THE ROLE OF EXECUTIVE FUNCTIONS IN THE ACQUISITION OF REFERENCE: THE PRODUCTION OF DEMONSTRATIVE PRONOUNS BY GERMAN MONOLINGUAL CHILDREN

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1. Introduction

This paper deals with the acquisition of reference by German monolingual children between the age of 8 and 10. In particular, we will focus on the acquisition of the use of demonstrative pronouns (*der*, *die*, *das* – d-pronouns, henceforth)[1] as compared to the use of personal pronouns (*er*, *sie*, *es*). We analyze the production of these referential expressions (REs, henceforth) in the context of story-telling.

When telling a story, speakers have to keep track of different referents, introducing them, maintaining reference to them across two (or more) adjacent discourse units, or reintroducing them after a hiatus. The degree of the referent's activation (alias accessibility, salience – cf. Arnold 2010) varies throughout the story based on these discourse functions (introduction, maintenance and reintroduction). More specifically, various factors contribute to determining the referent's activation. For example, recently mentioned referents are usually associated with a relatively high activation (cf. Ariel 1990). The grammatical role and the syntactic position of the referent's previous mention (antecedent) play a significant role, too. The referent's activation is enhanced if the antecedent is a subject (vs. object) and occurs in a main clause (vs. subordinate clause). The referent's activation is also affected by the occurrence of competitor referents in discourse (cf. Arnold 2010 for a discussion of these factors and Kibrik 2011 and Torregrossa & Bongartz, to appear for a multi-factorial approach). Other factors that have an impact on activation include the perceptual availability of the referent in the discourse context and the

extent to which both interlocutors are able to attend to the referent in question (Allen et al. 2008). In our study, we control for these additional factors, since the production of REs is elicited by means of a picture-based story-telling task, in which only the child has visual access to the pictures (Section 3). In this context, the assessment of the referent's activation in the discourse model – shared between the child and the investigator – should be insensitive to extra-linguistic sources (such as occurrence in the perceptual environment) and only based on discourse factors.

From the cognitive point of view, the ability to keep track of story referents requires attentional resources and executive functions (EFs, henceforth). The referent's previous mention has to be stored and maintained in memory along with its linguistic features (e.g., argument role, syntactic position and distance) and retrieved at the point of the story in which the referent is mentioned again. Thus, the referent's activation varies as a function of decay and retrieval history (Lewis et al. 2006). While working memory (WM, henceforth) is involved in the retention of information, the updating of this information in the unfolding discourse requires EFs (see, e.g., de Cat 2015).

The production of REs depends on the activation of the corresponding referent (Arnold 2010; Kibrik 2011). The more active a referent, the less explicit (or less informative) the corresponding RE. For example, personal pronouns in German (e.g., *er*, 'he') tend to pick up referents that are highly active, while full noun phrases (e.g., *der Hase* 'the rabbit') usually encode a low degree of a referent's activation. However, the mapping between the referent's activation and the use of a certain RE is not categorical, but rather subject to individual variation. For example, some speakers may rely on 'overprotective' strategies, using a full noun phrase in association with a high degree of the referent's activation, to avoid mistakes leading to ambiguities (Kibrik 2011). Cognitive constraints contribute to variation of reference production, too. For example, Rosa & Arnold (2011) argue that under cognitive load, speakers tend to produce REs that encode a lower degree of the referent's activation (i.e., full nouns vs. pronouns). Likewise, Torregrossa & Bongartz (to appear) show that a reduced processing speed correlates with the production of ambiguous forms (cf. also Hendriks 2016). In this paper, we investigate to what extent differences in EFs contribute to variation in reference production, given the role of WM in particular and EFs in general in maintaining and updating information held in mind.

