The Perception of Discontinuous Dependencies by 18-Month-Olds: On the Process of Acquiring Verbal Passives

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1. Introduction

Studies concerned with the acquisition of passives have traditionally aimed to answer whether children at a certain age have, or not, the ability to derive (comprehend/produce) verbal passives. In this respect, two major currents can be considered: one that regards the acquisition of passives as a late achievement, dependent on maturation (Borer & Wexler, 1987; Snyder & Hyams, 2015, among many others); and another one that considers it an early achievement (Crain, Thornton & Murasugi, 1987/2009; O’Brien, Grolla & Lillo-Martin, 2006; Bencini & Valian, 2008). Little attention has been devoted, however, to the procedures whereby children acquire these structures.

The present paper does not engage with any of the cited currents and changes the focus of attention to early processing abilities that are assumed to be required in order for the grammatical knowledge pertaining to passives to be achieved. These abilities involve detecting patterns that can be relevant for the identification of the discontinuous dependency that characterize the form of these structures in languages such as Portuguese.

In Portuguese, verbal passives display a specific morphophonological pattern, the Aux-foi (eventive be in its simple past form in Portuguese) plus the participial form of the main verb (see (1)). The present work investigates whether young children acquiring Brazilian Portuguese (who do not necessarily produce more than one-word utterances) can track this non-adjacent dependency. In order to do so, a preferential attention test (analogous to the Headturn Preference Procedure (cf. Kemler-Nelson et al. (1995)), inspired in Santelmann & Jusczyk (1998), was designed. It contrasts the mean listening time of stories containing the regular pattern of verbal passives, foi_V-do (see (1)), with an ungrammatical pattern involving the auxiliary foi and the Portuguese imperfective past morpheme –va, forming the complex foi_V-va (see (2)). The main hypothesis is that children can track such a dependency.
The paper is organized as follows: in the next section, an experimental study investigating children’s ability to track the morphophonological dependency of verbal passives is reported. In section 3, a brief characterization of the acquisition of passives mainly concerned with languages such as Portuguese is proposed in the light of a procedural view of language acquisition (Corrêa, 2009; 2014). Section 4 brings our final remarks.

2. Experimental Study

Discontinuous dependencies between functional items have been a matter of great interest in studies concerned with the interface language-cognition (Golinkoff, Hirsh-Pasek & Schweiguth, 1998; Santelmann & Jusczyk, 1998; Tincoff, Santelmann & Jusczyk, 2000; Hohle et al, 2006). In the classic study of Santelmann & Jusczyk (1998) children’s ability to track the morphosyntactic non-adjacent dependency between the verb *be* and the gerund morpheme –*ing* was tested. These functional items are codependent and together form progressive tenses in English.


In Santelmann & Jusczyk (1998), infants between 15 and 18 months were exposed to stories containing grammatical sentences as in (3). These sentences were contrasted with ungrammatical sentences, as in (4). Notice that in (4) the auxiliary verb *be* was replaced by the modal *can*.

(3) Gradma is singing.
(4) *Grandma can singing.

Their prediction was that infants would listen differently to the two types of stories (see (5-6)) if they could track the morphosyntactic dependency at stake. The results show that 18-month-olds tend to listen longer to stories with the grammatical complex *Aux-be+V-ing* than to stories with the ungrammatical complex. The same results have not been attested with 15-month-olds.

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\(^{1}\) The details of each experiment are omitted due to the fact that they are irrelevant to the purposes of the present paper.
At the bakery, everybody is baking bread. One person is mixing the flour and water together. Someone else is adding salt and yeast. In the next room, a big machine is kneading the dough. Another is shaping the loaves for the oven. The whole place is starting to smell great!

At the bakery, everybody can baking bread. One person can mixing the flour and water together. Someone else can adding salt and yeast. In the next room, a big machine can kneading the dough. Another can shaping the loaves for the oven. The whole place can starting to smell great!

