The processing of Determiner – Noun agreement and the identification of the gender of Nouns in the early acquisition of Portuguese

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Abstract

The early acquisition of the Portuguese gender system is investigated. It is argued that the acquisition of the gender system is based upon the identification of morpho-phonological information within the closed class of determiners and upon the processing of agreement within the DP. Experimental evidence is provided for young children's sensibility to morpho--phonological alterations in the class of determiners and for children's reliance on this sort of information in the identification of the gender of novel nouns. Developmental differences in the effect of a phonology-gender analogy in the processing of gender agreement suggest that the effect of this factor after the age of three is dependent upon the gender system of the language having been identified on the basis of grammatical agreement at an earlier age. A theoretical account is provided in terms of a processing model that incorporates a theory of language in which agreement is characterized as feature sharing.

1. Introduction

This paper is concerned with an aspect of the acquisition of the Portuguese gender system, namely, the identification of the value of the gender feature of Nouns – a basic condition for gender agreement to take place in language production.

Gender can be regarded as a universal lexical feature that characterizes classes of Nouns in the language (Chomsky, 1995). Gender classes may be semantically motivated (Corbett, 1991) and, possibly for this reason, gender has been regarded as an interpretable lexical formal feature in recent genera-

tive accounts (Chomsky, 1995; Carstens, 2000). However, gender classes do not necessarily have a semantic counterpart. Romance languages make it clear that the notion of interpretability must have a language internal meaning as far as gender is concerned. In these languages, there are only two possible values for the gender feature to assume – masculine and feminine. There are, therefore, two gender classes applying to all Nouns and it is only in a subset of the [+animate] Nouns that grammatical gender can be associated with natural gender – male and female. In this case, the value of gender feature is optional. As far as [-animate] Nouns are concerned, the value of the gender feature is always invariant or intrinsic. Their ascription to a particular gender class – either masculine or feminine – looks, therefore, completely arbitrary. Interpretability, in this case, is exclusively related to the possibility of an element from the lexicon controlling agreement – the interpretable element being the one controlling agreement.

Grammatical agreement involves two terms sharing a lexical feature (such as gender, number and person), with a particular value (masculine or feminine; singular or plural, for instance): a controller, which determines the value to be assumed by the formal lexical features of the elements in its syntactic domain[1]; and a controlled element, syntactically related with the former. In some languages, grammatical agreement may result in the inflection of the controlled element, which makes a syntactic operation recognizable by the language processing systems. Gender agreement is universally controlled by the Noun. The sort of gender agreement relations that are morpho--phonologically expressed in the elements syntactically related with the Noun varies across languages and characterizes the gender system of each particular language.

In Portuguese, as in other Romance languages, agreement can be observed in the morphology of Determiners, Adjectives, and Participial Forms. In other languages, such as Hebrew (Levy, 1983), gender agreement is also expressed in the morphology of finite Verbs and there are languages, such as English, in which grammatical gender agreement cannot be observed in the morphology. In this case, there is only pronominal gender agreement, which is outside the scope of grammatical operations.

One of the tasks of the child in the language acquisition process is to identify the gender system of the language in order to be able to produce grammatically legitimate utterances. Hence, it is primarily necessary that children recognize morpho-phonological variation pertaining to gender classes and that they identify the value of the gender feature of the controlling element. It is also necessary that they identify the elements that vary morpho--phonologically as a function of gender.

Gender agreement has not been extensively studied within linguistic theories and a theoretical account is not available, in which the factors that might

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[1] «Domain of a head α is the set of nodes contained in Max(α) that are distinct from and do not contain α" (Chomsky, 1995:178).

determine the morpho-phonological expression of gender agreement in a particular language are characterized. In any case, the minimalist framework provides a theoretical basis in which the acquisition of the gender system can be approached.

Children's recognizing the morpho-phonological variation pertaining to gender and their identifying the value of the gender feature of the controller are necessary steps of the acquisition process. It is commonly held that the acquisition of the gender system of a language is a process dependent upon cognitive strategies or other learning procedures, which take into account semantic correspondence between grammatical and natural gender, and phonological regularities. The idiosyncratic character of the gender system in different languages would make its learning dependent upon factors such as frequency and repetition and not on computational operations (Karmiloff--Smith, 1979; Pérez-Pereira, 1991; Karmiloff-Smith et al., 1997; Clahsen & Almazan, 1998).

It is argued here that the acquisition of the gender system is fundamentally dependent upon computational operations. This study departs from the hypothesis that children acquiring Portuguese identify morpho-phonological variation pertaining to gender within the closed class of the Determiner and that the parsing of a DP bootstraps the grammatical operation of agreement enabling the gender of the Determiner to be ascribed to the Noun. The identification of the gender of a Noun would then result from the parsing of a DP and the processing of agreement within the DP (Corrêa, 2001).

The aim of this paper is to provide empirical evidence for children's early ability to process gender agreement and a theoretical account of the early acquisition of the Portuguese gender system, in which a signal processing treatment to the acquisition process is reconciled with a generative model of language.

A model of the processing of agreement within the DP is characterized, which would account for both the processing of gender agreement by adults and for the process of identification of the gender of novel Nouns in early language acquisition (Corrêa, in press). This model incorporates a theory of language in which syntactic agreement is characterized as feature sharing (Frampton & Gutmann, 2000). Agreement as feature sharing makes it possible for the value of the gender feature of the Determiner to be ascribed to the Noun of the complement NP in the processing of a DP. This possibility would guarantee that agreement took place even though the value of the gender feature of the Noun was not available to the child (Name, 2002).

The present article is organized as follows: In section 2, the Portuguese gender system is described and the primary linguistic data regarding gender that is available to children acquiring Portuguese as their first language is characterized. Section 3 presents a model of the processing of Det-Noun agreement on the basis of which the requirements for children to identify the gender of a novel Noun are considered. In section 4, a grammatical charac-

terization of agreement within the DP is provided, which would account for the computational mechanism to be assumed in order for gender agreement to take place in the process of language acquisition. In section 5, experimental results suggesting infant's sensibility to members of the Determiner category are reviewed and two experiments conducted with young children acquiring Brazilian Portuguese as their first language are reported. Experiment 1 aimed at verifying whether young children (mean age 23 months) have their comprehension affected by alterations in the form of the Determiner and, in particular, whether their performance is affected by gender incongruence in the DP. Experiment 2 elicits the production of referential expressions requiring gender agreement with pseudo-Nouns by children younger and older than three (mean age 2;7 and 4;6 years of age, respectively). It aims at verifying the extent to which the processing of gender agreement with novel Nouns would be affected by a co-relation between the phonological form of the Noun and gender, in the course of development. In the final section, the present results and theoretical approach are discussed in relation to a current controversy over the availability of functional categories in early language acquisition.

