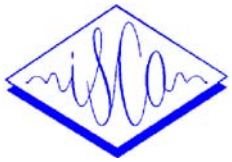

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THE ROLE OF PROSODY IN INFANTS' NATIVE-LANGUAGE DISCRIMINATION ABILITIES: THE CASE OF TWO PHONOLOGICALLY CLOSE LANGUAGES

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ABSTRACT

In this paper, the capacity of four-month-old infants from monolingual environments to distinguish between two syllable-timed languages is analysed. Catalan and Spanish are both Romance languages which present differences at the segmental level and at the syllable structure level, but show important similarities concerning prosodic structure at the phonological phrase level. Nevertheless, the presence of vowel reduction only in Catalan may determine rhythmic differences which could be detected by infants and used to tell these two languages apart. Two experiments have been run, with normal and low-pass filtered utterances, using a visual orientation procedure with a reaction time measure. Results indicate that infants are able to discriminate even when segmental information has been removed. The distinction seems to be the result of basic differential rhythmic properties between these two languages.

1. INTRODUCTION

An early ability to recognise one's native language seems to be a prerequisite for subsequent learning of its grammatical organisation. This ability to distinguish languages is especially important for infants growing in multilingual environments. Previous research has shown that newborns and young infants are able to distinguish sentences from two phonologically distant languages, that is, when syllable-timed vs. stress-timed language comparisons have been used. It has already been established [1] that infants' ability to group together different utterances from the same language is very early in place for pairs of languages such as French and Russian, or English and Italian. Other positive evidence of an early discrimination capacity has been gathered using English vs. Spanish material [2,3] and an English vs. French contrast [4]. Although these initial studies have used rather different procedures, they have in common the use of connected speech instead of just words or syllables. Their results can be said to indicate that the information infants use to classify or to distinguish utterances from different languages is probably based on prosodic characteristics. Prosodic properties such as pitch contour, duration and intensity of the vocalic nuclei in the syllable determine the specific rhythmic and intonational pattern of a language. Probably, it is this information what initially enables the infant to identify the maternal language. Recently, a model [5] has been developed to account for these early discrimination capacities. One interesting prediction from the Time and Intensity Grid Representation proposal is that very young infants would not be able to succeed in distinguishing between languages unless their prosodic properties were very distinct. Till recently, syllable-timed vs. stress-timed language comparisons had been used, but some indication exists [6] that when two stress-timed languages are compared (Dutch vs. English), newborns are not able to make the distinction. In this context, our research aims at finding evidence of a discrimination between two phonologically related languages, such as Spanish and Catalan, in four-month-old infants from monolingual environments. These two languages, although prosodically similar at the phonological phrase level, they differ in the presence of vowel reduction only in Catalan. At the segmental level the number of vowels and the type of fricative consonants is also different. If infants succeed in the native-language recognition task, then it will be interesting to know whether the discrimination is done solely on prosodic grounds or whether segmental information is needed and already used by infants that old.

2. EXPERIMENT 1: CATALAN VS. SPANISH

2.1 Method

2.1.1 Materials

Fourteen different utterances in each language, equated in duration and number of syllables, were selected from a narration of a child's story told by a highly proficient multilingual speaker. Utterances could be constituted by a single clause, two coordinate clauses or a main clause plus a subordinate. Mean duration of utterances was similar [Catalan 3701 ms. (SD=731) and Spanish 3723ms. (SD=689); $t<1$], and number of syllables was also similar [Catalan 16 sylls. (SD=3.4), Spanish 16.4 sylls. (SD=2.8); $t<1$]. Spanish was the non-familiar language for infants from monolingual Catalan environments, and viceversa. Two English sentences were employed in the training phase for all subjects.

2.1.2 Procedure

Infants were tested using a slightly modified version of

the visual orientation procedure first developed by G. Dehaene-Lambertz (LSCP, Paris). The testing took place in a three-sided test both inside a sound-treated laboratory room. Infants were sat on the special seat facing the monitor and the loudspeakers; the mother sat behind them, on a separate chair, with specific instructions not to touch the baby unless signs of distress were about to appear (facial reactions could be seen on a TV monitor inside the room). A trial started by drawing the infant's attention to a central monitor with two successive colourful and dynamic images. As soon as the second image disappeared an auditory stimulus (an utterance) was played through one loudspeaker. The side (left or right) and the type of language (maternal or non-familiar) were randomised for every subject with the following restrictions: no sentence was ever repeated, no more than three successive sentences could be played through the same side, and no more than two sentences drawn from the same language could appear in a row. Every 16 seconds a new trial began until the first block was completed (14 trials, seven sentences from each language). Then the second block (14 new sentences) started after a short pause. Before the test trials, a short training phase, consisting of two English sentences, each presented through one loudspeaker, was designed to familiarise the infant with the specific location of the two possible sound sources. If the infant failed to orient to both sides, s/he was given a second chance using the same English sentences.

