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Processing and acquisition of coreference: an investigation on Binding Principles development in Brazilian Portuguese

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Abstract

This article discusses the processing and acquisition of coreference by monolingual children acquiring Brazilian Portuguese (henceforth BP). More specifically, it is about the development of the coreferential relations established in the scope of the sentence, which are ruled by the principles defined by the Binding Theory. By using a version of the cross-modal picture decision task, we investigated how children acquiring BP process the input, in order to identify the coreferential relations present in the sentences and what role the binding principles play in this process. The results showed that binding principles pose different processing costs, and they also revealed a main effect of age, with adults being faster than children... To sum up, the results of this study showed that, as expected, both children and adults know the binding principles, however, the cost of processing them effectively increases with age. The results also revealed that each binding principles poses different processing demands, as reflected in the reaction times shown in our results.

Keywords: binding principles, coreference, language acquisition, Brazilian Portuguese, language processing

1. Introduction

Coreference is the phenomenon in which two linguistic elements refer to each other within a sentence and both refer to the same being in the extralinguistic universe. Within the generative framework, the study of co-referential relations, especially anaphoric ones, has been the object of study by a specific module, the Binding Theory (Chomsky, 1981). It has sought, basically, to determine the syntactic factors that rule the establishment of coreferential relations, through the formulation of formal principles concerning each type of resumption considered by the theory, namely, anaphors, pronouns and referential expressions.

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In general lines, binding poses three different principles, each related to one specific kind of proform: Principle A, which concerns with the constraints on the reference of anaphors, such as reflexives and reciprocals, Principle B, which defines constraints on pronouns, and Principle C, which defines constraints on other referring expressions. The following sentences can be seen as examples of each proposed principle:

(1) James thinks that George likes himself.
(2) James thinks that George likes him.
(3) James thinks that George hates Paul.

A brief description of these three principles is shown below:

Principle A: an anaphor must be bound in its domain.
Principle B: a pronoun must be free in its domain.
Principle C. a R-expression must be free in any domain.

In (1), Principle A allows *George*, but not *James*, to be an antecedent for the reflexive anaphor *himself*. On the other hand, in the sentence (2), Principle B allows *James* but not *George* to be the antecedent of the pronominal *him*. Principle C is related to the reference of nouns like *Paul* in the sentence (3), which are called *R-expressions*. As Sturt (2003) says, and applying the principles above, the explanations for the contrasts among these sentences is purely syntactic: the noun *George* and the anaphor *himself* are in the same local domain (in this case, a clause), and, in according to Binding Theory, the noun *George* is c-commanding *himself,* since it is placed in a position of syntactic prominence in relation to the *himself,* and c-command is enough to establish a syntactic domain be bound. In your turn, *James* and the pronoun *him* are not in the same syntactic domain (because they are in different clauses), so, *James* is not c-commanding *him*, leaving the pronoun free in its domain. Then, Principle A allows the reflexive anaphor *himself* to refer to *George*, but not to *James*, and the Principle B allows *him* to refer to *James*, but not to *George*.
It must be said that such principles are relevant to the functioning of these forms of resumption only when inserted in a sentencing context, not going beyond the limits of the sentence. This fact implies that the binding principles apply to cases of intrasentential correspondence, but do not apply to cases in which the correspondence is established beyond the sentence, at the level of the text / speech.
Regarding the acquisition of the binding principles, studies have focused, more often than not, on the characterization of the child mastery of the binding principles defined within the scope of generative linguistic theory (Chien & Wexler, 1990; Mckee, 1992, with data from English, Grolla, 2012, Bertolino & Grolla, 2012, with data from BP), as well as in the domain of the coreferential and anaphoric use of pronouns and reflexives (Grodzinsky & Reinhart, 1993). However, there are studies in which it was attempted to determine at what stage of children's linguistic development the binding principles would emerge (Mustafawi & Mahfoudhi, 2002; Kiguchi & Thornton, 2004; Kim & You, 2000), as well as discussing whether this

acquisition would have a universal shape among human languages (Iglesias, 2007). Other studies aim to investigate possible extralinguistic factors that could influence the linguistic processing of children involved in the acquisition of principles, such as the context of enunciation and knowledge of the world (Gordon & Hendricks,1997).

