

The early recognition of verb affixes: evidence from Portuguese*

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1. Introduction

This paper is concerned with the early sensitivity to the morphophonological pattern of verbal affixes in fluent speech by children acquiring Brazilian Portuguese (BP). It has been developed within a theoretical framework that reconciles the phonological bootstrapping hypothesis (Morgan and Demuth 1996; Christophe et al. 1994) with a minimalist conception of language (Chomsky, 1995). According to this view, infants perceive and process the speech sound as interface information and take recurrent patterns to be grammatically relevant in so far as language specific properties, represented as formal features of the functional categories of the lexicon, are expressed in the morphology and/or in canonical order patterns (Corrêa, 2009).

The early perception of closed class elements in speech segmentation is crucial to the delimitation of grammatical categories, to the initial parsing of linguistic expressions and the progressive specification of the formal features of functional categories (Gerken, 2001). Infants are sensitive to phonetic properties that distinguish functional elements since the first days (Shi, Werker & Morgan, 1999) and by the end of the first year of life they are sensitive to alterations in the pattern of functional elements in the speech flow (Shady, 1996, Shafer et al., 1998). In a study conducted in German, 15 month old children familiarized with monosyllabic nouns preceded by determiners (in an iambic structure) recognized these nouns when preceded by different determiners (in contrast with children familiarized with iambic dissyllabic nouns, who were not able to recognize the second syllable in a different context) (Höhle & Weissenborn, 2000). It appears, therefore, that

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determiners are recognized by this age and parsing in the DP has started, thereby enabling nouns to be delimited. Data from children acquiring Portuguese suggest that, by the beginning of the second year of life (15 months), phonological alterations in the pattern of the determiners can be detected in fluent speech, without prior familiarization (Name & Corrêa, 2003).

It is assumed here that the distinction between closed and open class elements by the end of the first year of life gives rise to a minimal lexicon, in which broad functional (closed) and lexical (open) categories are distinguished by a means of a formal feature. This formal distinction would bootstrap a universal computational system, thereby enabling the parser to start analyzing the input. Language development would proceed with the progressive specification of the formal features of the functional elements (Corrêa, 2009).

In this study, the extent to which infants are sensitive to the pattern of verbal affixes in Portuguese is investigated. There is evidence that 18 month old children are sensitive to bound morphemes being able to segment them (Golinkoff, Hirsh-Pasek & Schweisguth, 2000). Moreover, 18 and 21 month old babies seem to cope with a three syllable processing window, which is necessary for discontinuous dependences involving verbal bound morpheme to be processed (Santelmann & Jusczyk, 1998). More recent results suggest that, by the age of 16 months, children acquiring English are sensitive to the pattern of 3rd person singular subject-verb agreement in the present tense (Soderstrom, White, Conwell & Morgan, 2007, Soderstrom, 2008). An early sensitivity to the pattern of bound morphemes would, therefore, be expected in order for children to be able to process some sort of subject-verb agreement by the middle of the second year of life. In the present study, this hypothesis is tested with children acquiring Portuguese as their first language. Portuguese is a relatively rich morphology language. Verbal affixes encode grammatical distinctions pertaining to Person, Number, Tense, Aspect, Mood, and express subject-verb person and number agreement. The recognition of the morphophonological pattern of these elements is therefore the first step for a number of functional categories in this language to be fully specified. The experiment reported was intended to verify the extent to which the pattern of verbal affixes is recognized by the end of first year of life.

2. Experiment

The present experiment aimed at investigating infant's ability to recognize the morphophonological pattern of verbal affixes in Portuguese. In a previous study (Bagetti, 2009), it was observed that 9-18 month old children detect phonological alterations affecting the Portuguese syllable pattern both in verbal affixes and in nominal roots, indistinctively, as it would be expected on the basis of results obtained in English (Jusczyk, Luce & Charles-Luce, 1994). In the present experiment, children in same age range were tested. They were, nevertheless, divided into two age groups, being the youngest group constituted of children from 9-12 months of age. Unlike the previous study, the phonological alterations did not affect the syllable pattern of the language, but the morphophonological pattern of verbal affixes. The rationale of the present experiment was the following: If 9-18 months acquiring Portuguese detected these phonological alterations, then there would be evidence that they are sensitive to interface information that is crucial to the progressive specification of the formal features of this language.