[see Santelmann & Jusczyk (1998, p. 111)]

The same experimental procedure is entertained here regarding passive sentences. The working hypothesis is that 18-month-olds can track the discontinuous dependency of verbal passives involving the auxiliary *ser* and the participial morpheme *-do*. Adaptations had to be made, though, concerning the form of the contrast. In English, the focus of the ungrammaticality of the modified version was the auxiliary. In Portuguese, the participial morpheme (see (7)) was replaced by the morpheme *-va* of the indicative imperfective past (see (8)).

The independent variables were *Age* (younger; older infants) and *Type of complex* (normal; modified). Mean listening time was the dependent variable. It is predicted that if children can track the morphosyntactic dependency of passives, a significant difference between normal and modified conditions will be obtained. Although the results reported in Santelmann & Jusczyk (1998) have shown that infants, on average, listen longer to stories with grammatical sentences, no prediction has been made concerning the direction of the results.

2.1. Method

Participants. 27 infants participated in the test, 5 of which had their data excluded from analysis for not completing the task. The remaining participants (13 girls and 9 boys) were equally divided into two age groups (13-15; mean age 14;8 months VS 17-20; mean age 18;14 months).

Material. 8 experimental stories were created. Each of them had 6 experimental sentences. Two versions of these stories were created: one

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2 The test is not directly compromised with meaning, but with the (morpho)phonological patterns. The decision to make real stories instead of disconnected sentences is to make the material sound natural.
containing normal sentences with the complex Aux-foi+V-do (see (9)) and one containing exactly the same elements, but with a specific modification in the complex, the participial morpheme –do was substituted by the morpheme –va, forming the complex Aux-foi+V-va (see (10)).

(9) Normal version

Quando entrou em casa, a formiguinha falou: [O chão do meu quarto foi molhado]. Na cozinha, [o garfo foi babado pelo meu amiguinho]. Em cima da pia, [o queijo foi aguado] e [o melão foi cortado]. Não dá para acreditar! [O fogão foi quebrado]. No final, [meu carro foi roubado da garagem]. Que será que aconteceu aqui?

Translation: As soon as the ant got into its house, it said: the floor of my room was wetted. In the kitchen, the fork was slobbered by my friend. On the sink, the cheese was watered and the melon was cut. I can't believe it! The stove was broken! In the end, my car was stolen from the garage. What might have happened here?

(10) Modified version

Quando entrou em casa, a formiguinha falou: [O chão do meu quarto foi molhava]. Na cozinha, [o garfo foi babava pelo meu amiguinho]. Em cima da pia, [o queijo foi aguava] e [o melão foi cortava]. Não dá para acreditar! [O fogão foi quebrava]. No final, [meu carro foi roubava da garagem]. Que será que aconteceu aqui?

On average, each experimental story lasted 27 seconds (never less than 26 and never more than 28). Stories were all controlled to have the same number of words (57 words). The experimental sentences, in particular, also had the same number of words. Only disyllable verbs of the first conjugation (ending in –ar) were used in the complexes aux+part to keep the number of syllables controlled. The distance between the auxiliary foi and the termination (–do or –va) was always the same throughout the trials of the test; that is, two syllables.

An extra story, shorter than the experimental ones (17 seconds), was also created. No structure containing aux+part was used in it. This story opened the activity to give the participants some time to get used to the experimental situation.

A female native speaker of Portuguese recorded all stories by means of the Praat software. She was instructed beforehand to read the experimental sentences without emphasizing any of the areas of interest, particularly the modified ones. After some practice, she was asked to read the stories in a soft manner, as if she were really telling a story to a baby. Once it was recorded, no alteration in the material was necessary. \(^3\)

Device. The experiments were run in a baby-lab soundproof cabin with a chair for the caregiver to sit with his/her baby on the lap. The chair is opposite a
SONY TV set. A SONY camera was hidden between the parts of a drape. This drape has the same color of the wall of the cabin and is situated right behind the TV set. The camera is strategically positioned opposite the chair so as to capture the images of the baby face.