2. The Portuguese gender system and the data available to children

Portuguese has a two-value gender system – masculine and feminine. The value of the gender feature of Nouns can be either intrinsic or optional. The former applies to all [– animate] Nouns such as *o leite* (the milk (masc)) and *a casa* (the house (fem)) and to a few [+animate] Nouns, such as *a criança* (the child (fem)). The latter is correlated with natural gender (sex) and varies as a function of the referent of the DP.

The optional value of the gender feature is morphologically expressed by means of the feminine gender morpheme *–a*. The feminine form is, then, the morphologically marked one.

A subset of [+animate] Nouns is inflected for gender. In this case, the gender morpheme *–a* is adjoined to a masculine base as in *professor* (teacher – masc) / *professor-a*; *peru* (turkey – masc) / *peru-a*. Other [+animate] nouns, such as *vítima* (victim (fem)) and most animal names such as *cobra* (snake (fem)), *jacaré* (alligator (masc)) are not gender inflected. When the masculine base ends in the thematic vowels *–o* or *–e* (reduced medium vowels [ʊ] and [I]), the adjunction of the gender morpheme causes the suppression of the thematic vowel as in menin-*o (*boy*) /menin-*a* (girl); mestr-*e* (master) / mestr-*a* (mistress).

It is estimated that only 4,5% of the Nouns of the language are gender inflected (Rocha, 1981). For derived [+ animate] Nouns in *–(a)nte* or in *–ista*, such as *estud-ante (*student), *dent-ista* (dentist), as well as for athematic Nouns with a consonantal ending such as *refém* (hostage), the morphological expression of the value of the optional gender feature is restricted to the

inflection of the Determiner agreeing with the Noun (as in *o* (masc) */ a* (fem) *estudante).*

There is, nevertheless, a co-relational pattern between the phonological form of the Noun and its gender. For historical reasons, most Nouns having the thematic vowel *–o* are masculine whereas most Nouns having the thematic vowel *–a* are feminine. Since the thematic vowel *–a* has the same phonological form as the gender inflection *–a,* an associative pattern can be identified between *–o* ending for masculine Nouns and *–a* ending for feminine Nouns, regardless of their morphological status.

Gender agreement in Portuguese is morphologically marked by the presence of the feminine inflectional morpheme *–a* in the elements that are syntactically related to a feminine Noun within a DP – Determiners and Adjectives, as well as in Participial Phrases, which are syntactically related with the subject DP within an IP.

All members of the Determiner category – definite and indefinite articles and demonstrative pronouns – are gender inflected in the marked form. Possessive pronouns, which are subordinate to D in a grammatical derivation, are always gender inflected, too. As for Adjectives, those whose masculine form ends in *–o* are gender inflected (with the substitution of *–o* for the gender morpheme *–a* in the feminine form, as in *bonito/bonit-a* (beautiful). Those adjectives having *–e* or consonant ending are gender invariant (as *contente* (glad) and *feliz* (happy). Table 1 presents the morphological pattern of the Portuguese gender classes in the Determiner.

Table 1. Morphological pattern of the Portuguese gender classes in the Determiners

Masculine Determiners	Feminine Determiners
o(s)*	**a**(s)
um(ns)	um**a**(s)
Este/esse/aquele(s)	est**a**/ess**a**/aquel**a**(s)

∗ (s) stands for the number morpheme marking plural

In sum, the primary data children have access to when acquiring Portuguese present: (i) a closed class of Determiners systematically varying in two forms: a morpho-phonologically variable unmarked form and a marked form, characterized by the presence of the morpheme *–a* (an unstressed [a]); (ii) an open class of Nouns having a small subset of [+ animate] Nouns morphologically marked for gender; (iii) an open class of Adjectives, which includes gender invariant forms. The most systematic and reliable morphological information for children concerning gender stems, therefore, from the presence of the gender inflection in the closed class of the Determiners.

The establishment of a correlation between the phonological form of Nouns and their gender presupposes a data basis for a pattern to be identified. Moreover, such a correlation presupposes that there is gender agreement

between the Determiner and the Noun in a given syntactic domain. The unconstrained learning of such a basic presupposition would be time consuming, if at all possible. Hence, it is unlikely that a co-relation between the phonological form of nouns and the gender controlled elements (Determiner, Adjective, Participial Form) contributes to the learning of the gender system of the language, as traditionally proposed (Karmiloff-Smith, 1979). Rather, any strategic use of a co-relation between the phonological form of the noun and gender in the identification of the gender of a noun would depend on the gender system of the language having been identified and on children's mental lexicon maintaining a minimum amount of lexical representations with the value of the gender feature fixed in order for a pattern to be identified. It should be expected, then, that young children identify the gender of a novel Noun solely on the basis of the gender classes (marked and unmarked) that can be identified within the closed class of the Determiner. As language development proceeds, they may establish a correlation between the phonological pattern of Nouns and gender, and even between grammatical gender and natural gender, given the correlation holding between grammatical gender and natural gender, as far as a subset of [+animate] Nouns is concerned.

The literature on language acquisition presents evidence compatible with this view. Data from spontaneous speech in a number of languages present instances of gender inflection in the early production of multiple word utterances (Mills, 1985; Bonacker, 1997; Comrie, 1999). Errors consisting of regularizations of exceptions to phonological and semantic co-relations involving the form of the noun and gender, as well as self-repairs leading to those errors, have been identified in natural longitudinal data of children acquiring Portuguese. These errors are sporadic and have been detected in a period ranging from 2,3 to 8,8 (Figueira, 1996; 2001), though a quantitative analysis is not provided which could suggest whether there is a developmental difference in their frequency. Experimental evidence for children's reliance on a phonological co-relational pattern has been obtained from 3;4 year-old French–speaking children (Karmiloff-Smith, 1979) and from 4 year-old Spanish–speaking children (Pérez-Pereira, 1991). These experimental data together with spontaneous self-repairs suggest that children become aware of co-relational factors during the development of linguistic abilities. This awareness may be useful for strategic purposes even for adults (having to infer the gender of a novel isolated word, for instance). The available data on gender acquisition taken as whole suggest, nevertheless, that gender agreement within the DP is automatically processed since an early age, solely on the basis of the information provided by the Determiner.