The study of the acquisition of the binding principles has proved to be of great importance not only for the increment of the research on binding itself, but also for the empirical evidence brought about that supports the propositions of the formal model in which they are inserted. Indeed, since these principles are considered innate, within the framework of the language model suggested by the generative linguistic theory, it is expected that the restrictions of referential interpretation imposed by them will be operative from the initial stages of linguistic development, with the child mastering them as soon as exposed to the sentences in which they appear (Guasti, 2002, Thornton & Wexler, 1999). Furthermore, some others studies have addressed some factors that must be taken into account when knowledge of innate principles are considered, such as lexical learning (Wexler & Manzini, 1987), maturation of grammar (Grimshaw & Rosen, 1990) and the role of non-specific components, as working memory (Araújo & Ferrari-Neto, 2020). Thus, the investigation regarding the acquisition of binding principles seems to be fundamental to the so-called innate hypothesis on which the theoretical generative model has been based.

Studies in this field have shown that, crosslinguistically, children seem to master the principles around 3 to 4 years of age (Guasti, 2002). Such studies have focused, in most cases, on the interpretation given by children to pronouns, anaphors and referential expressions, using offline experimental paradigms. The evidence obtained in such studies suggests that the mistakes made by children in this age group in tasks of interpreting coreferential forms (proforms) are not due to the unavailability of the principles at a given moment in the acquisition process, but probably to difficulties in experimental procedures. With regard to the acquisition of each principle, specifically, some interesting results can be reported. Chien & Wexler (1990), researching the acquisition of Principle A, claim that children acquiring English demonstrated knowledge of this principle at around 5 years of age. McKee (1992) found that children had acquired Principle A around 3 years of age. Regarding Principle B, the studies by Chien & Wexler (1990) and McKee (1992) showed that this principle is acquired later than Principle A (so called *Principle B delay effect*), which shows a certain difficulty for children acquiring English in processing reflexive elements.

The acquisition of binding principles in BP has also been presented in a series of papers (Grolla, 2009; Grolla, 2012, Bertolino & Grolla, 2012). In these studies, it was evidenced that children around 4 years of age show knowledge of Principle C, recognizing the sentences in which there is a violation of this principle (Grolla, 2009). In addition, children acquiring BP seem to have difficulties in establishing the correct referent of reflexive expressions, like *himself* (Grolla, 2012) and that children around 6 years of

age, who speak BP, presented a performance similar to that of BP adult speakers (Bertolino & Grolla, 2012).

The common feature of all these studies is the fact that they used offline methodologies, focusing, especially, on the infantile use of the binding principles in the interpretation of the correct antecedent of pronouns, anaphors and referential expressions. This particular manner to look at the problem of acquisition of binding principles is related to child's capacity to use grammatical knowledge in the process of identification of the correct antecedents of pronouns and anaphors as well as the recognition of possible violations. In other words, this view is concerned to *binding*, here considered as the establishment of a link between the referring expression and one or more possible antecedents (Sturt, 2003). Although it is possible to extract from them a very well delineated picture in which the linguistic development related to coreference can be seen, especially with regard to the mastery of binding principles and the recognition of their violations, some questions seem to need further elaboration. It seems to be necessary to investigate the process of *resolution*, defined as the stage in which the link made in the binding process is evaluated, recomputed and integrated into the semantic interpretation, as well as the factors that can be related to this process (Sturt, 2003).

Specifically, some of these factors may be the (probable) relation between the development of working memory, which is fundamental for maintaining possible antecedents in memory and later recovery, is not considered. The role of contextual and semantic information in the processing is considered only tangentially, which prevents them from being isolated from the performance of the principles and from being analyzed as possible resources that the child in the early acquisition stage uses to establish the correct coreferentiality. Still, given that each form, whether pronoun or anaphor, or even referential expressions, has its semantic, contextual and even structural specificities, carrying information of different natures, it is reasonable to assume that they make specific demands on processing systems, which can entail different procedural costs, which, in turn, would be reflected in the way and order in which they are processed and acquired. Finally, the type of information that is presented to the child in the input, and from which the child recognizes both a certain proform and the principle linked to it, and becomes able to establish the correspondence, is neither clear nor determined. In short, the acquisition of principles has been studied so far, notably with regard to its maturation, and not in its relation with the processing systems that support them.