The HPP procedure (Kemler-Nelson et al. 1995) was used. Unlike the standard procedure, a comic cartoon image of a talkative girl was presented in synchrony with the audio stimuli. It had been previously noticed that the presence of a speaking character contributes to diminish the loss of participants (Name, 2002). Unlike most of the studies involving pattern recognition in infant's speech processing, there was no prior familiarization to the test stimuli. Children were presented to short stories in a fluent child direct speech style, a mode of presentation that has enabled to attest infant's sensitivity to determiners in Portuguese (Name, 2002; Name & Corrêa, 2003). The stories were presented in normal and modified versions. In the modified versions, phonological alterations not affecting the syllable pattern were made in verbal affixes and the same alterations were made in nominal roots. The sequences [ey]; [ow]; [ew] and [iw] in stressed syllables were altered to [ɔw]; [un]; [ɔR]; [ɛy], in about 20% of the verbs (verb affixes) and nouns (nominal roots), in a balanced manner. Alteration in verbal affixes resulted in unrecognizable verbal forms and these alterations affected the morphophonological pattern of 1st/3rd person singular past tense perfective indicative forms. The alteration in the verbal affixes gave rise to ungrammatical forms, since their morphophonological pattern was affected. Alterations in nominal roots gave rise to pseudo-nouns, that is, to possible novel

nouns in the language. Consequently, whereas the former would be expected to be noticed by children already acquainted with morphophonological pattern of verbal affixes, the latter would be expected to be unnoticed.

Table 1 presents the phonological alterations made and examples of the resulting forms, when alterations are made in the verbal affixes (resulting in an ungrammatical form) and in nominal roots (resulting in pseudo-nouns).

Table 1:
Phonological alterations and resulting forms

Phonological alterations	Verbal affixes		Nominal roots	
	Normal form	Resulting ungrammatical form	Normal form	Resulting pseudo-nouns
[ey] → [ɔw]	[aka'bey]	[aka'bɔw]	[ba'leya]	[ba'lɔwa]
[ow] → [un]	[aka'bow]	[aka'bun]	[be'zouro]	[be'zunro]
[ew] → [ɔR]	[ko'Rew]	[ko'RɔR]	[kama'few]	[Kama'fɔR]
[iw] → [ɛy]	[su'biw]	[su'bɛy]	[ba'Riw]	[baRɛy]

The experiment had a factorial design with two independent variables: *Type of story* (a within-subject factor with three levels) – Normal (NOR), Modified in verbal affixes (AFMOD), and Modified in nominal roots (RMOD); and *Age* (a between-subject factor with two levels: 9-12 months and 14-18 months).

The hypothesis was that the morphophonological pattern of verb affixes are identified by the end of first year of life. It predicts that young children are sensitive to phonological alterations not affecting the syllable pattern but the morphophonological pattern of verbal affixes. Assuming that longer listening times are obtained in the most familiar conditions, it was expected that shorter listening times would be obtained in the AFMOD condition. NORMAL and RMOD were not expected to differ significantly. The prediction was then $NOR = RMOD \neq AFMOD$.

Method

Participants

27 babies were tested. Two of them were, however, eliminated for being inattentive (either crying or sleepy). The participants were, then, 14 babies (7 girls and 7 boys) aged between 9 to 12 months (mean age: 10 months) and 11 toddlers (3 girls and 8 boys) aged between 14 to 18 months (mean age: 16 months). Children were from middle-class families, living in Rio de Janeiro.

Material

There was a total 14 stories: 12 test stories, 4 of each type (NORMAL, AFMOD, RMOD) plus 2 familiarization stories (NORMAL and MOD, either AFMOD or RMOD, randomly). The stories were presented in 2 blocks of 8 stories each: 2 familiarization followed by 6 test stories (2 of each type), presented in a random basis. Care was taken for two versions of the same type of story being not presented sequentially. The stories were small narratives in children's story style and they were recorded in female voice, as if directed to a child. The overall size of the stories was controlled (57-69 words, mean length 61 words) and the mean duration of the recording was 41 secs. Table 2 presents an example of a single story in three experimental conditions.

