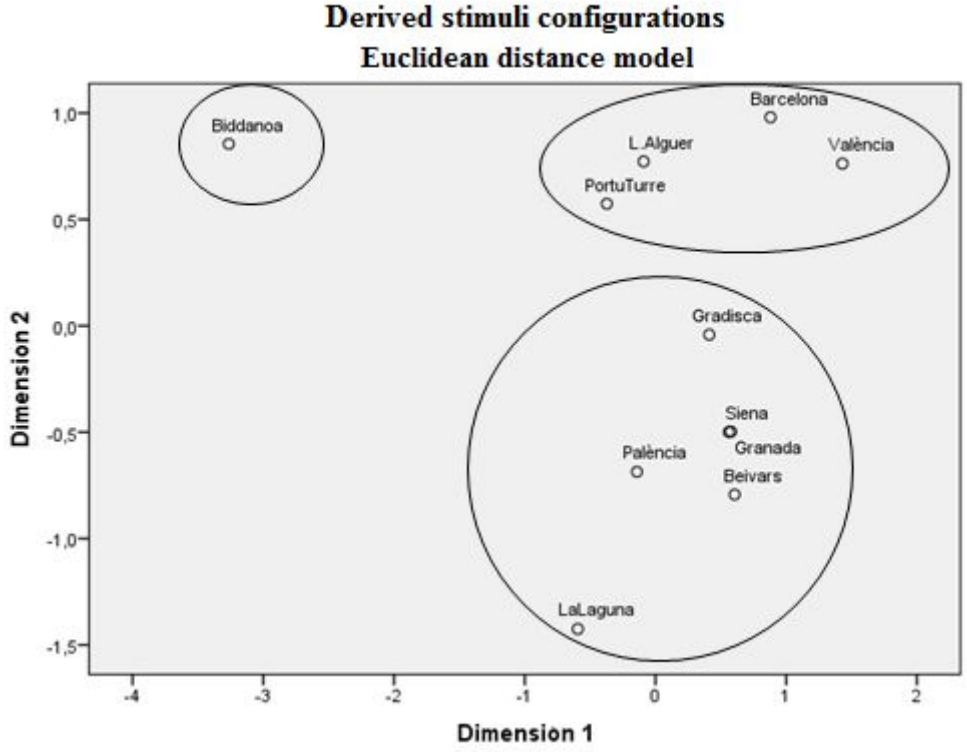
	BCN	Alghero	Valen	Palen	Gran	La Lag	Grad	Beiv	Siena	Porto T.	Villan
Barcelona	93,5	45,2	80,6	41,9	22,6	9,7	58,1	45,2	38,7	35,5	19,4
Alghero	83,9	96,8	83,9	25,8	48,4	22,6	51,6	45,2	35,5	51,6	19,4
Valencia	77,4	58,1	100	41,9	61,3	25,8	45,2	29	48,4	48,4	9,7
Palencia	51,6	32,3	38,7	100	51,6	32,3	51,6	51,6	64,5	38,7	16,1
Granada	41,9	48,4	77,4	48,4	100	61,3	41,9	74,2	58,1	32,3	16,1
La Laguna	32,3	32,3	41,9	48,4	54,8	100	54,8	51,6	48,4	35,5	12,9
Gradisca d'Isonzo	51,6	38,7	51,6	48,4	38,7	51,6	96,8	87,1	51,6	38,7	12,9
Beivars	58,1	41,9	58,1	41,9	58,1	38,7	67,6	96,8	38,7	48,4	6,5
Siena	35,5	22,6	67,6	64,5	51,6	38,7	48,4	32,3	100	51,6	9,7
Porto Torres	58,1	38,7	48,4	32,3	29	32,3	45,2	35,5	58,1	100	22,6
Villanova	19,4	22,6	0	16,1	9,7	16,1	29	16,1	12,9	35,5	100

As could be expected, the distances between any point and itself give a 100%, or nearly 100%, dialect match. In the distance matrix created from the information on table 2, this fact translates into zero distance.

Considering both presentation orders together, the data falls into the groups presented in figure 4. Above we can see the dendrogram that shows the data groupings based on Euclidean distances; while below, we can see the virtual map obtained through the statistical technique of multidimensional scaling.

Figure 4. Perceptive distances in declarative sentences. Above, dendrogram (method: Euclidean distances); below, MDS (Stress=0.14817; RSQ=0.92714).