The present article can be considered as a first attempt to address these questions and understand them better. Here, it is considered that the task of the child when it comes to acquire coreference is, at the first moment, to identify the nouns that represent external entities as possible antecedents, and store them in working memory. Previous works do not deal with this question directly, since their focus is the identification of antecedents at the moment the retrieval is recognized. Secondly, the child must recognize proforms and classify them into anaphor or pronoun, identifying its grammatical properties. For this, the ability to process the linguistic primary input to which the child is exposed is required, alongside the development

and maturation of the binding principles. So far, the process deals with the grammatical knowledge required, its development and use in the processing of coreferential relations present in sentences in a certain language (in our case, BP). But, in a broader psycholinguistic approach, some additional steps should be taken into account. Under this view, a child must establish the coreferential relations with the nouns stored in the working memory by applying the correct binding principle, which is supposed to be linked with the development of the working memory capacity, as the child develops and the maturation of the working memory is complete. Eventually, the use of other kind of information (semantic, pragmatic) in order to determine the correct antecedent of a proform can occur in this process.

By using the experimental methodology described below, it is believed that these issues can be addressed. An experimental factor, type of binding principle, has been controlled, since each principle is represented by a specific kind of retrieval, based on the hypothesis that the binding principles pose different processing demands for their identification, with main effects of type of principle being expected. In addition, subjects already know principles A and B, despite of principle B showing a delay, when compared to principle A in tasks of interpretation of the correct antecedent (Principle B delay - Chien and Wexler, 1990, among others). Assuming this hypothesis, a main effect of matching can be expected, with the matching conditions being faster than the mismatching conditions. Such a scenario can be taken as an evidence of the subjects' intuition of the grammaticality of the sentences. Last, results can indicate that the knowledge of the binding principles increases with age, since it is part of the development of the linguistic competence (see Sekerina et al., 2004), as well as it can suggest distinct stages of working memory's maturation. A main effect of group can be expected with the adults being faster than children in both age ranges analyzed, and with the older children being faster than the younger ones.

2. Methodology

This study uses a modified version of the cross-modal picture decision task experimental paradigm (McKee et al., 1993), in a version adapted for Brazilian Portuguese. It consists of the presentation of auditory stimuli (in this case, sentences previously recorded) and, in a certain point of the stimuli, a word or a picture is shown on a screen. The subjects are asked to decide about the word or picture that they were exposed to, such as, for instance, whether the word or picture they were exposed to represents an animate or inanimate entity. The point in which the visual stimuli are shown is considered the critical point and, in the case of coreference or binding processing, it marks the position of the proforms in the sentence. The basic idea here is that the reaction times are differently affected by the kind of proform, so that the response times for the different proforms can be taken as a reliable measure of their processing cost.

So, this paradigm is based on the priming effect[3], which has been used in many psycholinguistic experiments in order to reveal some aspects of sentence processing, as well as some important issues about lexical processing. Regarding coreference and binding principles, some studies using priming effects have revealed differences in response times in sentence processing tasks involving different kinds of proforms (Fodor, 1988; Nicol and Swinney, 1989; McKee et al.,1993), thus suggesting the reliability of priming.

Last, but not least, experimental paradigms based on priming effects can be used to build on-line studies, since the responses are collected at the exact moment of the presentation of the stimuli, then increasing the reliability of the registered measures. In the case of the present study, this means that the processing cost of the proforms analyzed here will be measured in a very precise way.

2.1. Experimental Design

The experiment has two independent variables: type of binding principle and matching between the picture and the antecedent of the proform. The former contains three levels: principle A1 (represented by the BP anaphora *se*), principle B (represented by the personal pronouns *ele(a) (he/she*), and the principle A2 (represented by another type of reflexive anaphora existing in BP, *ele(a) mesmo(a) (he/she himself/herself*). The latter has three conditions as well: matching, mismatching and control. In the matching condition, the picture that appears on the screen is related to the antecedent correctly licensed by the correspondent principle, i.e., in the principle A condition, the picture is related to the closest NP, whereas in the principle B condition, the picture is related to the furthest NP. In the mismatching condition, the opposite occurs: the picture is related to the antecedent not licensed by the correspondent principle. Thus, in the principle A condition, the picture is related to the furthest NP, whereas in the principle B condition, the picture is related to the closest NP. In the control conditions the picture is not related neither to the furthest NP, nor the closest NP, but something not present in the sentence. These variables were crossed in a 3 x 3 factorial design, with 9 experimental conditions overall. A group factor (age of subjects) was included, and it has three levels too: 5-7 years old, 8-10 years old[4], and adults, thus forming a within- subjects design, as can be seen in Table 1 below:

[3] Priming is an effect in which the previous exposure to a stimulus affects the processing of a subsequent stimulus. For example, the word *nurse* is recognized faster following the word *doctor* than following the word *milk*. In general, in studies that explore this effect in experimental paradigms, the stimuli are the same kind (a pair of writing words, or a pair of sounds, for example). In the cross-modal priming tasks, the stimuli are not the same kind – in our case, we used pictures and recorded sentences.

[4] The choice of this age range was due to the fact that Grolla (2012) shows that the BP anaphor "ele mesmo" is harder for Brazilian children up to 6 years of age. Besides, according to Gathercole (2003), the development of working memory shows qualitative changes from infancy until around 7 years of age, when its function is more adult-like in organization and capacities, but showing a gradual quantitative increasing.

Table 1

The List of Stimuli

Groups (by age)	Conditions
5-7 years old	Principle A1 (matching and mismatching)
	Principle B (matching and mismatching)
	Principle A2 (matching and mismatching)
8-10 years old	Principle A1 (matching and mismatching)
	Principle B (matching and mismatching)
	Principle A2 (matching and mismatching)
Adults	Principle A1 (matching and mismatching)
	Principle B (matching and mismatching)
	Principle A2 (matching and mismatching)

A yes-no control question was included at the end of each experimental sentence, in order to verify if the subjects paid attention to the task. Reaction times for the appearance of the picture consist of the dependent variable.

2.2. Experimental Conditions

Examples of each experimental condition can be found below. The word in brackets indicates the picture that is shown, as well as the point of the sentence in which the picture appears:

- Principle A1 Matching
A professora falou que a aluna de olhos azuis se [ALUNA] penteou na aula. A aluna se penteou?
"The teacher said that the student with blue eyes brushed herself [student] during class. Did the student brush herself?"

- Principle A1 Mismatching
O policial avisou que o menino de cabelo longo se [POLICIAL] pintou na escola. O menino se pintou?
"The policeman said that the boy with long hair had painted himself [policeman]. Did the boy paint himself?"

- Principle A1 Control
A bailarina percebeu que a menina de vestido verde se [MULHER] feriu na cozinha. A menina se feriu?
"The dancer realized that the girl in the green dress hurt herself [woman] in the kitchen. Did the girl hurt herself?"

- Principle B Matching
A borboleta contou que a galinha de bico afiado arranhou ela [BORBOLETA] na fazenda. A galinha se arranhou?

"The butterfly said that the sharp beaked chicken scratched it [butterfly] in the farm. Did the chicken scratched itself?"

- Principle B Mismatching
A dançarina contou que a formiga com boca grande mordeu ela [FORMIGA] na perna. A formiga se mordeu?
"The dancer said that the ant with a large mouth bit her [ant] in the leg. Did the ant bit itself?"

- Principle B Control
A mulher percebeu que a barata de asas escuras sujou ela [ABELHA] em casa. A barata se sujou ?
"The woman realized that the dark winged cockroach messed her [bee] up at home. Did the cockroach mess itself up?"

- Principle A2 Matching
O leão contou que o urso de pelo marrom assustou ele mesmo [COBRA] no mato. O urso se assustou?
"The lion said that the brown haired bear scared itself [snake] in the bush. Did the bear scare itself?"

- Principle A2 Mismatching
A vovó percebeu que a filha de cabelo louro beijou ela mesma [VOVÓ] em casa. A filha se beijou?
"Grandma realized that her blonde haired daughter kissed herself [grandma] at home. Did her daughter kiss herself?"

- Principle A2 Control
O papai disse que o homem de braço forte cortou ele mesmo [MENINO] no trabalho. O homem se cortou?
"Dad said that the strong man cut himself [boy] during work. Did the man cut himself?"