What would enable children to process gender agreement within the DP? In order to answer this question, it is necessary to characterize a model of the processing of gender agreement within the DP. On the basis of this model, the requirements for children to be able to do so can be considered.

3. The processing gender agreement within the DP

The processing of gender agreement within the DP has given rise to a number of investigations having, in their background, the dispute between interactive models of language processing and models with modular components (Friederici & Jacobsen, 1999). The former predicts that the gender of the Determiner pre-activates elements from the lexicon whose gender can be matched with it, thereby facilitating gender agreement (Bates et al., 1995; Bates et al., 1996). The latter predicts that the processing of gender agreement is a post-lexical "checking" process (Wright & Garrett, 1984; O'Seaghdha, 1997). In this case, the gender of the Determiner does not facilitate agreement but incongruence between the gender of the Determiner and the gender of the Noun inhibits agreement processing. This effect seems to indicate that the parsing of a DP necessarily results in the automatic processing of syntactic agreement. The matching of the information concerning the actual value of the gender features of the Determiner and the Noun would either confirm or disconfirm what would be required by the parsed structural relation between Determiner and Noun in a DP.

It is our assumption that language processing by the child and by the adult operates in a similar fashion once language and memory capacities are comparable. It would be unnecessarily costly for the processing system to evolve in such a way that the processing operations conducted in childhood would have to be qualitatively altered during development. Hence, it is assumed that if a structure such as a DP can be parsed and gender distinctions can be made in the Determiner, the processing of gender agreement within the DP will be conducted by children in a similar fashion as adults do it.

According to an interactive model, the identification of the gender of the Determiner in Portuguese pre-activates either masculine or feminine Nouns in the mental lexicon. The model does not predict, therefore, how the processing of gender agreement would proceed when a particular Noun is not represented in the lexicon, that is, in the case of novel Nouns. If the identification of the gender of a novel Noun depends upon the presumption of agreement in a particular syntactic configuration, then, this model can be reduced to a post--lexical one, as far as lexical acquisition is concerned.

A model in which agreement is a post-lexical "checking" process makes it natural for the child to identify the gender of Nouns once a DP can be parsed. The processing model would operate as follows: a phonological phrase is perceived in which a Determiner and a Noun can be segmented on the basis of their phonological and distributional properties (Christophe, 2002; Gout & Christophe, in press). A parsing operation takes place merging D and N in a D-Complement configuration. Given this configuration, the value of the gender feature of the Determiner (say, 0 or 1, corresponding to unmarked and marked forms) and the value of the gender feature of the Noun are matched. If the Noun is not represented in the lexicon, the DP configuration requires that the value of its gender feature be the same as the value of the gender feature

of the Determiner. It appears, therefore, that a procedural model that can account for the processing of gender agreement by adults would naturally account for the identification of the gender of a novel Noun in the process of language acquisition if children can parse a DP.

This model would require that children distinguished Determiner and Noun in a phonological unit and were sensitive to morpho-phonological variation within the D category in order to represent (gender) categories corresponding to a marked and an unmarked pattern. The processing model would also require that children relied on a computational system that enabled Determiner and Noun to be merged and processed as head and complement and that incorporated the operation of agreement in the derivation of linguistic expressions.

The concept of agreement as feature sharing (Frampton & Gutmann, 2000) provides a grammatical characterization of agreement that can be incorporated in this model of the processing of gender agreement. In the section below, the concept of feature sharing will be discussed in relation to gender processing within the DP.

4. Agreement as feature sharing and gender processing within the DP

The concept of agreement as feature sharing departs from the view of agreement as valuation of features in the generation of linguistic expressions, as proposed in the *Derivation by Phase* (DBP) framework (Chomsky, 1999). In this framework, elements with [-interpretable] formal features enter in the derivation with these features unvalued, unlike previous accounts in which all elements enter the derivation with valued features to be checked in the derivational process. An element with an unvalued feature behaves as a probe searching its goal – an element with a feature of the same dimension as the unvalued one, that is, the dimension "gender", "number", and so on in its domain (cf. Uriagereka, 2000). Once the goal is a valued feature, the unvalued feature of the probe is valued, getting the same value as the feature of the goal. Frampton & Gutmann (2000) develop this conception further in an attempt to avoid the difficulties that the DBP model faced in the treatment of expletives. In that model, once features are paired and the probe-goal relation is satisfied, there is no reason for the process to proceed. The expletive *there* in English would, however, contain an unvalued person feature to be valued by T (Tense), which would have already been valued by the person feature of D. Agreement as feature sharing would be a means of enabling feature valuation to proceed after a probe-goal relation having been satisfied.

Gender agreement is not a concern in either of these theoretical accounts. Nevertheless, a model of language in which agreement is conceived as feature valuation and feature sharing, when incorporated into a processing model, can contribute to an account of identification of the gender of novel Nouns in Portuguese.

Agreement as feature sharing can be basically characterized as follows. A head containing unvalued features, called *pivot*, triggers a succession of operations called *Attract*, by means of which unvalued features search for features of the same dimension (person, number, gender), even though the operation is blind as far as the value of these features is concerned. Once dimensions are matched, the features at stake are shared. If the matched features are unvalued, the shared feature remains unvalued. If one of these features is valued, the shared feature assumes the value of the original valued feature and attraction proceeds until all the unvalued features of the pivot are satisfied. As for gender, the pivot head would be the Determiner with an unvalued gender feature to be shared with the valued gender feature of the Noun in the DP domain. What would be the advantage of this treatment as far as language acquisition is concerned? The relevant point lies in the fact that once a pivot head is identified by the computational system the Attract operation proceeds on the basis of the feature dimension, being blind as far as the value of features are concerned.

Incorporating this model of language in a processing model, the mode of operation of the computational system guarantees that agreement takes place once a DP is parsed. If the language processor identifies the value of the gender feature of the Determiner on the basis of morphological information, the fact that Determiner and Noun necessarily share the gender feature entails that Determiner and Noun have the same gender. This mode of operation of the computational system guarantees, therefore, that the gender of novel Nouns is identified post-lexically in the processing of a DP.