In the control cabin, outside the soundproof cabin, the experimenter controlled the test by means of a Macbook computer in which the Habit 2000 software was installed. This software is usually used in preferential listening tests to control semi-automatically the presentation of stimuli and time the attention children give to these stimuli. A Pioneer sound amplifier was used to remotely control the volume of the stimuli. A Phillips TV set received the images of the child from the inside of the baby-lab cabin. The caregiver and the experimenter also used two mp3 players with earphones to avoid any sort of interference during the test.

**Procedure.** All infants were tested individually. Toys were available and strategically positioned on a rubber mat right in front of the door to the baby lab cabin. Children were invited to play on this mat with the caregivers and experimenter. The aim was to make children at ease in the lab.

The caregivers were previously oriented about how to proceed inside the cabin. For instance, they were asked to calm down their children before the beginning of the test; they were told to use the mp3 players and to put the earphones on; they were also informed not to give any further instruction to their children after the test began.

As soon as the door of the experiment cabin was closed, the test started. From the outside of the cabin, the experimenter, who also had earphones, could observe the babies’ behavior inside the experiment cabin.

The test started with the exhibition of a humanized (anthropomorphic characteristics) light bulb on the TV screen in the format of an animated gif. The gif blinked and its exhibition was synchronized with the emission of a sharp and intermittent sound. The image and sound were used as the attention getter throughout the test; that is, a mechanism with the aim of attracting children’s attention to the experimental stimulus to be subsequently presented.

As soon as the child reacted to the exhibition of the attention getter, fixating his/her eyes on the TV screen, the first stimulus was released. While the auditory stimulus was being played, another gif, now the face of a girl moving her mouth as if she were speaking, was simultaneously exhibited. The same image was used in all trials.

After listening to the shorter story, created to make infants familiarized with the test, the child had to listen to 8 different stories (4 of the normal version e 4 of the modified version). The stories were semi-randomized in a way that babies never listened to two normal and two modified stories in sequence.

Child’s attention to the TV monitor was controlled from the outside of the cabin. The attention time is here characterized as listening time. The Habit software registered the listening times automatically.

When the baby deviated his/her attention from the TV screen for more than 2 seconds, the attention getter was immediately released. As soon as the child’s
attention was retaken, a new stimulus was let off. This procedure successively occurred until all the stories were released. The whole time inside the baby-lab cabin was very short, usually 5 to 8 minutes. At any child’s sign of clear discomfort, the procedure was immediately halted.

2.2. Results

The maximum mean listening time registered was 16.8 seconds (in the normal condition). The total mean listening time of the test considering both conditions (normal and modified) was 9.42 seconds. All the means of the test are presented in figure 1.

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Condition</th>
<th>Mean listening time (sec.)</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-15</td>
<td>Normal</td>
<td>8.57</td>
<td>1.74</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>Modified</td>
<td>7.85</td>
<td>2</td>
<td>0.62</td>
</tr>
<tr>
<td>18-20</td>
<td>Normal</td>
<td>12.85</td>
<td>3.06</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>Modified</td>
<td>8.4</td>
<td>1.66</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Figure 1: all means obtained in the test

A 2 (Age) X 2 (Type of Story) ANOVA was conducted. Type of story was a repeated measure. Two significant main effects were obtained Age and Type of story.

For Age F(1,20) = 9.31 p<.006 SS=64.49 MSe=6.93 the mean listening time of older children was 10.63 sec. and of younger children was 8.21 sec.. An increase of listening time is thus obtained as infants get older.

For Type of story F(1,20) = 26.9 p<.00005 SS=73.43 MSe=2.73) the mean listening time of normal stories was 10.71 sec. and of modified stories was 8.13 sec.. Such an effect shows that infants, in general, prefer the normal stories to the modified ones. An interaction between the independent variables Age*Type of story F(1,20) = 14 p<.001 SS=38.32 MSe=2.73 was also obtained.