2.3. Materials

Nine lists of stimuli were used, as seen in Table 1 above. The stimuli were recorded using a female volunteer, through the specialized software Audacity, version 2.0, and equalized and adjusted in volume, pitch, tone and level of noise. Each list had 6 experimental sentences, two per condition, and these sentences were all built following the structure [NP1[VP that [NP2...], with the proform always placed in the second clause of the sentence. All the NP´s were controlled in frequency and familiarity through a familiarity test which subjects were submitted to, in order to avoid possible effects of unfamiliarity that could have caused delay in response times. Between the second NP and the second verb, the experimental sentences had a PP modifying NP, placed there to separate away the NP from the proform, thus avoiding effects of recency. Besides that, a PP was added at the end of the experimental sentences, so that subjects could continue to process the sentence normally even after they had seen the picture. Both the gender of NPs and of the proforms that agree with them were counterbalanced. In addition to experimental sentences, 20 fillers sentences were included in each list as distractors. Among these fillers, there were 7 sentences, so called pseudo-experimental, which were similar in structure to experimental sentences. In addition, 13 filler sentences were included, whose structure were quite different from the experimental ones. This procedure was required

in order to avoid possible sentence structure effects, which could reflect in a strict correlation between sentence type and response type (cf. McKee et al, 1993). All the pictures used were controlled in size and type. The experiment was build using the software Paradigm, version 2.5, in a notebook computer HP Pavillion x360.

2.4. Participants

Children of two age ranges will be analyzed: 5-7 years old and 8-10 years old. A group of adults will also be analyzed. These three groups will be divided into three other subgroups. Each subgroup will have 10 subjects at least, totalizing 90 subjects. All the children were selected in schools in the cities of João Pessoa/PB and Campinas/SP, and adults, ranging from 18 to 40 years old, were selected among undergraduate students of the Federal University of Paraíba and University of Campinas, both located in Brazil.

2.5. Data collection

Subjects were first submitted to a pre-test, in order to verify whether the nouns used in the experiment were familiar to them. This pre-test consisted of the presentation of the pictures in the computer screen. For each picture, subjects were asked to point out if the picture was familiar or not, through pressing the correspondent key on the keyboard (previously selected). The list was composed of 80 words, among which 24 proved more familiar and were chosen to build the experimental sentences. Secondly, subjects were submitted to a test that consisted of pointing whether the pictures represented an inanimate or an animate being. The pictures used here were the same used in the experiment, so that the possibility to commit errors in the task was decreased. In the experiment properly, subjects seated in front of the computer and with the hands on the keyboard, were submitted first to a training session, in order to correctly learn the task. The task consisted of pressing either the yellow key every time the picture represented an animate being, or the green key, otherwise. After that, they listened to the sentences one by one, pressing the correspondent key (yellow key in the case of “yes” response, or green key, in the case of “no” response.). The computer collected and stored all the given responses, as well as their respective times. The training session was formed by six sentences, 2 using the pronoun ele(a), 2 using the reflexive anaphor se, and 2 using the reflexive anaphor “ele(a) mesmo(a)”. 3 sentences required a “yes” response, and 3 required a “no” response. The experimental session was composed of 26 sentences, with all the 6 experimental sentences requiring a “yes” response plus 7 pseudo-experimental filler sentences that required “no” responses, and 13 filler sentences that required either “no” responses (7 sentences) or “yes” responses (6 sentences), as to counterbalance the number of responses of each type. The complete session, including the animate-inanimate pre-test, the training session and the experimental session lasted around 20 minutes.

3. Findings

Data was submitted to a normality test (Shapiro-Wilk test), in order to check their normal distribution. Since this distribution was found in the data, a

parametric test was chosen to be applied to them. An analysis of variance with three factors (three-way ANOVA), factorial design 3 (type of principle) x 3 (age) x 2 (matching) was carried out. The results revealed a main effect of type of principle ($F(17, 1063) = 26,18$, $p<0.05$). A 2x2 comparison test (Tukey test) was also carried out, in order to reveal differences among the levels of this experimental factor, according to the Figure 1 and Table 2 below:

Figure 1

A 2x2 comparison test (Tukey test)