The whole experimental session was videotaped so that it could be coded later on to identify the orientation latencies for each test trial. The procedure was blind in that the coder did not know which language was being played. The beginning of the trial was signalled on the tape and the orientation time was the temporal difference between the frame on which the signal appeared and the frame in which an ocular movement clearly directed to one of the loudspeakers was identified.

Infants' responses were also coded so as to identify whether they had oriented to the right side or not from the start. A trial was considered null if the infant failed to orient to either side or if s/he had not been looking at the visual display at least for the last second of its presentation (anticipation responses). Trials in which the infant moved, cried, or was touched by the mother were also considered invalid. As additional criteria, trials with short latencies (below 400 ms) or the ones in which infants oriented late, after the end of the auditory presentation, were also rejected. All infants' videotapes were first coded and later on revised by the same experimenter. A trained assistant also conducted a separate coding to validate the measures.

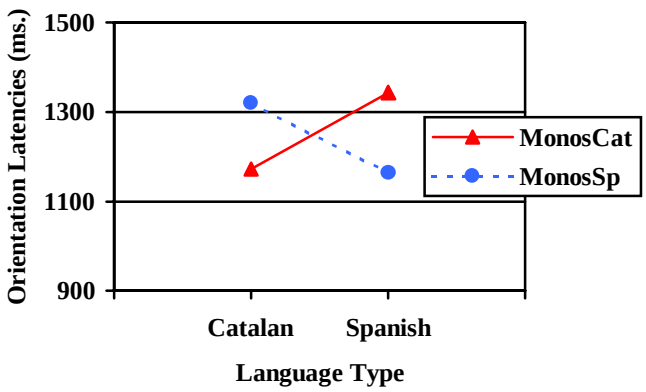
2.1.3 Subjects

Twenty full term, healthy, four-month-old infants from the Barcelona area were tested. Half of them belonged to Catalan monolingual families and the other half to Spanish monolingual families. A questionnaire was applied to ensure that they had been mainly exposed to only one language for their first four months of life. Catalan infants had an average age of 126 days (range: 118-138 days), and for the Spanish group it was 128 days (range: 118-138 days). Seven additional subjects were also tested, but they were rejected due to crying (1), fussiness (1), failing to reach the predetermined criterion of minimum number of valid trials required (4) and equipment failure (1).

2.2 Results

For the Catalan group, the average orientation latencies were 1173ms (SD= 189ms) to sentences in the native-language and 1344ms (SD=343ms) to sentences in the unfamiliar language (Spanish). Seven out of ten infants showed a preference for their maternal language. For the Spanish group, mean orientation latencies were 1164ms (SD=372ms) in the case of Spanish material and 1320ms (SD=442ms) for Catalan material. Eight out of ten infants reacted faster towards the sentences in their maternal language. Data from the two groups were submitted to an ANOVA. No significant effects were found for group (Catalan vs. Spanish environments) [F< 1] and for type of language (Catalan vs. Spanish) [F< 1], but a significant interaction effect between the factors analysed was observed [F (1,18) = 14.5, $p < .001$]. A paired t test confirmed that the difference in orientation latencies to native and non-native language material was significant in both groups [Catalan infants: $t(9) = -2.265$, $p < .050$; Spanish infants: $t(9)= 3.789$, $p < .004$].

Figure 1. Mean orientation latencies with non-filtered materials



Thus, in this first experiment we were able to find evidence of an early native-language recognition ability when two phonologically close languages are contrasted. This finding is especially relevant as the languages being compared can be said to share certain prosodic characteristics. In order to test whether the discrimination relies on prosodic information alone or if segmental information must be present to succeed in separating this pair of languages, a second experiment was run after having low-pass filtered the sentences.

3. EXPERIMENT 2: LOW-PASS FILTERED SENTENCES

3.1 Method

3.1.1 Materials

The same as in experiment 1, but this time the fourteen utterances were low-pass filtered (400 Hz) to remove segmental information and leave only prosodic and rhythmic cues.

2.1.2 Procedure

The same as in experiment 1.