Dendrogram using mean linking (between groups)
Combination of re-scaled distance clusters
0
5
10
15
20
25
Gradisca 7
Beivars 8
Granada 5
LaLaguna 6
Palencia 4
Siena 9
Alghero 2
Valencia 3
Barcelona 1
PortoTor 10
Villanova 11


Derived stimuli configurations
Euclidean distance model
Biddanoa
Barcelona
L'Alguer
València
PortuTurre
Gradisca
Siena
Granada
Palència
Beivars
LaLaguna
Dimension 2
Dimension 1
1,0
0,5
0,0
-0,5
-1,0
-1,5
-4
-3
-2
-1
0
1
2

The survey points appear to split in two major groups: the languages of the island of Sardinia plus the points of peninsular Catalan in one group; and the points of Friulian, peninsular Spanish, and peninsular Italian, in the other. Of all of them, it is the Sardinian from Villanova that presents the most unusual perceptive results. In fact, the acoustic data show that this is the only survey point studied that presents a second peak that is slightly higher than the initial peak and, in addition, it has a slightly rising nucleus. This explains why the listeners find it unlikely to belong to the same dialect as any of the other points presented, although it does appear closest to Porto Torres and Alghero, the other points on the island of Sardinia.

4.4. Test 3. AX Discrimination in polar interrogatives

The third test, like the previous one, consisted in a discrimination experiment between sentences from the eleven survey points, in this case, interrogatives. From the responses of the judges, we wanted to establish the perceptive distance that might exist between areas based on this sentence type.

The results appear in the confusion matrix of table 3. In this case also, there is data in every box because this reflects the order in which the stimuli were presented to the perceptive judges and, as can be seen, the results are not identical. For instance, in the Granada-Barcelona pair, if the Andalusian stimulus was presented first, the percentage of responses that indicated that they could belong to the same dialect was 90.3%, while if the Catalan stimulus was presented first, the percentage was of 61.3%.

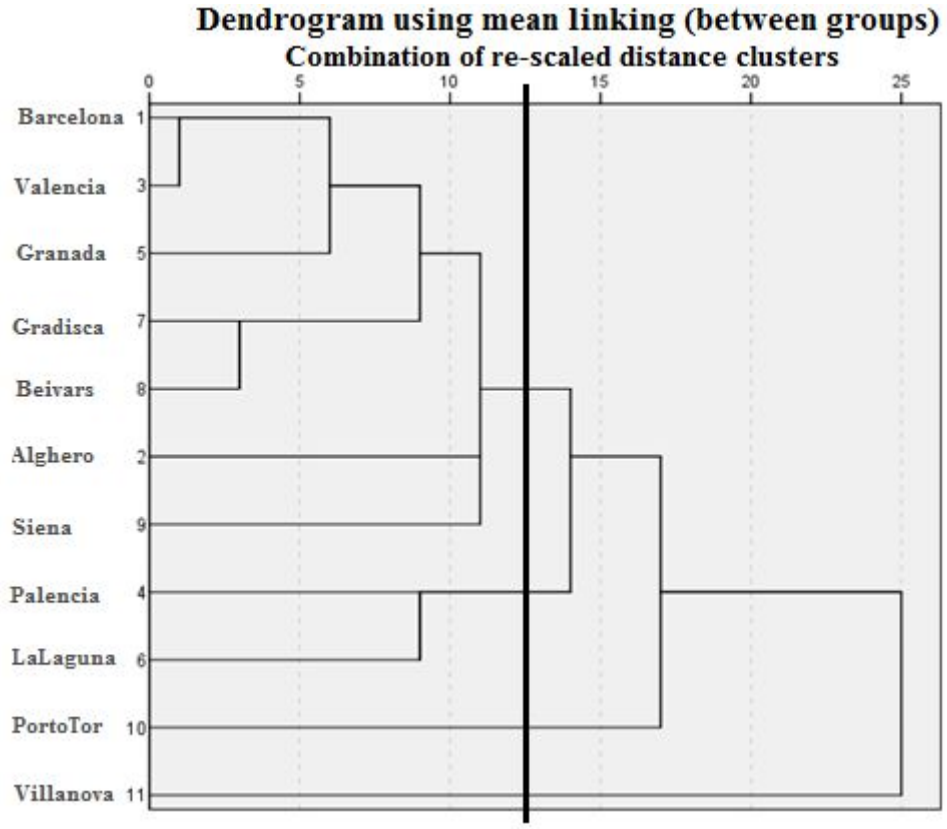
Table 3. Confusion matrix of interrogative sentences, in percentages.