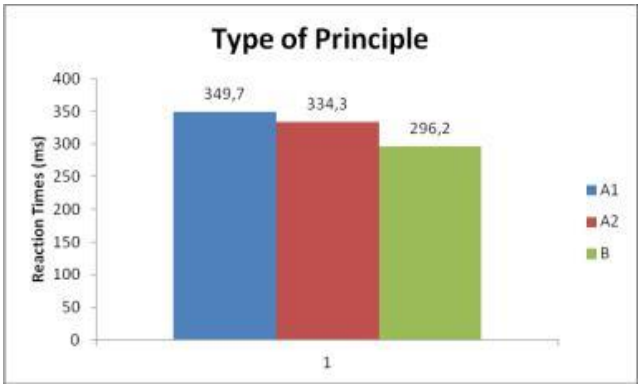

Table 2

2x2 Comparisons (Tukey Test)

Factor	Means	p.value
A1	349,7	0,142883608
A2	334,3	1,18446E-09*
B	296,2	2,55765E-05*

The results showed that principle B was processed faster than both principle A1 and A2, which is in accordance with the predictions assumed here. Besides, principle A2 was faster than principle A1, as expected. In addition, the ANOVA also revealed a main effect of age ($F(17, 1063) = 96,10$, $p<0.05$), with adults being faster than children, thus confirming the second prediction, according to the following Figure 2 and Table 3.

Figure 2

Reaction times based on the age of the participants

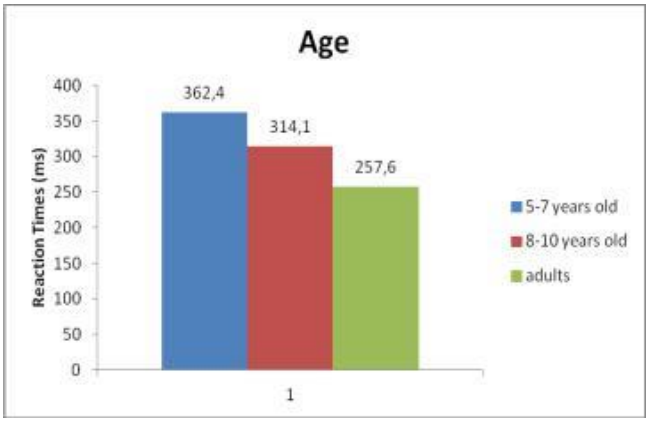

Table 3

2 x 2 Comparisons Tukey Test

Factors	Means	p.value
5-7 years old	362,4	2,43051E-09*
8-10 years old	314,1	2,07565E-10*
Adults	257,6	6,74275E-10*

No main effect of matching was found, but an interaction effect between principle and matching was found ($F(17, 1063) = 9,18$, $p<0.05$). The match conditions made the processing of principle B faster than principle A1, and the mismatch conditions made the processing of principle A1 faster than principle B, as shown in the Figure 3 below.