At last, a pairwise-comparison reveals that longer listening times were obtained in the normal condition ([Normal] vs [Modified] t(10)=5.97 p<.0001) in the older group only (see graph 1). It thus suggests that, as predicted, 18-month-
olds are able to detect the morphophonological pattern of passives while 15-month-olds are not.

![Graph 1: Mean listening time in the two groups tested and standard deviation bars; the asterisk indicate the significant effect](image)

**2.3. Discussion**

It has been demonstrated here that Brazilian babies identify the complex *Aux_foi+V-do* as American babies identify the complex *Aux_is+V-ing* in English (cf. Santelmann & Jusczyk, 1998). These results replicate previous ones concerning the ability of 18-month-olds to detect discontinuous morphosyntactic dependencies (Cf. Golinkoff, Hirsh-Pasek & Schweisguth, 1998; Santelmann & Jusczyk, 1998; Höhle et al, 2006). As in these previous studies, children younger than 18 months were not able to track such a dependency here.

It is relevant to mention that all previous investigations conducted in Portuguese, although few and incipient, indicate that the occurrence of passives is very low in spoken language, particularly in the caregiver-children interaction (Cf. Perotino, 1995; Pesirani, 2009; Estrela, 2016). Lots of studies have been suggesting that non-adjacent dependencies would be acquired via statistical learning mechanisms (see references in Sandoval & Gómez (2013)). However, the apparent low frequency of passives in Portuguese did not seem to be problematic for the 18-month-olds.
The novelty of these results is that, for the first time, the ability of very young children to detect the morphophonological pattern that characterizes verbal passives has been shown experimentally. The next section inserts the interpretation of these results in the context of a procedural theory of language acquisition.

3. A procedural theory of language acquisition and the case of passives

The procedural view of language acquisition in Corrêa (2009; 2014) aims to reconcile the early identification of morphophonological patterns in speech processing with the notion of interfaces between an internal language and processing systems - as expressed in the Minimalist Program of generative linguistics (Cf. Chomsky, 1995; subsequent work). Under this view, the idea of innately guided learning (Cf. Jusczyk & Bertoncini, 1988) and the phonological bootstrapping hypothesis (Cf. Morgan & Demuth, 1996) are considered to be compatible with an initial state of language that constrains the identification of the information that can be grammatically relevant in the input data.

It has been assumed that the grammatical information for the identification of a particular grammar is available at the interfaces between (internal) language and the so-called performance systems, particularly as morphophonological patterns. The sort of information that the linguistic theory assumes to be necessary for the functioning of a universal computational system - formal features - is expressed in these patterns. Once formal features are represented in the lexicon, they provide information for the computational system to build syntactic structures. These features are initially represented in an underspecified manner and will be progressively specified in the course of the development based on referential/semantic information.

Results interpreted in the light of the phonological bootstrapping hypothesis have shown that infants are able to detect morphophonological distributional

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4 It is important to clarify that in the first place the procedural view of language acquisition addresses the issue of how the computational system of human languages (Cf. Chomsky, 1995; subsequent work) is bootstrapped (put to work) (Cf. Corrêa, 2009). The approach can be considered a first-merge theory in the sense that it speculates about the time the first merge operation - as stated by Chomsky - occurs. In a more concrete way, suppose that an infant is innately guided to detect regularities in the linguistic input, as assumed by Jusczyk and Bertoncini (1988). In this sense, an infant may detect that a certain sound corresponding to a determiner ‘the’ is usually uttered before sounds corresponding to words uttered to name different entities in the world, nouns. An infant acquiring English, for instance, notices that the former, determiners, always precedes the latter, nouns. Based on these two pieces of information represented in the lexicon - (i) the distinction between words pertaining to closed (determiners) and open classes (nouns) and (ii) order - the computational system may proceed to derive its first syntactic phrase and send it to the logical form in order to seek for an interpretation (cf. Corrêa, 2009; 2014). Corrêa claims that the representation of this rudimentary information would suffice for the computational system to be initialized.
regularities in the speech sound since very early - far before the first year of age. As previously pointed out, children are assumed to be guided (Cf. Jusczyk & Bertoncini, 1988) to take these patterns as grammatically relevant. Therefore, in the particular acquisition of passives, the Aux-foi+V-do might be the sort of information that will lead young children to acquire the structures at stake.