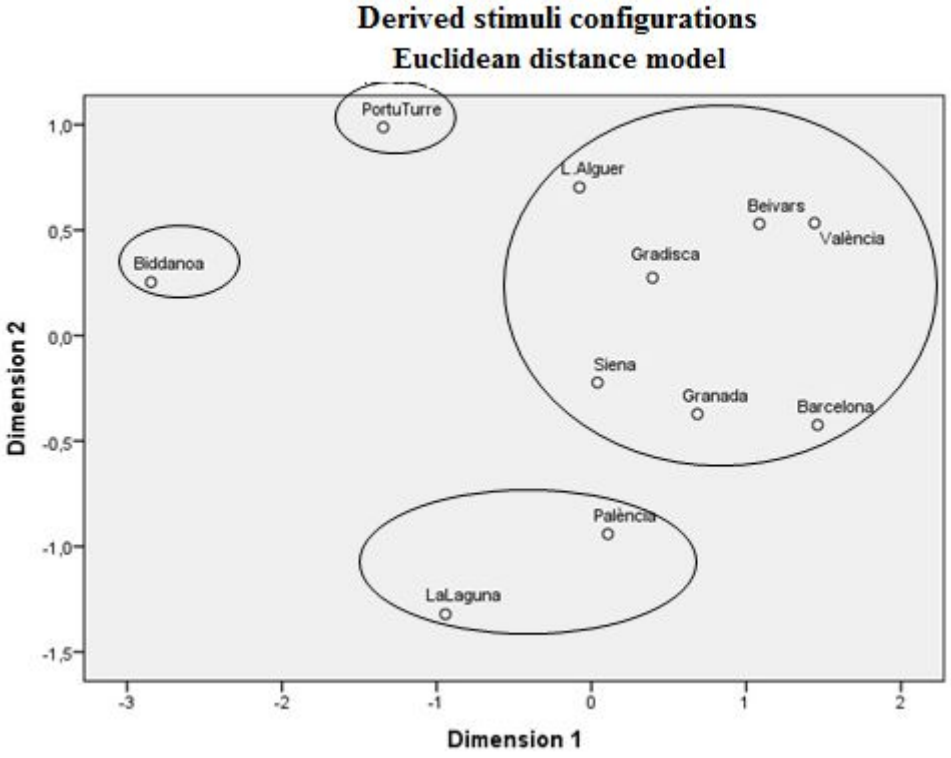
	BCN	Alghero	Valen	Palen	Gran	La Lag	Grad	Beiv	Siena	Porto T.	Villan
Barcelona	96,8	64,5	96,8	54,8	61,3	25,8	29	67,7	54,8	25,8	6,5
Alghero	51,6	96,8	67,7	35,5	41,9	22,6	32,3	45,2	32,4	16,1	19,4
Valencia	93,5	61,3	100	32,3	48,4	22,6	51,6	77,4	45,2	29	6,5
Palencia	54,8	45,2	41,9	100	45,2	48,4	32,3	54,8	35,5	19,4	12,9
Granada	90,3	45,2	71	64,5	100	35,3	45,2	71	48,4	22,6	12,9
La Laguna	45,2	41,9	32,3	48,4	41,9	96,8	25,8	25,8	29	22,6	9,7
Gradisca d'Isonzo	45,2	54,8	71	41,9	45,2	38,7	100	87,1	35,5	48,4	19,4
Beivars	67,7	45,2	67,7	38,7	71	32,3	74,2	96,8	45,2	35,5	19,4
Siena	61,3	45,2	51,6	58,1	51,6	25,8	32,3	48,4	100	41,9	12,9
Porto Torres	25,8	54,8	45,2	35,5	22,6	12,9	38,7	45,2	35,5	100	25,8
Villanova	12,9	25,8	12,9	12,9	3,2	3,2	19,4	9,7	9,7	29	93,5

In the same way as in the previous test, and as expected, the distances between one point and itself render a dialectal coincidence value of 100% in most points, or nearly 100% in the remaining points, which translates as zero distance in the distances matrix that is created from table 3.

If we take into account both presentation orders together, the data falls into the groups presented in figure 5. Above we can see the dendrogram that shows the data groupings based on Euclidean distances; while below, we can see the virtual map obtained through the statistical technique of multidimensional scaling.

Figure 5. Perceptive distances in interrogative sentences. Above, dendrogram (method: Euclidean distances); below, MDS (Stress=0. 08366; RSQ=0. 96820).


Dendrogram using mean linking (between groups)
Combination of re-scaled distance clusters
0
5
10
15
20
25
Barcelona 1
Valencia 3
Granada 5
Gradisca 7
Beivars 8
Alghero 2
Siena 9
Palencia 4
LaLaguna 6
PortoTor 10
Villanova 11


Derived stimuli configurations
Euclidean distance model
PortuTurre
L.Alguer
Beivars
València
Gradisca
Biddanoa
Siena
Granada
Barcelona
Palència
LaLaguna
Dimension 2
1,0
0,5
0,0
-0,5
-1,0
-1,5
-3
-2
-1
0
1
2
Dimension 1

Noticeably, those survey points that present a rising nucleus (Barcelona, Valencia, Granada, Gradisca d'Isonzo, Beivars) tend to form a more compact group—that is, they are perceived as possibly belonging to the same dialect—than the rest (Alghero, Porto Torres, Villanova, La Laguna, Palencia) that present a falling nucleus. The case of Siena constitutes an exception in this respect because it should fall into the first group rather than the second, since it has a rising nucleus. It is, however, also true that together with Alghero, they form the first points that join the more compact initial block, which means that some sort of differences are perceived between them.