From this short overview, it can be concluded that the acquisition of reference is a complex task, since it involves the integration of linguistic competence and cognitive abilities. Children have to acquire the repertoire

of REs available in their language and the syntactic constraints regulating their distribution (cf. Torregrossa et al. 2015). Furthermore, they have to keep track of the varying activation of referents in the discourse model and learn how to adequately map the referent's activation into the use of a certain RE. All these learning processes are supported by cognitive systems which are not fully developed. For example, at the age at stake in this paper (i.e., from 8 to 10 years), EFs have still not reached the adult level (Gathercole et al. 2004). Some studies on the acquisition of reference have shown that in early spontaneous productions, children are sensitive to the distinction between given and new information from early on (i.e., from 3 y.o), which is reflected in the production of less explicit REs for given referents and more explicit REs for new ones (Skarabela et al. 2013; Hickman et al. 2015 for discussion). However, when taking into account more complex tasks, such as picture-based narrative production, adequate form-function mappings do not seem to be well mastered until 7-10 years. These tasks require the integration of visual and verbal information into a coherent discourse and the dynamic updating of the discourse model (de Cat 2015), and therefore impose a cognitive load. The literature indicates different patterns of acquisition of reference, depending on the discourse function that the child intends to express. While reference maintenance is mastered early on (from 4-5 years, Hickmann & Hendriks 1999), the acquisition of reference introduction and reintroduction emerges later (Koster et al. 2011; Hendriks et al. 2015). The short narrative in (1) – taken from Hendriks (2016: 2) – was told by a 6 y.o. Dutch child (Hendricks reports the English translation).

(1)   **A pirate$_1$** with the football. Then **he$_1$** kicks it. Then it is in the water. Then the knight$_2$ goes to catch it. And he$_2$ has caught the ball in a net. Now **he$_1$** has his ball back again.

To reintroduce the pirate in the last sentence, the child produces a pronoun. The use of a pronoun results in ambiguity for the interlocutor, since *he* can refer to both the pirate and the knight. Van Rij et al. (2011) and Hendriks (2016) argue that the production of underspecified, ambiguous REs is motivated by insufficient WM-capacity. Children have difficulty in managing (i.e., maintaining and updating) discourse information (distance, intervening referents, etc.) to determine the discourse topic, to which pronouns usually refer.

In this paper, we investigate how the acquisition of reference depends on the development of WM and EFs, by analyzing the production of d-pronouns by German monolingual children. In Section 2, we will show

that the felicitous use of d-pronouns involves maintaining grammatical information encoded in previous discourse and updating the discourse model following a topic shift.

2. The phenomenon: The use of d-pronouns in German

German has demonstrative pronouns that are inflected for number, gender and case, and can refer to persons, as is the case of personal pronouns (Bosch et al. 2003). Some studies have shown that personal pronouns and d-pronouns exhibit a complementary pattern of anaphoric reference resolution: while personal pronouns tend to be resolved to antecedents that are topical, d-pronouns refer to non-topical entities (Bosch et al. 2003). This claim is supported by the corpus analysis carried out by Bosch et al. (2003). The authors show that more than 75% of d-pronouns refer to non-nominative antecedents, while this is the case of only 13% of personal pronouns[2]. However, more recent studies have reconsidered the complementary hypothesis formulated by Bosch et al. (2003) and argued that while d-pronouns usually refer to non-topical entities, personal pronouns can be resolved to antecedents that are either topical or non-topical (Bosch & Umbach 2007 and Hinterwimmer 2015). The different distribution of d-pronouns and personal pronouns is illustrated by the sentences (2b)-(2d) below – taken from Patel-Grosz & Grosz, to appear. (2c) and (2d) show that d-pronouns can only refer to the object (i.e., non-topical) antecedent *Paul*. On the contrary, *er* (he) and *ihn* (him) in (2a) can pick up both *Hans* and *Paul*.

(2)   a. $Hans_1$ wollte $Paul_2$ besuchen.
         Hans want.$_{3SING.PAST}$ Paul visit.$_{INF}$
      b. aber dann hat $er_{1/2}$ $ihn_{2/1}$ angerufen.
         but then AUX.$_{3SING.PRES.}$ he him   call.$_{PPT}$
      c. aber dann hat der_2 ihn_1 angerufen.
         but then AUX.$_{3SING.PRES.}$ D-PRON him call.$_{PPT}$
      d. aber dann hat er_1 den_2 angerufen.
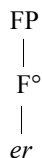   but then AUX.$_{3SING.PRES.}$ he D-PRON call.$_{PPT}$