5. The processing of gender agreement by children

In order to incorporate this processing model in a procedural model of the acquisition of the gender system of the language, it is necessary to assume that young children segment functional items, in contrast with lexical items. This is a basic condition for the identification of Determiners within a phonological phrase constituted of Determiner and Noun. The literature on infants' perception of language provides some evidence for this ability (Shady, 1996; Shafer et al., 1998; Shi, Werker & Morgan, 1999). Moreover, preliminary results concerning infant's sensibility to the class of Determiners have been obtained on the basis of German data (Höhle & Weissenborn, 2000; Höhle et al., 2002) and on the basis of Portuguese data (Name, 2002). In Name (2002), an experimental task in the preferential head-turn paradigm was used in order to detect children's sensibility to phonological alterations in the members of the Determiner class. Children (mean age 15 months) were auditory presented to two versions of four small stories – one version corresponding to the normal condition and the other version to the modified condition. In the latter, Determiners were systematically replaced by phonologically legal pseudo--Determiners counterparts. A significant difference in the listening time for

the two conditions was obtained with longer listening time in the normal than in the modified version. These results are in the line of previous ones suggesting early sensibility to function words as opposed to content words. They suggest further that by the beginning of their second year of life children are sensible to Determiners as a class even though Determiners in Portuguese do not present a totally homogenous phonological pattern (since they include polysyllabic stressed forms, such as the demonstrative pronoun *aquele/a* (that)).

The first experiment reported here explores further young children's sensibility to the class of Determiners and their ability to extract grammatically relevant information to the processing of gender agreement from the members of this class.

5.1. Experiment 1

The present experiment was intended to verify the extent to which grammatically relevant information provided by an item in the Determiner position is taken into account by young children in the recognition of nouns in sentence processing.

It is well known in the literature on child language that children's first multiple word utterances can be characterized as telegraphic speech (Brown, 1973). A commonly held hypothesis concerning children's linguistic knowledge is that lexical categories would be solely available to the computational system at an early stage and that functional categories would become available later in development, as suggested by production data (Radford, 1986, 2002).

This view of children's grammar in early language development predicts that children's recognition of words from their receptive vocabulary would dispense with information pertaining to the D category. Consequently, it predicts late processing of gender agreement and identification of the gender system of Portuguese.

Speech perception data, on the contrary, suggest that young children make use of the phonological information provided by Determiners in the very segmentation of Nouns. Would the information provided by Determiners be strictly phonological in the sense of creating a phonological pattern in which Nouns can be segmented? Or would children extract more grammatically relevant information from these function words?

It is hypothesized here that young children do perceive the information provided by Determiners as grammatically relevant regardless of whether or not their language production presents evidence for the availability of functional categories. Grammatically relevant information to the processing of gender agreement includes phonological information concerning the identity of Determiners in the set of function words and morpho-phonological information concerning a grammatical class (marked/unmarked).

Previous study on the basis of English (Gerken & McIntosh, 1993) suggests that two year olds do distinguish Determiners from other function words of the language. Determiners in English are not, however, morphologically marked. Consequently, it is still unclear whether children would be sensitive to subtle morpho-phonological alterations in the members of Determiner category.

In the present experiment, an experimental task similar to Gerken & McIntosh's (1993) is used. This experiment investigates whether alterations within the set of Determiners would affect the recognition of words from children's receptive lexicon. As in Gerken & McIntosh's study, there were phonological and syntactic alterations. In the former, the Determiner was replaced by a phonologically legal monosyllabic word). In the latter, it was replaced by a different type of function word – a complementizer, in the present study. Additionally, a morpho-phonological alteration was included: the gender of the determiner was altered, either by the addition or by the suppression of the gender morpheme *–a*.

The present experiment had two aims: The first one was verifying whether Gerken & McIntosh's results would hold for children acquiring Portuguese. The set of Determiners in Portuguese is more varied than the Determiners in English due to the presence of the polysyllabic demonstrative pronoun and to gender and number inflection. Though preferential hearing studies suggest that children are sensitive to this class, it is not clear whether this sensibility would affect word recognition. The second aim was verifying whether gender incongruence between Determiner and Noun resulting from a morpho--phonological alteration in the Determiner affects word recognition in sentence processing.

Four experimental conditions were created as a function of the manipulation of the *Element in the Determiner position preceding the target word.* These were:
  • A gender congruent Determiner (CONG);
  • A gender incongruent Determiner (INCONG);
  • A functional item not belonging to the Determiner category – a legitimate Complementizer (COMP);
  • A phonologically legal pseudo functional item (PS).

The relevant questions are: would word recognition be affected by alterations in the Determiner? Would children detect gender incongruence in the DP? Considering that the language contains homophones with different gender (and different lexical meanings), would gender incongruence induce the processing of the Noun as a novel one?

A control condition was also created as a means of characterizing children's performance when the syntactic context does not provide information that can facilitate word recognition. In this condition, an ungrammatical version of the normal sentences (CONG condition) was presented, in which the

lexical and the functional items were randomly ordered (RAN). This condition was intended to attest the extent to which the task would be adequate to capture syntactic effects upon word recognition in Portuguese.

A puppet called *Dedé* [dɛ'dɛ] asked the child to identify a picture for him in a book sheet containing four picture options. The linguistic stimuli consisted of a sort of baby talk imperative sentences in which the dative pronoun that was expected in the adult language was replaced by the proper name of the character who requests an action from the child. So, instead of "saying" the Portuguese equivalent to *Show the ball to me (Mostre a bola pra mim)*, the puppet would "say" *Show the ball to Dedé (Mostre a bola pro Dedé)*. The target word (ball) was always placed in the middle of the sentence in order to avoid that its recognition was facilitated by a sentence-final position.

The target words were twenty Nouns with an intrinsic gender feature, counterbalanced for gender. There were 10 masculine nouns – *tre**m***, *barco*, *carro*, *chap**éu***, *livro*, *peixe*, *avi**ão***, *rel**ógio***, *sapato*, *telefone*; and 10 feminine nouns – *m**ão***, *bola*, *casa*, *bolsa*, *lua*, *porta*, *árvore*, *banana*, *cadeira*, *estrela*. The number of syllables was counterbalanced across gender as much as possible within the limits of the receptive vocabulary of the children. Care was also taken to avoid that the phonological pattern "–*o* ending for masculine words and –*a* ending for feminine words" predominated, in order to prevent a mere phonological congruence effect from being confounded with a gender congruence effect in the results. The phonological form of the masculine words was, in any case, more varied than the phonological form of the feminine words as far as their last syllable or phoneme is concerned (in accordance with the overall pattern of the language).