The mean reaction time for interrogatives is 5 s. while for the declaratives studied in the previous section it is 5.3 s. The shortest reaction times are those of the identical pairs, namely, the same stimulus repeated; and they also tend to be shorter in pairs where one of the stimuli belongs to a sample for the languages of the northwest of Sardinia, especially from Villanova. This means that, as would be expected, the judges react faster to either identical stimuli, or stimuli that are significantly different from each other. That which might or might not belong to the same dialect requires more reflection; in other words, two stimuli that share some but not all of their characteristics require a longer time to evaluate whether these shared characteristics are relevant enough to assign both stimuli to the same group.

4.5. ABX discrimination test in declaratives

In the next two experiments, we continued studying the perceptive distances between survey points, but in discrimination tests 4 and 5, the number of points was restricted to keep the length and difficulty lower than they would have been had all locations been taken into account. In this case, attention was focused on the three languages in contact

on the island of Sardinia (Catalan, Italian, and Sardinian), which were compared both amongst them and to one peninsular Catalan point (Barcelona) and one of peninsular Italian (Siena).

Just as with tests 2 and 3, all the cells in the corresponding confusion matrix (table 4) contain data because this reflects the presentation order of the stimuli in the test.

As was indicated in the methodology section, the stimuli were presented in triads conforming to the ABX design, were X could match A, B, or neither A nor B, that is, it could correspond to C. The objective was to discriminate whether X was more like (or the same as) A or B.

The design of this perceptive test is more challenging than the one followed for experiments 2 and 3, and therefore none of the items considered reaches 100% when two out of the three stimuli presented are identical. This is also true for the next experiment, which follows this same design, but focuses on interrogative sentences. In test number 4, which corresponds to declaratives, the results obtained are shown in the confusion matrix of table 4.

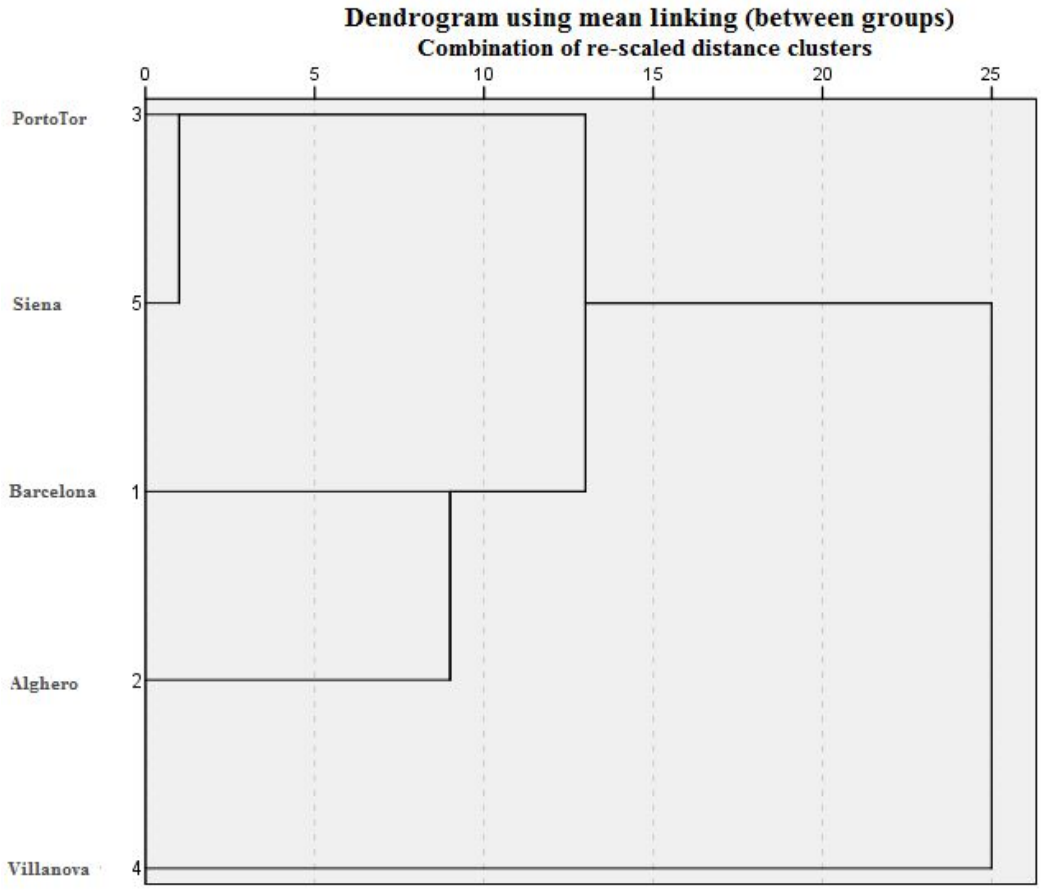
Table 4. Confusion matrix of declarative sentences, in percentages.