The pattern shown in (2) is confirmed by the corpus analysis presented in Torregrossa (submitted). Based on narrative production data elicited from adult speakers, the author analyzes the distribution of personal pronouns and d-pronouns in four different contexts – which we will refer to again in Figure 1 under Section 4: i) the referential expression and the antecedent are in subject position (SUBJ-SUBJ); ii) the referential

expression is in subject position and the antecedent is non-subject (NONSUBJ-SUBJ); iii) the referential expression is in non-subject position and the antecedent is subject (SUBJ-NONSUBJ); iv) both the referential expression and the antecedent are non-subjects (NONSUBJ-NONSUBJ). The corpus analysis shows that the great majority of d-pronouns (almost 70%) appear in contexts where the antecedent is a non-subject (i.e., NONSUBJ-SUBJ and NONSUBJ-NONSUBJ), in compliance with (2c) and (2d). Crucially, the study in Torregrossa (submitted) relies on the same methodology for data elicitation that is used in this paper (i.e., ENNI stories, cf. Section 3.2). Therefore, the results of the two papers are readily comparable with each other.
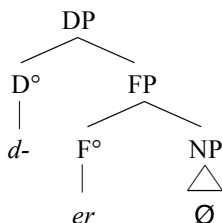
The example in (2c) also shows that d-pronouns may be associated with a topic-shift function: *Hans* is the topic in (2a), while *Peter* is the topic of (2c). Topic-shift has the effect of updating the activation of the referent and, more in general, the discourse model.

Finally, it should be noticed that the distribution of personal and d-pronouns complies with the abovementioned principle, according to which the more complex (i.e., the more explicit) the DP, the less activated is the corresponding referent in discourse. (3a) and (3b) illustrate the structure of personal pronouns and d-pronouns, respectively. While personal pronouns consist only of a functional projection, d-pronouns have a null NP and a DP-shell (cf. Wiltschko 1998 and Patel-Grosz & Grosz, to appear, from which the two structures are taken). The more complex structure of d-pronouns reflects their preference to pick up less activated antecedents (i.e., in object position)[3].

(3a) Personal pronouns   (3b) D-pronouns

FP   DP

F°   D°   FP

er   d-   F°   NP

er   Ø

Coming back to the acquisition issue, our analysis aims to investigate whether children's production of d-pronouns complies with the adult pattern described in this section. In particular, since d-pronouns tend to be used to reintroduce referents in discourse, we will verify the claim that the acquisition of reference in contexts of reintroduction is vulnerable

(Section 1). Furthermore, we will verify to what extent WM and EFs contribute to the acquisition of reference. In particular, the children's adequate use of d-pronouns should be predicted by their performance in EF task.

3. Methods

3.1 Participants

The study is based on a sample of 21 German monolingual children ranging in age from 8.10 to 10.6 (mean age: 9.4; SD = .72). At the time of testing, the children attended the third or the fourth grade of a public primary school in the North Rhine Westphalia in Germany. The teachers reported that none of these children had a history of language delay or disorder, or socio-emotional problems.

3.2 Materials and procedure

The production of REs (personal pronouns and d-pronouns, in particular) was observed in the context of a story-retelling task. Retellings were elicited by using the Edmonton Narrative Instrument (ENNI) designed by Schneider et al. (2005). ENNI includes six stories, divided into three groups of increasing complexity. For our task, we used the stories of the greatest complexity (A3 and B3). Each of them consists of 13 pictures representing a series of events involving two major characters (an elephant girl and a giraffe boy in A3 and a dog girl and a rabbit boy in B3) and two minor ones (of different gender, too). The two stories have been designed to be structurally equivalent. The retelling task is used to facilitate the decoding of the pictures and the comprehension of the story (see Gagarina 2016 for discussion). Furthermore, it allows to establish the gender of the characters from the beginning of the experiment and avoid confounding effects caused by the fact that the elephant and the dog (which are masculine in German, i.e., *der Elefant* and *der Hund*) have visual appearance consistent with female stereotypes (e.g., a long dress, a skirt), while the giraffe and the rabbit (which are feminine in German, i.e., *die Giraffe* and *die Hase*) have visual appearance consistent with male stereotypes (e.g., short trousers and a hat). In the story prompt, the dog and the elephant are referred to by means of the feminine gender, i.e., *Hundina* and *Elefantina* respectively, while the giraffe and the rabbit by means of the masculine gender, i.e., *Giraffo* and *Haso*. Accordingly, the children were able to associate consistently throughout the story the

masculine gender to one character and the feminine gender to the other character.