20 imperative test-sentences were created, which were distributed in the four experimental conditions and in the control condition. For pragmatic reasons, the use of the Determiners was restricted to definite articles (*o* (masc) / *a* (fem)) and to demonstrative pronouns. Two types of demonstrative pronouns were used: *esse/ess-a (this)*; *aquele/aquel-a (that) (*in the context of the task, the semantic difference between these pronouns was irrelevant). Two sentences were created for each condition having a definite article and a demonstrative pronoun as the determiner of the target noun. In the COMP condition, the complementizers *que* and *se* were used. The pseudo functional items used were the monosyllabic forms *gur* and *biu*, which are in accordance with the phonological pattern of monosyllabic words in the language. Two imperative verbs were alternated along the list (*mostrar* (to show) e *achar (to find)*) in order to avoid excessive repetition of a single lexical item. The imperative verb was either the 2nd (*tu*) or the 3rd person (*você*) (*mostra/mostre*, *acha/ache*), which can be interchanged as the second person in the discourse in Brazilian Portuguese. This variation was intended to avoid vowel assimilation between Determiner and Nouns with a vowel in the first syllable. Table 2 presents examples of the test sentences in each condition.

Table 2.   Examples of test-sentences in the experimental
and in the control conditions.

Conditions	Examples of sentences
CONG	Mostre **a** bola pro Dedé. (Show the ball to Dedé) Ache **aquele** carro pro Dedé. (Find that car to Dedé)
INCONG	Mostre **a** carro pro Dedé. (Show the (fem) car (masc) to Dedé) Ache **aquele** bola pro Dedé. (Find that(masc) ball (fem) to Dedé)
COMP	Mostra **se** bola pro Dedé. (Show if ball to Dedé) Acha **que** carro pro Dedé. (Find which car to Dedé)
PS	Mostre **biu** carro pro Dedé. (Show biu car to Dedé) Ache **gur** bola pro Dedé. (Find gur ball to Dedé)
RAN	Dedé a mostre bola pro (Dedé the show ball to) Pro carro ache Dedé o. (To call find Dedé the)

Method:

Participants: A total of 32 middle-class children from 21 to 28 months, living in Rio de Janeiro (mean age 23;2 months) took part in the activity. All children were acquiring Brazilian Portuguese as their first language and had no systematic contact with a foreign language. None of them was reported to have family history of language deficits nor was affected by factors that might impair language development. All children were reported to be able to recognize the target words used in the test. A subset of 14 children was considered as valid subjects for having produced valid responses to at least 25% of the stimulus-sentences.

Material:

The material consisted of five lists of sentences recorded in CDs, a picture-book, a puppet and electronic equipment for auditory presentation of the linguistic stimuli and for the video recording of the experimental session. The puppet was a male child character with a small loud speaker inside it and its mouth was opened and closed by the experimenter as the auditory stimuli were presented. The lists of sentences presented four tokens of each condition in a randomized order. Care was, nevertheless, taken to avoid the presentation

of adjacent tokens of the same condition. The type of the Determiner (article and demonstrative pronoun), the gender of the Noun (masculine and feminine) and its phonological pattern (with gender characteristic thematic vowels or not) were counterbalanced in the lists. The lists were varied in such a way that each child was exposed to all conditions, to only one instance of each target word and that each target word was presented in all conditions across children. The picture book was constituted of 22 pages, each of them presenting 4 pictures — the target-picture and 3 distracters. The distracters included a picture corresponding to a name of the same gender of the target word; a picture corresponding to a Noun differing in gender from the target word and an unknown object (invented object). This was included as a possible referent in the INCONG condition if gender incongruence gave rise to the acquisition of a novel Noun. All images except the invented ones corresponded to lexical items of the receptive vocabulary of 18-24 middle-class children living in Rio, as previously attested on the basis of parents reports to the McArthur Inventory, adapted to Brazilian Portuguese (Teixeira, 1998). The additional electronic equipment consisted of one DCR-TRV 120 Sony Camera, one Sony Discman connected with the puppet, 5 CDs, each of which containing one of the five experimental sentence-lists, preceded by interactive greetings and comments in informal register (*Oi, tudo bem?,*(Hi, is everything all right?)*, Que lugar legal!* (What a nice place!)*, Você está bem?* (Are you ok?), followed by two training imperative sentences. The CDs were recorded in a feminine voice (synthesized by means of SoundForge speech synthesizer) in close approximation to the kind of voice used in Gerken & McIntosh's study (the standard female voice of DECtalk, Beautiful Betty).

Procedure:

The experiment was conducted in either a nursery school or in a home environment. The experimental session had two phases: a warming-up and a test phase. In the warming-up phase, the experimenter presented different toys and dolls to the child and interacted verbally with him/her until he/she felt at easy. Afterwards, the puppet was named and presented to child, and it was demonstrated to the child that the puppet could "speak". The recorded greetings were then presented. Children were finally invited to look at Dedé's book. If he/she demonstrated to have interest in the book, the training questions were presented. If children responded accordingly and kept interested in the task, he/she entered into the test phase when the Discman was turned on and the sentences were presented. Children's responses were positively commented upon, regardless of their correctness. The procedure was interrupted whenever children's failed to pay attention to the test sentence. The whole session took about 15 minutes and was video recorded. The video record of each session was submitted to posterior analysis.

Results and discussion:

The dependent variable was the percentage of correct responses in each condition. The counting procedure used in Gerken & McIntosh (1993) was also used here. The percentage of correct responses was calculated in relation to the total of valid responses produced in each condition. A valid response corresponded to the pointing of any of the pictures presented in the book sheet.

The percentage of valid responses in each experimental condition was submitted to a one-way ANOVA in which the element in the Determiner position was taken as a repeated measure. A significant effect was obtained $F_{(3,39)} = 3.98$, p= 0.01. Table 3 presents the means. Additional paired comparisons of the conditions revealed that the difference between CONG and INCONG was significant (t=3.28 *df*13, p< 0.01) as it was the difference between the INCONG and PS (t=2.22 *df*13, p= 0.04).