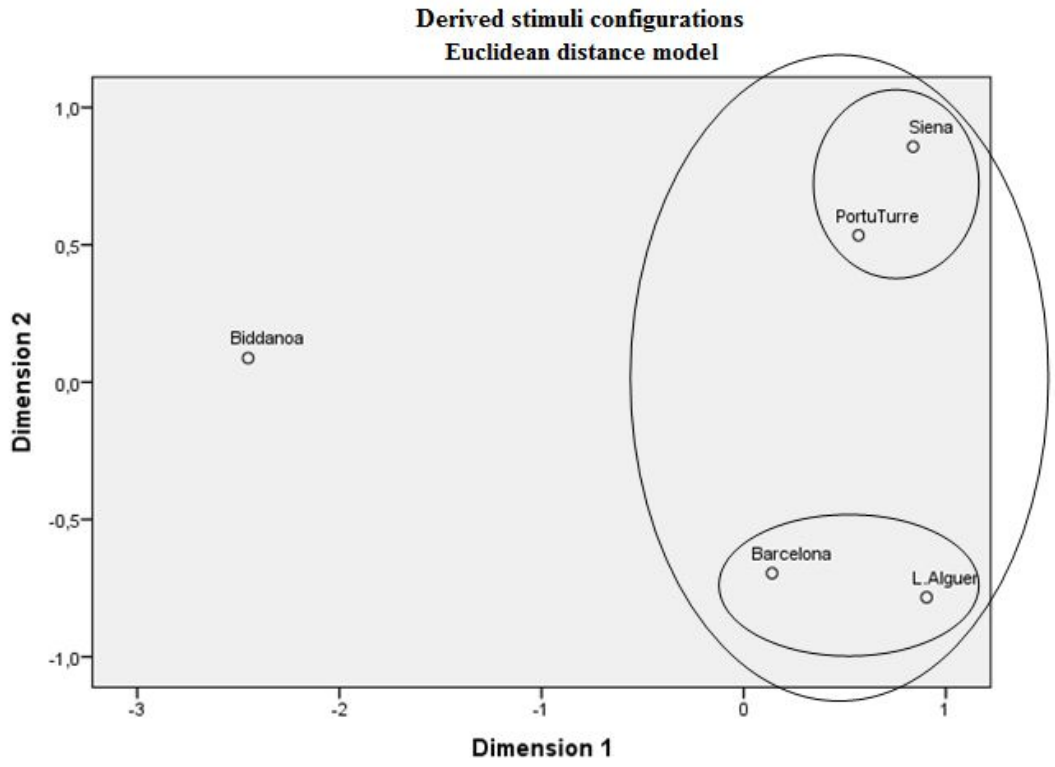
	Barcelona	Alghero	Porto Torres	Villanova	Siena
Barcelona	88,2875	53,2125	45,5875	20,1625	42,7375
Alghero	50,2125	90,725	48,3625	13,725	40,725
Porto Torres	42,7375	42,35	82,6625	20,1625	62,0875
Villanova	51,225	30,2375	43,1625	93,525	31,85
Siena	41,95	45,1625	59,675	16,1375	87,075

Based on the judges' responses, each survey point is notably more like itself than any other, as expected. The groupings—the likeness or shortest perceptive distance between

varieties—are reflected in figure 6. The survey points arrange themselves by language, more than by geographical distance. The survey point that presents the most manifestly rising nucleus, Villanova Monteleone, appears farthest from the others that have a falling or sustained nucleus.

Figure 6. Perceptive distances in declarative sentences. Above, dendrogram (method: Euclidean distances); below, MDS (Stress=0. 00000; RSQ=1,00000)


Dendrogram using mean linking (between groups)
Combination of re-scaled distance clusters
0
5
10
15
20
25
PortoTor
3
Siena
5
Barcelona
1
Alghero
2
Villanova
4


Derived stimuli configurations
Euclidean distance model
Siena
PortuTurre
Biddanoa
Barcelona
L.Alguer
Dimension 2
1,0
0,5
0,0
-0,5
-1,0
-3
-2
-1
0
1
Dimension 1

The mean reaction time for declaratives is 7.32 seconds. Although the data obtained through Praat does not offer significant differences between stimuli, the sets of stimuli that present triads with two identical stimuli tend to take a shorter time. The opposite is true of the triads that include all three languages from Sardinia (probably because they are all somewhat alike and making a decision is difficult) or two languages from Sardinia plus either Barcelona or Siena (presumably because Barcelona / Siena can be clearly discriminated from the other two and this, too, is difficult).