Table 2:

Story types	
Story type	Story
NORMAL	O rei descobriu uma lagoa e estabeleceu uma lei: - É só minha! O plebeu partiu e o besouro não mais se banhou. O hebreu enfureceu-se e mandou secar a lagoa. O rei se arrependeu. O hebreu mandou encher a lagoa...
AFMOD	O rei descobr <u>ey</u> uma lagoa e estabele <u>oR</u> uma lei: - É só minha! O plebeu part <u>ey</u> e o besouro não mais se banh <u>un</u> . O hebreu enfures <u>oR</u> -se e mand <u>un</u> secar a lagoa. O rei se arrepend <u>oR</u> . O hebreu mand <u>un</u> encher a lagoa...
R-MOD	O r <u>ow</u> descobriu uma lagoa e estabeleceu uma l <u>ow</u> : - É só minha! O Pleb <u>oR</u> partiu e o besunRo não mais se banhou. O hebr <u>oR</u> enfureceu-se e mandou secar a lagoa. O r <u>oR</u> se arrependeu. O hebr <u>oR</u> mandou encher a lagoa...

Apparatus

A sound-proof cabin in a baby lab with a glass window, contiguous to a control room. This cabin contained a chair for the mother and the baby, a central table and two lateral stands. On the top of the table, a box containing a red lamp encircled by small white lamps (connected to a DELL computer outside the cabin) was placed in front of the chair in order for the lamps to be centered, straight in the direction of the child's eyes. A Sony video camera was disguised under the table, so that a person could manipulate it without his/her presence being noticed by the child. The lateral stands contained one JBL loud-speaker each, which were disguised by curtains. On the top of each of the stands, a Samsung computer screen was made visible to the child. They were used to present the image of a talkative girl as the audio stimuli were presented in the corresponding loud-speaker. A headphone connected to a Sony MP3 was available for the mother/caretaker. The control room contained the DELL PC, a bottom box, for the presentation of the stimuli by the experimenter, a Pioneer sound amplifier and a Phillips TV, in which the image of child inside the cabin was transmitted. Labview was used for the programming.

Procedure

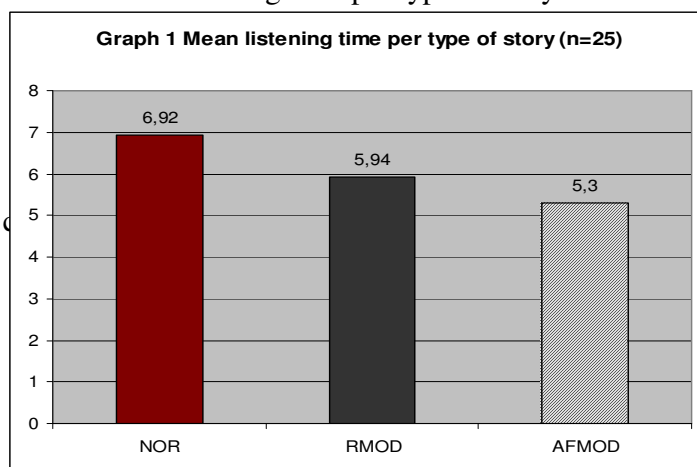
Children were tested individually in the sound-proof cabin of a baby lab. They were initially put at ease by playing on a mat outside the cabin, with his/her mother (or caretaker) and the experimenter. After becoming acquainted with the lab environment, the child and the mother/caretaker were invited to enter the sound-proof cabin. The child sat on the lap of his/her mother/caretaker in front of the table with the apparatus having the central red light. The mother/caretaker used headphones playing music. The two loud speakers were placed in a 45° degree angle to the left and to right of the mother/child. The experiment started with the red light encircled by while small lamps blinking. The blinking light was intended to make the child look straight. As soon as the child was looking at the red lamp, the audio version of a story was presented in one of the loudspeakers at the same time as the cartoon image of a talkative girl was presented at the screen placed above it. Children would turn their head left or right, depending on the source of the sound (the left or the right loud speaker). Both sound and image would remain turned on while the child was listening to/looking at them. The experimenter monitored children's attention by

looking at the TV outside the cabin and controlled the presentation of the stimuli. When the child lost his/her interest for more than 2 seconds (having the head turned to a different direction), the sound/image were turned off and the central red light blinked again. A different story was then presented and this cycle was repeated. If the child was tired or gave any sign of discomfort after the first block of stories, the procedure was stopped at the end of it. The maximum listening time was 11.41 sec and the mean listening time as 6.1 sec. The listening times for each story were automatically registered in the computer.