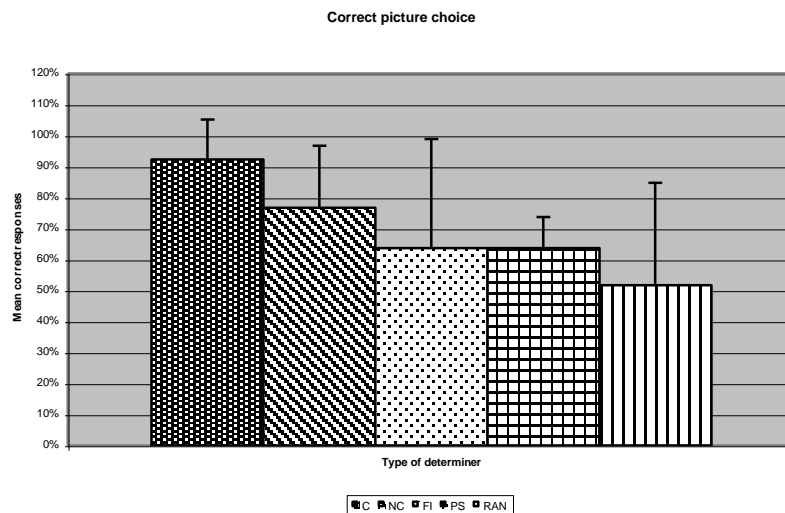Table 3. Mean % correct responses as a function of the element in the determiner position (n=14).

Element in the Determiner Position	Means
Gender congruent determiner (CONG)	92.21
Gender incongruent Determiner (INCONG)	76.64
Complementizer (COMP)	63.64
Pseudo determiner (PS)	63.64
Total Mean	74.03

The effect obtained in the number of correct responses is compatible with the view that children are sensitive to grammatical information conveyed by the Determiner.

Graph 1 presents a comparison of children's performance in the experimental conditions with their performance in the RAN control. Their poor performance in this condition clearly indicates that children were not simply detecting a lexical item in the flow of speech regardless of its syntactic environment (see Graph 1).

Graph 1
% correct responses in the experimental and in the control condition(n=14)

Correct picture choice

Mean correct responses

120%
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

Type of determiner

■C ▨NC ▨FI ▨PS ▨RAN

An additional paired comparison between the random condition and the other ones was carried on. For both the CONG and the INCONG conditions performance was significantly better than in the RAN condition (CONG X RAN: t= 5.82 *df*13, p< 0.001; INCONG X RAN: t= 3.08 *df*13, p< 0.01). The difference between children's performance in the COMP and in the PS conditions, on the contrary, did not achieve the significance level (COMP X RAN: t= 1.65 *df*13, p= 0.1; PS X RAN: t= 1.55 *df*13, p= 0.1). It appears, therefore, that the disruption created by an inadequate element in the Determiner position can impair comprehension in a similar fashion as a random ordering of words.

The results of Experiment 1 are compatible with the view that children by the age of two are able to perceive phonological and syntactic alterations in the members of the D category and to detect morpho-phonological alterations pertaining to gender. A pattern of errors in the INCONG condition could not, nevertheless, be identified, suggesting that children by the age of two do not assume that a novel Noun is introduced due to gender incongruence.

5.2. *Gender agreement in the production of referential DPs.*

The results of Experiment 1 provide evidence for the effect of gender incongruence in children's performance, which is compatible with the view that young children process gender agreement in the DP – a condition for the identification of the gender of novel Nouns, according to the working hypothesis assumed here.

This hypothesis predicts that the gender of a novel noun is identified solely on the basis of the morpho-phonological information provided by the Determiner. Longitudinal production data reveal, nevertheless, that self-repairs and gender errors can be sporadically identified from early till late childhood (Figueira, 1996, 2001) and experimental data suggest that 3 and 4 year olds rely on strategies based upon the phonological properties of the Noun in order to infer its gender (Karmiloff-Smith, 1979; Pérez-Pereira, 1991). It is not clear, therefore, the extent to which young children would be sensitive to the phonological pattern that can be established between the vowel endings of Nouns and gender – *o* – ending-masculine gender / *a*-ending-feminine gender, regardless of the morphological status of the ending.

This empirical evidence, in the light of the theoretical argument put across here, suggests that a co-relation between the phonological pattern of Determiners and Nouns in Portuguese is likely to affect children's performance on the production of a recently acquired noun. The developmental hypothesis is that the younger the child the less vulnerable he/she is to this effect. Experiment 2 was intended to test this hypothesis.

5.2.1. Experiment 2

The present experiment aimed at verifying to what extent the processing of gender agreement in the production of novel Nouns would be affected by a co-relation between the phonological form of the Noun and gender, in the course of development.

An elicited production task was presented to two groups of children: children younger than three years of age (mean age 31;16 months) and children older than three (mean age 54.2 months). They were shown a sequence of three pictures in a computer screen each of them containing one invented object named by a pseudo-Noun, another token of the same invented object type with a distinguishing property and these two tokens together, respectively. Then they were presented to an additional picture showing an event with one of the previously introduced objects and were requested to identify which of the objects took part in that event. Their use of a referential expression would necessary involve gender agreement. The dependent variable was then the number of correct responses, that is, responses in which the gender of the recently introduced Noun was maintained.

The eliciting material is exemplified below:

"Isso aqui é **uma depa**". (Picture 1)
  This here is a (fem) depa (fem). (This is a depa)
"Olha, aqui tem **uma depa** também". (Picture 2)
  Look, here there is a depa too. (Look, there is a depa here too)

"**As depas** estão juntas no armário". (Picture 3)
  The depas are together in the cupboard.