4.6. ABX discrimination test in interrogatives

Test number 5 corresponds to the interrogative form and the results obtained appear in table 5.

Table 5. Confusion matrix of declarative sentences, in percentages.

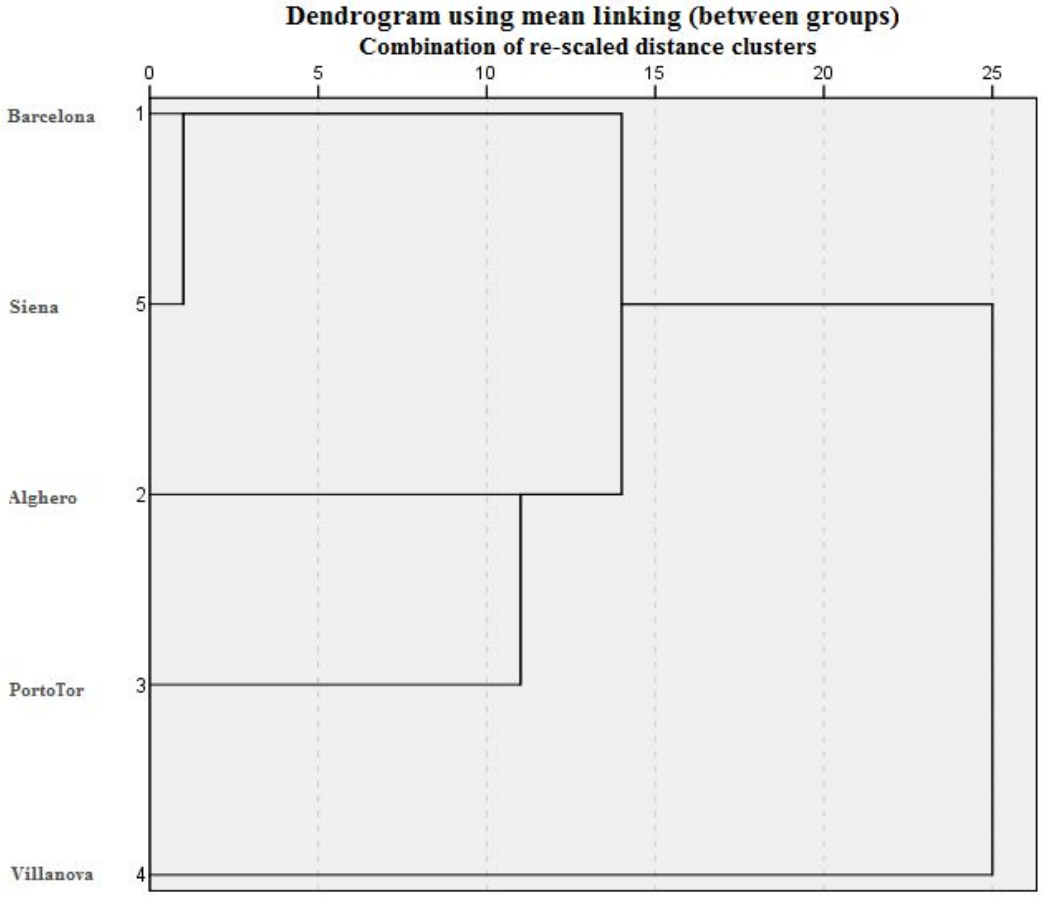
	Barcelona	Alghero	Porto Torres	Villanova	Siena
Barcelona	92,325	50,8125	34,3	11,3125	60,875
Alghero	60,0625	91,1375	45,9625	16,95	35,8875
Porto Torres	40,7125	41,1375	92,6375	33,32222	43,3
Villanova	32,675	36,75	59,25	95,575	25,8
Siena	61,2875	39,1125	41,5375	15,725	92,3375