2.4 Results

The mean listening time for each story type was the dependent variable. Only 4 children (15%) required the procedure to be stopped at the end of the first block. The data were analysed by means a 3X2 ANOVA in which the first factor was a repeated measure. There was a main effect of *type of story* $F(2,46) = 8.44$ $p < .001$ and no main effect of *age* $F(1,23) = 1.84$ $p = .19$. Figure 1 presents the means. Pair-wise comparisons show smaller listening time in the AFMOD in comparison with the NOR condition, as predicted. However, the difference between NOR and RMOD approached significance and no significant difference was obtained between AFMOD and RMOD. In order to account for this unpredicted result, the listening times of each age group were analyzed separately.

Fig.1
Mean listening time per type of story



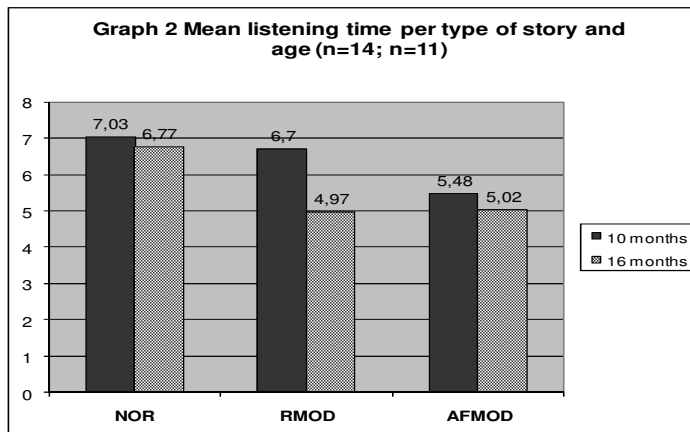
Pairwise comparisons (T-student):

NOR vs RMOD $t(df24)=2.04$ $p=.05$

NOR vs AFMOD $t(df24)=2.71$ $p<.0001$

RMOD vs AFMOD $t(df24)=1.55$ $p=.13$

Fig 2
Mean listening time per type of story and age



Pairwise comparisons (t-student)
 10 month olds:
 NOR vs RMOD $t(df13)= 0.7$ $p = .49$
 NOR vs AFMOD $t(df13)= 2.47$ $p < .001$
 RMOD vs AFMOD $t(df13)= 1.46$ $p = .01$
 16 month olds:
 NOR vs RMOD $t(df10)= 2.07$ $p = .06$
 NOR vs AFMOD $t(df10)= 1.67$ $p < .01$
 RMOD vs AFMOD $t(df10)= 0.07$ $p = .94$

It can be noticed (Fig. 2) that the predicted pattern of results was obtained in the 10 month old group: NOR = RMOD \neq AFMOD. No significant difference was obtaining between NOR and RMOD and RMOD and AFMOD differed significantly. It appears, therefore, that by the age of 10 months children are sensitive to the pattern of verb affixes. As for the oldest group, the difference between AFMOD and UNMOD was also significant ($p < .01$) and the difference between UNMOD and RMOD approached significance ($p = .06$). This tendency (difference between NORM and RMOD) may be due to the fact that the pseudo-nouns obtained in the RMOD condition had stressed syllables with open diphthongs and the probability of a high number of such words to occur in a single piece of discourse is low. Older children may, therefore, be acquainted enough with the language to be sensitive to this fact.

Conclusion

Infants by end of their first year of life (9-12 months) are sensitive to alterations in the morphophonological pattern of verbal affixes in Portuguese. This age appears to be the most adequate one for the assessment of young children's sensitivity to affix patterns. Other factors such as the relative number of nouns with stressed syllables with open diphthongs in the language may affect children's perception in their second year of life. In any case, the overall pattern of the results and the results of 10 year olds provide strong evidence for young children's perception of morphophonological units, which are required for the identification of the relevant properties of the grammar of the language.

In sum, by the age of 10 months infants have satisfied the basic perceptual conditions for the progressive specification of formal features of functional categories such as Tense, Aspect, Mood, Person and Number. Such a specification will involve processing at the semantic interface and may take long until full specification is achieved. The semantic interpretation of verbal affixes will enable morphophonological patterns to be converted into morphological representations to be retrieved in language production. The present results are then compatible with the hypothesis that closed classes are initially delimited on the basis of information available at the phonetic interface, a condition for the progressive specification of formal features.

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