"Oh! **Uma depa** sumiu!" (Picture 4)
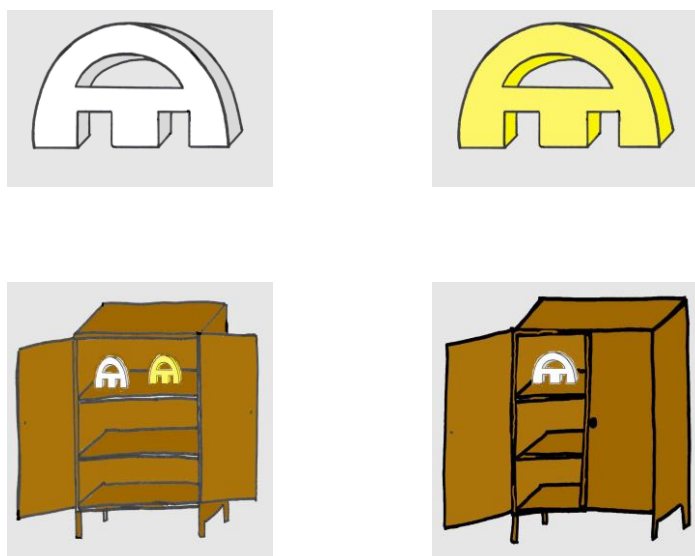 Oh! One depa has disappeared. (Oh! One of the depas has disappeared)
"Que **depa** sumiu?"
  Which depa has disappered?

The expected responses would be: ***A depa vermelha*** (The (fem) red (fem) depa (fem)) or ***Essa aqui*** (This (fem) one here).
  The pictures corresponding to each sentence are illustrated in Fig. 1

Figure 1. Visual Display for eliciting the production of a referential expression

Three conditions were created as a function of *Phonology-gender co--relation*, i.e. the co-relation between the pattern of the pseudo-Noun vowel endings and the morpho-phonological information concerning gender provided by the Determiner:
  • Positively co-related (the vowel-ending of the Noun being the same as the one of the Determiner: –*o* for masculine and –*a* for feminine Nouns):
  • Negatively co-related (the vowel-ending of the Noun being opposite to the one of the Determiner: –*a* for masculine and –*o* for feminine Nouns);
  • Neutral (nouns with the vowel ending –*e*, which cannot be co-related with gender).

All the pseudo-Nouns had two syllables following the most typical Portuguese CV pattern with stop consonants to facilitate perception and reproduction. Table 4 presents the pseudo-Nouns used in each condition resulting from the manipulation of *Phonology-gender co-relation*.

Table 4. Pseudo-nouns as a function of phonology-gender co-relation.

Positively co-related		Negatively co-related		Neutral	
Masculine	Feminine	Masculine	Feminine	Masculine	Feminine
Dab**o**	Bid**a**	Bid**a**	Dab**o**	Mip**e**	Mip**e**
Puc**o**	Dep**a**	Dep**a**	Puc**o**	Tob**e**	Tob**e**
Mab**o**	Poc**a**	Poc**a**	Mab**o**	Baf**e**	Baf**e**

Two other conditions were created due to the manipulation of gender (masculine and feminine). Eight children were presented to masculine pseudo-Nouns and the other seven to feminine ones in each age group in order to avoid submitting children to more than nine testing situations. The experimental design was 2(age) X 2 (gender) X 3 (phonology-gender co-relation) in which age and gender were grouping factors.

It was predicted that if phonology-gender co-relation affected the identification of the gender of the later, then performance should be better in the positively co-related condition and poorer in the negatively co-related condition. If age affected children's achievement, more correct responses to the negatively co-related condition should be obtained in the youngest age group.

Method:

Participants: The participants were 30 middle-class children living in Rio de Janeiro acquiring Portuguese as their first language, without systematic contact with a foreign language and without record of family language deficits or adverse conditions for language development. The children were equally distributed in the two age groups (15 children in each group). In the youngest age group, the age range was 2;2;17 to 2;10;3 years and the mean age was 2;7 (31;16 months). In the oldest age group, the age range was 3;0 to 5;4;25 and the mean age was 4;6 (54;2 months).

Material:

The linguistic material consisted of two lists of twenty-one short stories constituted of three descriptive statements and an interactive attention-holding kind of questions, as exemplified above. Each list contained nine short stories corresponding to a gender condition. The short stories corresponding to experimental conditions introduced a pseudo-Noun. The other twelve stories made use of familiar Nouns and were used as fillers. The order of presentation of the stories was randomized though care was taken to prevent consecutive test conditions from occurring.

The visual material consisted of twenty-one Power Point displays, each one containing four pictures. Each display corresponded to a short story. All pictures presented inanimate objects. Those corresponding to the experimental conditions presented an invented object (cf. Figure 1). The others corresponded to words from the vocabulary of two-year old children according to a sample of questionnaires of the McArthur Inventory adapted to Portuguese (Teixeira, 1998). The equipment used was a Notebook Compaq Presario, a Sony tape recorder with a cassette tape and a microphone stereo AIWA, model CM-TS22.

Procedure:

The experiment was conducted either in a nursery or in a home environment. The child was initially invited to look at picture books and then he/she was presented to the computer. He/she was then invited to play a game in which a short story would be presented and he/she would have to say what happened at the end. The pictures were gradually presented on the screen as the experimenter told the "story" and asked the final question eliciting the use of a referential expression. The three first displays consisted of warming-up fillers. The whole session was tape-recorded. The procedure took about 10 minutes.

Results and discussion:

The responses were submitted to an 2 (age) x 2 (gender) x 3 (phonology--gender co-relation) ANOVA in which age and gender are grouping factors and phonology-gender co-relation a repeated measure. A significant main effect of phonology-gender co-relation was obtained ($F_{(2,52)} = 11.24$, $p < 0.001$) as well as a significant interaction between phonology-gender co--relation and age ($F_{(2,52)} = 4.85$, $p = 0.01$). Table 5 presents the means.

Table 5.   Mean correct responses as a function of age and phonology--gender co-relation (Max Score=3) (n=30).

Age groups	Phonology-gender co-relation		
	Positive co-relation	Negative co-relation	Neutral
Younger than 3 year-olds	2.93	2.67	2.8
Older than 3 year-olds	3.0	1.87	2.73
Total Mean	2.97	2.27	2.77

The main effect of the phonology-gender co-relation indicates that children are sensitive to the phonological pattern Det-N since an early age. However, the direction of means indicates that this sensibility increases with age with a smaller number of correct responses to the Negative condition in the oldest age group. The responses of the youngest children were further sub-

mitted to a 2 (gender) X 3 (phonology-gender co-relation) ANOVA and no significant result was obtained (F (1,13) = 1.15, p= 0.33).