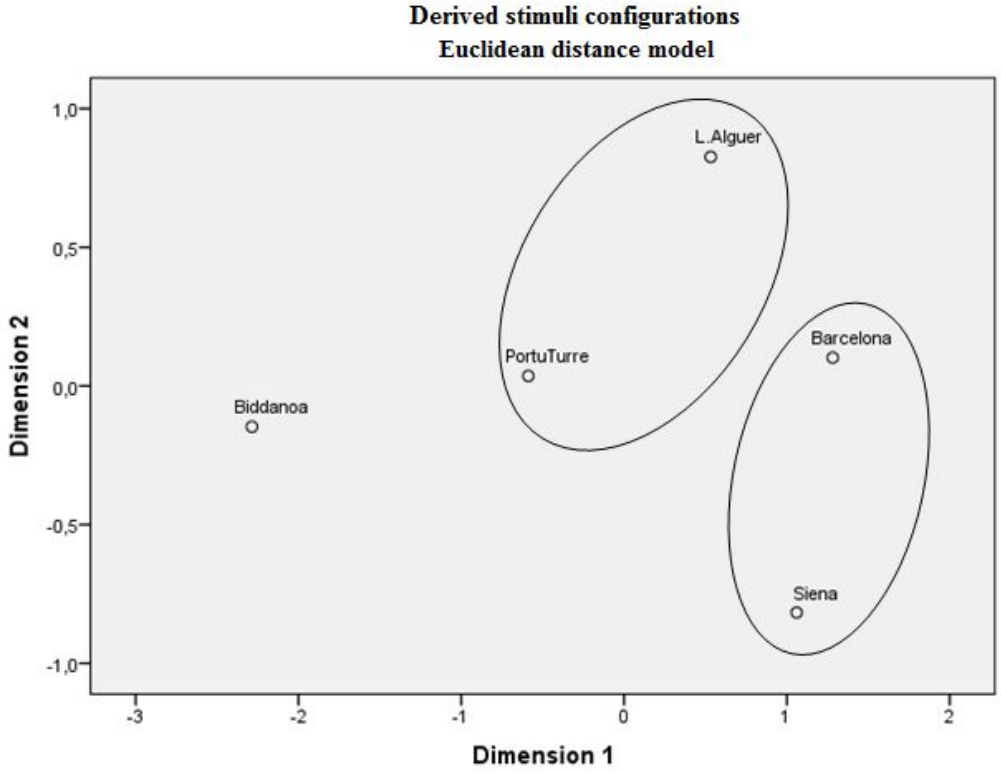
The judges once again determine that each survey point is more like itself than any other, as expected, and more evidently than in the declarative sentences, although in no case does it reach 100%. The groupings—the similarity or shortest perceptive distance between varieties—are reflected in figure 7. Alghero and Porto Torres cluster together

due to the influences their geographic proximity has exercised on their prosody, more than to its linguistic affiliation. The survey point with the most decidedly falling nucleus and two almost equally prominent peaks in the prenucleus, Villanova Monteleone, appears farthest from all the others that have a falling or sustained nucleus (Alghero and Porto Torres, representing the other two languages of the northwest of the island of Sardinia), and clearly removed from those with a rising nucleus (Barcelona and Siena). The MDS shows that it is nonetheless closest to the group constituted by the other two languages of the northwest of the island of Sardinia. These perceptive results absolutely coincide with the acoustic results found in our own studies (Martínez Celdrán et al. 2008 and Roseano et al. 2014, 2015a), where this intonational convergence is postulated thinking of Sardinian as a substratum for both Algherese Catalan and the Italian of the island. They also coincide with the acoustic findings of other researchers (Contini 1995, Prieto et al. 2009, Cabré & Vanrell 2013, and Vanrell et al. 2013).

Two macroareas can be identified (rising interrogatives vs. falling interrogatives). This classification reinforces, then, the acoustic characterizations performed in earlier studies according to which, geographic proximity determines a greater similarity between these varieties of different languages than between varieties of the same language that were more distant from each other. It would seem that, in accordance with the Strong Universalist Hypothesis, listeners are quicker to group the points with rising nucleus, which are more clearly identifiable in interrogatives, than those with falling nucleus that are also further removed from each other.

Figure 7. Perceptive distances in interrogative sentences. Above, dendrogram (method: Euclidean distances); below, MDS (Stress=0,00188; RSQ=0,9998).


Dendrogram using mean linking (between groups)
Combination of re-scaled distance clusters
0
5
10
15
20
25
Barcelona
1
Siena
5
Alghero
2
PortoTor
3
Villanova
4


Derived stimuli configurations
Euclidean distance model
1,0
0,5
0,0
-0,5
-1,0
Dimension 2
L.Alguer
PortuTurre
Biddanoa
Barcelona
Siena
-3
-2
-1
0
1
2
Dimension 1

The mean reaction time is 7.03 s., which signals that the listeners are quicker to identify similarities between interrogative utterances that between declarative ones. The fastest identification, below the mean, occurs with triads that contain two identical stimuli. Indeed, the best recognized stimuli are those that match with themselves and at a higher rate than in declaratives. This fact had been highlighted in acoustic studies: the interrogative form describes language varieties better and distinguishes them from one another better than the declarative form. This is also why perceptive identification of this type of sentence tends to be easier, quicker, and more accurate.

The triads that require the most time (between 7.5 and 8.2 s.) are: Barcelona-Villanova-Porto Torres, because the stimulus from Barcelona is perceived as quite different from the other two, rendering it more difficult to identify as more similar to either of the other two, which is what the task is. Siena-Porto Torres-Alghero is also a troublesome triad (which implies that Porto Torres and Alghero are truly similar). Finally, the Villanova-Barcelona-Siena triad presents difficulties because the Sardinian stimulus is perceived as quite different from the others, making the decision of which of the other two is more like it quite a complicated one.