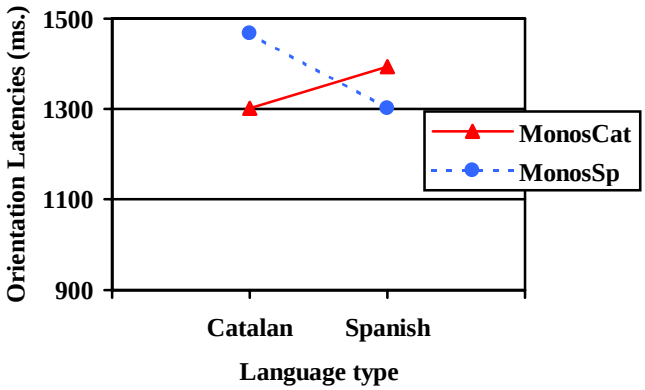
2.1.3 Subjects

A second group of twenty full term, healthy, four-month-old infants from the Barcelona area were tested. Half of them belonged to Catalan monolingual families and the other half to Spanish monolingual families. A questionnaire was applied to ensure that they had been mainly exposed to only one language for their first four months of life. Catalan infants had an average age of 125 days (range: 117-134 days), and the Spanish group was 127 days (range: 120-140 days). Nine additional subjects were also tested, but they were rejected due to fussiness (3), failing to reach the predetermined criterion of minimum number of valid trials required (4) and unclear monolingual status of the family (2).

2.2 Results

For the Catalan group, mean orientation latencies were 1302ms (SD= 378ms) for utterances in the native language and 1393ms (SD=363ms) for Spanish material. Seven out of ten infants oriented faster to the sentences in their maternal language. For the Spanish group, mean orientation latencies were 1301ms (SD=183ms) in the case of Spanish material and 1468ms (SD=196ms) for Catalan material. All infants in this group oriented faster to their maternal language.

Figure 2. Mean orientation latencies with filtered materials



Data from the two groups were submitted to an ANOVA. No significant effects were found for group (Catalan vs. Spanish environments) [F< 1] and for type of language (Catalan vs. Spanish) [F(1,18)=2.4, p<0.14), but a significant interaction effect between the factors analysed was observed [F (1,18) = 27.53, p < 0.0001]. A paired t test confirmed that the difference in orientation latencies to native and non-native language material was significant in both groups [Catalan infants: $t(9)$ =2.877, p < .018; Spanish infants: $t(9)$= 4.434, p < .002].

Results seem to indicate that the discrimination can still be done when segmental information has been removed. The early manifestation of this preferential response (the effect can be observed after having heard about 1500 ms. of connected speech) sets the limits of our search for differential prosodic/rhythmic cues that have been reliably used by infants to distinguish their native-language from a non-familiar one.

4. CONCLUSION

The present study has expanded previous work on young infants' native-language recognition abilities as it has been shown that by four months of age a native-language preference can be established when sentences drawn from two phonologically close languages are presented. Results of experiment 1 demonstrate a language discrimination for a language pair that had not been tested previously. Selecting a closer pair of languages and finding positive evidence of a discrimination broadens our perspective on how fine-grained infants' sensitivity to the specific characteristics of their native-language is. Results from experiment 2, in which infants succeeded in making the distinction using low-pass filtered material, suggest the existence of differential prosodic/rhythmic cues that distinguish these two Romance languages and that they must be salient enough to be easily captured by young

infants. infants. The specific methodology used in our infant experiments seems to be particularly useful to determine how much information from continuous speech is needed to recognise a familiar language, and which cues make this identification possible. The early manifestation of this preferential response (the effect can be observed after having heard around 1500 ms. of linguistic information) establishes the limits of our search for differential prosodic/phonological cues. First, the duration of the orientation latency suggests that the relevant information can be found inside a unit which roughly corresponds to a phonological phrase. Nevertheless, as regards prosody, the languages in our study are considered to be similar at the level of the phonological phrase, suggesting that the differences infants were able to detect are probably related to smaller prosodic units, at the clitic group or the phonological word levels. When comparing Catalan and Spanish, there is evidence [7] of a differential pattern in stress assignment to words that come from other languages: while Catalan shows a preference for iambic forms (right headed binary constituents, as in the English word *handball*, usually produced [hanBOL], Spanish seems to prefer trochaic forms (left headed ones, so that *handball* is produced [HANbol]. The differences in stress assignment in these two languages may account for dissimilarities as regards prosodic information, which could be detected by infants and used in this maternal-language recognition task.

On the other hand, it must be kept in mind the important role played by vowels [8] as they carry acoustically relevant and regularly distributed information in the speech signal. Not only do they effectively represent sequential information in the speech stream [9], but they also signal the characteristic rhythmic properties of a specific language. Since an important difference between Catalan and Spanish is the presence of vocalic reduction in the former, it may be hypothesised that the distinction is made on this basis: vowel reduction specifically determines a change in duration and intensity of the syllabic nuclei, which in turn would contribute to the basic differential rhythmic properties between these two languages.

5. ACKNOWLEDGEMENTS

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