The main effect of gender is compatible with previous results obtained on the basis of French and Spanish data, which dealt with children older than three years of age (Karmiloff-Smith, 1979; Pérez-Pereira, 1991). The developmental trend obtained here does not justify, however, the view that children rely on a phonological strategy in the acquisition of the gender system of their language. On the contrary, this developmental trend supports the hypothesis that it is necessary for the gender of Nouns to be identified by means of the processing of agreement within the DP in order for a co--relational pattern to be established between the phonological form of the Noun and gender. As children's vocabulary increases, the co-relation between the phonological pattern of the Determiner and the vowel ending of the Noun starts to interfere in the processing of gender agreement in production. Such interference does not, however, appear to facilitate gender processing. The number of correct responses was generally high and the difference between the number of correct responses in the Positive Co-relation Condition and in the Neutral one in the oldest age group was not significant, as revealed by a post-hoc t-test (t=1.74 p=0.1). Children's performance on the Neutral condition suggests that a phonology-gender co-relation is not the basis for the establishment of gender agreement.

The present results are compatible with findings of language production by adults. Data from an anomic Italian patient (Badecker, Miozzo & Zanuttini, 1995) provide evidence for the selective preservation of the ability to recover the gender of words whose phonological form cannot be retrieved. These data strongly suggest that access to gender is independent from the phonological formulation that precedes production. Moreover, there is evidence suggesting that the level of phonological information of lexical nodes activated in the production of DPs may affect naming latencies and the selection of the phonological form of the determiner regardless of the grammatical status of the nodes activated (i.e. whether a head noun or an adjoined adjective) (Costa & Caramazza, 2002 and references therein)). It is possible, therefore, that the activation of the phonological form of the Noun prior to the actual production of the DP facilitates the retrieval of a phonological pattern, which interferes in the phonological encoding of the Determiner giving rise to what is usually interpreted as a gender error. It this case, the gender errors children produced are not actually agreement errors for they are likely to occur in a late post--syntactic stage of production.

In sum, the results of the Experiment 2 are compatible with the view that gender identification involves the processing of agreement within the DP. They also suggest that co-relational patterns that may be identified in the course of language development do not interfere in the operation of the computational system as far as gender agreement is concerned. It should be noticed, in this regard, that two two-year olds and five children of the oldest

age group introduced an inflected Adjective in their responses, suggesting that the computation of agreement within the DP takes place beyond the relationship Det-Noun as soon as Adjectives are incorporated in children's speech. It appears, therefore, that the acquisition of the gender system is accomplished as soon as the morphological information in the Determiner bootstraps the operation of agreement within the DP.

6. Conclusion

This study departed from the working hypothesis that the identification of the value of the gender feature of Nouns in the acquisition of Portuguese is accomplished due to the processing of gender agreement within the DP. Children would identify morpho-phonological variation pertaining to gender within the closed class of the Determiners. The parsing of a DP would bootstrap the grammatical operation of agreement enabling the gender of the determiner to be ascribed to the noun.

This hypothesis requires specific processing abilities and the availability of a computational system that operates upon the formal features of the functional category D since an early age. The availability of functional categories in early language development is a controversial matter and it is generally assumed that the acquisition of the gender system of the language is a relatively long process, which is dependent upon cognitive strategies or other learning procedures.

The results obtained here suggest that young children's sensibility to determiners is not restricted to their phonological properties. They suggest early sensibility to syntactic and morpho-phonological properties of determiners (Experiment 1) and that the morpho-phonological information provided by the determiner is reliably taken into account when the gender of novel nouns is identified (Experiment 2). It appears, therefore, that the perceptual abilities captured in Experiment 1 are instrumental to the processing of agreement in the DP.

The performance of the youngest children in Experiment 2 also suggests the availability of a computational system that operates with the formal features of the category D during the third year of life. This computational system would enable the parsing of a DP and incorporate an agreement operation that guarantees the syntactic computation of gender agreement regardless of whether or not the particular value or the intrinsic gender feature of the noun could be recognized by the language processing system.

The computation of gender agreement was characterized in terms of feature sharing. According to this formal account of syntactic agreement, [-interpretable] and [+interpretable] formal features are shared blindly as far as their actual value is concerned. From the point of view of the child acquiring the language, the availability of such a computational system would guarantee that gender agreement was syntactically processed, regardless of the

availability of information concerning the actual value of the gender feature of the noun to the language processing system. The processing system would have to recognize a member of the class of the Determiners in the input data in order to parse a D node. Parsing this node would activate the formal features that characterize this category. The activation of a [-interpretable] gender feature would suffice for agreement as feature sharing to take place once a DP was parsed. Children's distinguishing morpho-phonological classes within the closed category of the Determiners would enable them to ascribe a particular value to the gender feature of the determiner that is activated. Given the compulsory sharing of features, the value of the gender feature of the determiner would be ascribed to the noun. Once this value was ascribed, this information could be registered in the mental lexicon to be used in language production.

The results of Experiment 2 suggest that this information remains available in the course of the production task though it is not clear how frequently gender agreement needs to be processed in comprehension in order for the gender of a particular noun to acquire stability in the mental lexicon. The results of Experiment 2 also suggest that the activation of the phonological properties of the Noun prior to the production of the DP may promote an effect of phonology-gender co-relation as soon as children's lexicon has incorporated sufficient information to identify such a co-relational pattern. This effect appears, nevertheless, to be post-syntactic, i.e. in the selection of the phonological form of the determiner in the DP production.

Theories of language acquisition that rely on analogy to explain the learning of the gender system of a particular language would not be able to account for the developmental pattern obtained here. Theories of language acquisition that predict a late availability of functional categories in the course of language development would also have difficulty in explaining the present results. It appears that it is necessary to assume the availability of a computational system that operates upon the formal features of the D category as soon as this category can be identified in the input language data. Early sensibility to the phonological properties of this category would bootstrap the operation of such a system.

It is our contention that a procedural theory of language acquisition must take into account the actual information available to children in the speech signal and a model of language, which expresses a concern with learnability and which can be articulated with a language processing model (Corrêa, in press). In the present study, a model of language conceived in the light of the Minimalist Program was incorporated into a model of gender processing in the DP. This model is compatible with results on gender processing by adults and provides a procedural account for the early acquisition of the Portuguese gender system. The predictions of this model to the acquisition of the gender system in different languages bear on how systematic the information concerning gender classes is in the closed class of the determiners.

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