5. Discussion y conclusions

Perceptive results do not always match acoustic ones, although the most relevant differences do tend to be perceived.

It seems that in the sentence type identification test a falling (or somewhat sustained, or even slightly rising) ending is predominantly interpreted as declarative, while a rising ending constitutes a key perceptive indicator in the identification of interrogativity. This

fits the Strong Universalist Hypothesis (Ladd 1981), according to which a rise in F0 signals a question and a fall, a statement, as an initial universal approximation. Nonetheless, it is also true that the Nuclear Tone Hypothesis (Ladd 1981) states that the distribution of contours and their relation with sentence function has an arbitrary component and is language-dependent. This is why there are linguistic varieties in which declarative sentences show some sustainment or rise (for example, in the points of Friulian studied), or fall in the interrogatives, like in the three languages studied from the northwest of the island of Sardinia.

In addition, each language presents some variation in the functional patterns of the pragmatic function of sentences. This variation is recognized if the perceptive judges are familiar with the variety in question, or if these patterns coincide with their language, because the phonetic implementation of the phonological component of languages is not universal. In perceptive experiments carried out with data from Spanish and with Spanish listeners, Face (2008) also concludes that a final rise constitutes a sufficiently strong indication to take precedence over all other identification cues for sentence type, even when all the other cues signal a different type of sentence. However, among the other cues, the height of the initial peak and the presence, compared to the absence, of a tonal peak in middle position also shows a significant effect in sentence type identification.

In our listeners, general perceptive cues tend to be combined with cues in the native language of our perceptive judges because they identify similar but not identical models.

In the AX-type tests, the listeners believe that a stimulus can correspond to the same dialect as another on the basis of acoustic similarities present in intonation. In both sentence types, the utterances in Logudorese Sardinian from Villanova Monteleone are

perceived as the most disparate from all others, that is, as the ones that can hardly be identified as belonging to the same dialect as another. Undoubtedly, the central peak present in both types of sentences fails to follow the staggered fall pattern, as does the falling ending of interrogatives or slight rise in declaratives, cues all that constitute important indications for the listeners.

The results obtained in the ABX discrimination test for declaratives show how the clustering of the stimuli is formed by linguistic domain, most strongly for the Italian stimuli, and how the most removed point is Villanova. In the case of interrogative stimuli, the ones from Sardinia (with falling nucleus) form an ample block against the peninsular points with rising nucleus. In this case, listeners group the two peninsular points in one compact block to which first Alghero, then Porto Torres, and finally Villanova Monteleone are joined.

Our perceptive judges, Catalan speakers, in general identify interrogatives better and faster. We are working on expanding our research to perform the same tests on listeners whose mother tongue and everyday language is Spanish, Italian, and Sardinian, in order to compare our results and the influence that the judges' own language has on perception.

A fitting general reflection based on the results we obtained in the five perception tests carried out with stimuli from different Romance linguistic varieties allows us to conclude the following: 1) speakers of central Catalan are capable of perceiving prosodic similarities/differences between Romance varieties, judging by the percentages of the responses we obtained; and 2) it is possible to plot prosodic distances from perceptive data, as has been made evident through three different methods (identification, AX-discrimination experimental design, and ABX-discrimination experimental design).

The similarities/differences perceived by the judges are not identical to those that can be exposed through acoustic analysis; however, both in the AX and ABX tests, tend to point in the same direction, especially as pertains to the interrogative form, as is the case in acoustic studies. This sentence type is also the one that has the shortest reaction times.

The speakers of central Catalan are able to identify sentence type (information-seeking yes/no questions vs. broad-focus statements) in other Romance varieties, but with some limitations. Our perceptive judges often perceive the rising declaratives of Friulian as interrogatvies, and the falling interrogatives of Logudorese Sardinian as declaratives. These results seem to confirm the Strong Universalist Hypothesis on the one hand, but also the Nuclear Tone Hypothesis on the other, because in the language of the judges, SVO declaratives are falling and SVO interrogatives are rising. The accurate perception of the falling interrogative pattern (¡H* L%) of Leonese Spanish from Palencia is, undoubtedly, due to the presence of the similar echo question pattern in Catalan (L+¡H* L%), which reinforces the position that specific patterns in the judges' own language is significant. In the case of a greater or smaller similarity between three stimuli, the listeners from Barcelona tend to group the three languages from the northwest of the island of Sardinia as similar among them, and different from their own dialectal variety. In this respect, it will be interesting to see in the research we have underway to extend this study, what results the Spanish-, Sardinian-, or Friulian-speaking judges will deliver. The results obtained from judges who are speakers of other languages with specific strategies will contribute new empirical evidence to the discussion of both hypotheses.

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