In a language such as Portuguese, the complex Aux-foi+V-do seems to function as an index for the acquisition of passives. This index may be represented in the lexicon as a rudimentary formal feature (call it II). At first, the detection of this complex solely means that the dependency between the discontinuous elements was identified. II would be thus a formal feature that promotes a syntactic binding between the auxiliary foi and the participle -do. In minimalist terms, these functional items might be merged together. Having this information represented in the lexicon, a merge operation between the auxiliary foi and the participial morpheme may be driven. The result of this rudimentary computation may be formally represented as a hierarchical structure (see (11)).

(11) \[\text{foiP foi}[II] \text{[partP –do[μII] [VP V]]}\]

It is well known that the process of acquiring a language is based only upon positive evidence. In this regard, a particular morphosyntactic index (Aux_foi+V-do) from which an abstract formal relation is extracted (see (11)) will certainly help infants in their task of mapping syntactic information into the semantic interface. How children would then proceed to acquire the semantic information of Portuguese verbal passives via syntax?

Once children have a feature represented in their lexicon informing that this merge is possible, their subsequent task would be to differentiate the semantic properties of the Aux-component of the complex at the semantic interface. This differentiation needs to be done in relation to analogous complexes - the complexes of adjectival passives (see (12-13)), respectively resultative and stative passives.

(12) O cachorro ficou amarrado.
   The_Masc._Sing. dog become_Past_Sing. tie_Part._Masc._Sing.
   ‘The dog got tied’
(13) O cachorro está amarrado.
   The_Masc._Sing. dog bestative_Past_Sing. tie_Part._Masc._Sing.
   ‘The dog is tied’

5 The name II is just a formalization, a way to account for the distinctive nature of this dependency in relation to other morphosyntactic dependencies.

6 It must be clarified that, in this formal representation, the maximum projection foiP is used instead of auxP. This choice is justifiable due to the fact that it is possible that the child identifies dependencies, at least initially, on the basis of an item-to-item relation (Cf. Tincoff, Santelmann & Jusczyk, 2000). In this respect, the infant could not initially associate foi with the flexional category of the verb ser (be_eventive).
Each passive predicate is thus semantically distinct in Portuguese. According to Embick (2004), the semantics of these complexes may be formally characterized by means of two semantic features: [agentivity] and [eventivity]. In this respect, a resultative predicate, as in (12), is positively marked only for eventivity [−agentive; +eventive]; stative predicates, as in (13), are not positively marked for any of the two features [−agentive; −eventive]. An eventive predicate, as the ones in verbal passives, is positively marked for both features [+agentive; +eventive]. The identification of these semantic properties will lead children to syntactically specify the properties of Π.

Notice that the distinctive semantic property of eventive passives is *agentivity*. Roughly, the presence of an auxiliary *ser* (beeventive) and the participial form of the main verb must indicate to the parser/computational system the need for an agentive layer to be operational while deriving eventive passives. When it occurs, it is possible to affirm that Π has been syntactically specified, meaning that a voice/passive feature (cf. Collins, 2005; Lima Júnior & Augusto, 2015) has been eventually represented in the lexicon and is available for syntactic computation.