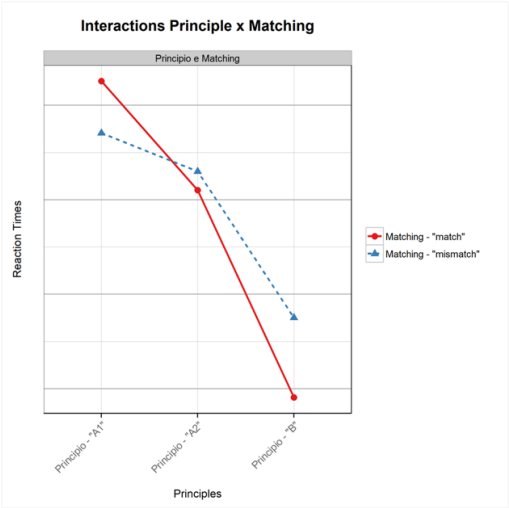

Figure 3

Interactions Principle x Matching

The significant difference observed in the reaction times in each binding principle goes in the direction of the hypothesis assumed here, that the principles impose different processing costs. Principle B, which is related to full pronouns, presented a lower processing cost than Principle A in the two reflexive forms studied here. At first glance, this seems to go in the opposite direction to what would be predicted by Principle B Delay Effect. However, it is necessary to keep in mind that this effect is related to the identification of the correct antecedent of a pronoun, more than an investigation about its processing, which implies the reactivation of an antecedent in the working memory and its subsequent binding with the retrieval. Analyzed from this perspective, it is possible to say that pronouns, at least in BP, activate an antecedent stored in working memory more easily than a reflexive anaphor, despite being able to establish relations that are not always local. A possible explanation for this effect may be the fact that the pronouns refer back to the name located in the subject position of the main clause, a more prominent topic position. In addition, the fact that it was mentioned first may contribute to make the antecedent of the pronoun more active in working memory, within what is known as the primacy effect (BADDELEY, 1986). These two factors act to facilitate the action of principle B in the search and recovery of its possible antecedents at the time the pronoun is processed. Principle A, even establishing more local relations (which is to say that the retrieval is closer to its antecedent), causes greater difficulty in reactivating its antecedent when compared with the antecedents licensed by principle B, which delays its processing in the sentences used in this experiment, probably due to the fact of the antecedent of the anaphor is placed in a less prominent topical position. To summarize, the action of the binding principles seems to be affected not only by factors of syntactic configuration, but also by effects related to the working memory, especially with regard to the way the stored antecedents are activated and retrieved when pronouns and anaphors are processed.

The differences observed with regard to the analyzed ages are consistent with the natural course of linguistic development and maturation of working memory. Adults have shorter processing times due to their full acquisition process as well as the maturation of their working memory. The same can be said of children in the intermediate age group, who are faster in response times than younger children. The age effect observed here, therefore, goes against what is proposed by the hypothesis assumed here, that there is a progressive maturation of the grammar being acquired, in addition to the working memory[5] that serves as a basis.

The lack of a significant matching effect could cause some confusion, at first, that it could denote a precarious acquisition of the binding principles, or even that adults are not able to perceive violations of these principles. However, the observation of the interaction effects resulting from ANOVA

[5] To provide more evidence on this hypothesis, the use of some working memory test should be applied. Initially, we thought about applying the standard memory span tests (digit span, word span). However, we realized that such tests focus on working memory only in terms of its capacity, which could not prove to be predictive of a more complete development of working memory. A more appropriate test would be the reading span test, like the one being developed by Vasconcelos, Almeida, Estivalet and Ferrari-Neto (2019).

may provide a possible explanation. Longer reaction times were recorded in condition A1, regardless of matching, possibly due to the fact that anaphors, as already seen, hinder the activation and retrieval of their antecedents in working memory, also causing greater difficulty in the perception of violations of principle A. In turn, shorter reaction times recorded in condition B seem to indicate a more accurate perception of the violations of principle B, since their activation and recovery in working memory are easier. Then, the perception of violations when the antecedents are not so activated is more unlikely. With pronouns, since they activate their antecedents more strongly, the perception of violations is easier, which explains the shorter reaction times of condition B in the interaction with the matching condition.
To sum up, the results of this study showed that, as expected, both children, as well as adults, know the binding principles, however, processing them effectively increases with age. The binding principles also pose different processing demands, as reflected in the reaction times shown in our results, and seems to be affected by factors related to working memory operation.

4. Conclusions and Discussion

The study of the acquisition of anaphoric coreference, together with the acquisition of the binding principles, suggested by the generative linguistic theory, focuses on determining the correct antecedent of reflexive anaphors, as expected in a theory whose main goal is to model the grammatical knowledge possessed human speakers. However, more than that, it is also necessary to include in this modeling the use of that knowledge in the processing of language, as proposed by psycholinguistics theories. Under this view, the study of processing and acquisition of binding principles must determine how the antecedents are kept in the working memory and retrieved from it, at the moment when a proform is recognized in the input, as well as it is necessary to verify how children during the acquisition process perceive linguistic elements which will enable them establishing co-referential relationships. According to Ferrari-Neto and Marinho (2015), this type of information is undoubtedly very relevant to the knowledge of the acquisition process of this module of grammar, but there is also a need to verify the influence of other factors. Thus, in this paper, we aimed to explore, through online methodology, the cost of processing of binding principles, providing some insights about how these principles are acquired and used in sentence processing. In addition, the working memory maturation factor was also investigated, by comparing different age groups. In general, the results obtained here allow us to claim that the linking principles are available early in children's grammar, in the direction of what Grodzinsky and Reinhart (1993) sustain. The differences observed in the processing times of principles A and B, here studied, suggest that they impose specific demands, at least with regard to the ages analyzed, which can be understood as evidence of the way they are perceived and processed by the child from the input to which they are submitted.

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