An experiment run with Brazilian children showed that the most fundamental distinction regarding verbal (eventive) and adjectival passives (resultative and stative) has been made by children as young as 3 years of age (Lima Júnior, Augusto & Corrêa, 2016). The results of a truth-value judgment task revealed that 3 year-olds master resultative and stative passives as adults do. When verbal/eventive passives are concerned, although these children hesitated to answer as adults do, they demonstrated to have an understanding of the eventive nature of verbal passives.

While distinguishing passive predicates and even after having the passive feature represented in the lexicon, children still need to be able to recognize which verbs are, or are not, passivizable. This may change from language to language.

Notice that the verb *have* and its counterpart in Portuguese *ter* do not admit passivization (see (14)). As for walk, in English, the verb is perfectly passivizable while in Portuguese *caminhar* is not (see (15)). In this regard, overgeneralizations have been experimentally attested in English over the age of 4 (Cf. Pinker, Lebeaux & Frost, 1987). Aspectual and semantic features, such as *affectedness*, also seem to help British and Brazilian children to have a better performance on verbal passives (see Messenger et al., 2012; Lima Júnior & Augusto, 2014).

(14)  
  a. *The dog was had by the boy.*  
  b. *O cachorro foi tido pelo menino.*

(15)  
  a. The dog was was walked by the boy.  
  b. *O cachorro foi caminhado pelo menino.*

It is important to notice that passive sentences are pragmatically marked in Portuguese as they are in English. Additionally, these sentences have been reported to be more costly than adjectival and active sentences even for adults.
(Griffin & Bock, 2000; Ferreira, 2003; Lima Júnior & Corrêa, 2015). Reversibility of theta roles and pragmatic factors also have been shown to add to the burden of processing passives (Ferreira, 2003; Lima Júnior & Corrêa, 2016; Lima Júnior, Corrêa & Augusto, 2016). Therefore, even if the syntactic information was properly represented and is at work, the use of passives at certain circumstances may be unfavored.

At last, language external factors such as inhibitory control can contribute to the development of the ability to cope with these structures (cf. Lima Júnior, Augusto & Corrêa, 2016). It is expected then that children take longer to find out when it is more advantageous to use a passive sentence instead of alternative structures, such as an active or a topical sentence, for instance (cf. Lima Júnior, Corrêa & Augusto, 2016). Thus, having difficulties to parse passives at a certain age does not necessarily mean that the competence to parse it is not existent. Being able to cope with these apparently cognitive difficulties is also necessary for an adult-like performance with passives to be attested experimentally.

To summarize, a procedure view of the acquisition of passives in languages such as Portuguese would include:

(a) Detecting the phonetic and distributional pattern corresponding to AUX+Part at the phonetic interface;
(b) differentiating the Aux-foi+V-do complex from other analogous complexes (adjectival passives, for instance) at the semantic interface (see Crawford, 2012; Koring, Sangers & Wexler, 2015).
(c) identifying semantic restrictions associated with main verbs in passive structures (Cf. Pinker, Lebeaux & Frost, 1987; Lima Júnior & Augusto, 2014);
    dealing with the cost of computing/processing passives in different conditions (Bencini & Valian, 2008; Crain, Thornton & Murasugi, 2009; Lima Júnior, Corrêa & Augusto, 2016).

4. Final Remarks

In this study the non-adjacent dependency of passives has been investigated in the light of a procedural theory of acquisition. A preferential attention test (a similar testing ground to the Headturn Preference Procedure) was designed. In the task, the complex involving the auxiliary of passives and the participial morpheme was contrasted with an ungrammatical complex, in which the participle was replaced by the imperfective past morpheme –va. The results show that children at the age of 18 months tend to listen longer to stories involving the grammatical complex that provides morphophonological information concerning the voice/passive feature in Portuguese. The same was not observed with 15-month-olds, though. This difference has been interpreted here as an evidence that children at the age of 18 have the syntactic information required to proceed to the acquisition of the semantic specifications of verbal passives.
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