The task was administered as a sequence of Power Point slides on a computer screen. The children had to choose one of three envelopes. Although all the envelopes contained only one of the two target stories (i.e., either A3 or B3), the children were told that the envelopes contained different stories (Serratrice 2007). Then, the participants looked at the story pictures two by two, while listening to the model story on the headphones. Finally, once the thirteen picture synopsis had appeared on the screen, they were asked to tell the story to the investigator, who feigned ignorance of the plot.

Each child was asked to tell one narrative and hence, the materials of the study consist of 21 narratives. The stories were audio-recorded and then transcribed into CHAT format (MacWhinney 2000) by a German native speaker. We refer to Andreou et al. (2015) for further details concerning the procedure of the experiment.

At the end of the experiment, we tested each child for WM and EFs, by using the backward digit recall test, which consists in listening to and recalling sequences of digits in reverse order. This test is classified as a complex memory span test, since it involves both storage (digit recalling) and processing (inverting order), and hence taps the phonological loop and the central executive, respectively (Baddeley & Logie 1999; Gathercole et al. 2004).

3.3 Analysis

We divided each narrative into clausal units, defined by the occurrence of a verbal form. To control for animacy effects, we analyzed only referential expressions denoting animate characters[4]. We labelled each pronoun and d-pronoun for its grammatical role (distinguishing between subjects and non-subjects, see the third column in Table 1) and for the grammatical role of its antecedent (see fourth column in Table 1). For instance, the antecedent of the d-pronoun *der* in subject position in (2) is the definite DP *der Hund* (the dog) in subject position in the previous clause (see Table 1). Then, we counted the instances of personal and d-pronouns referring to subject or non-subject antecedents.

Table 10: Coding of referential expressions for: i) type (column 1); ii) grammatical role (column 2); and iii) grammatical role of the antecedents (column 3).

	UNITS	TYPE	GRAMMATICAL ROLE (RE)	GRAMMATICAL ROLE (A)
(1)	[...] und dann kam *der Hund* [and then came the dog]	DEFINITE DP	SUBJECT	...
(2)	und *der* wollte ja auch einen neuen Luftballon [and he also wanted a new balloon]	D-PRONOUN	SUBJECT	SUBJECT
(3)	und *der* hatte auch kein Geld dabei. [and he also had no money with him]	D-PRONOUN	SUBJECT	SUBJECT
(4)	und dann kam *die Mutter* von dem Hasen [and then came the mother of the rabbit]	DEFINITE DP	SUBJECT	INTRO
(4')	und dann kam die Mutter *von dem Hasen* [and then came the mother of the rabbit]	DEFINITE DP	NON-SUBJECT	SUBJECT
(5)	und *der* hat die eingeholt. [and he reached her]	D-PRONOUN	SUBJECT	NON-SUBJECT
(5')	und der hat *die* eingeholt. [and he reached her]	D-PRONOUN	NON-SUBJECT	SUBJECT
(6)	und *er* fragte (...) [and he asked (...)]	PRONOUN	SUBJECT	SUBJECT

To account for individual variation in the (felicitous vs. infelicitous) use of d-pronouns, we took into account the instances of d-pronouns referring to a subject antecedent (which corresponds to the non-adult-like pattern, see Section 2) produced by each child, and normalized them for the square root of the total number of instances of d-pronouns. Finally, we ran a correlation between the results of this normalization and the scores obtained in the backward digit recall test (which amount to the number of correct trials) on the one hand, and with the participants' age on the other. In this way, we could investigate whether the non-adult like production of d-pronouns was an effect of age or limited EF abilities (or both).

4. Results

The children produced 584 units in total. The narratives ranged in length from 20 to 38 units (M: 29.79; SD = 4.65). The analysis is based on 114 pronouns and 67 d-pronouns.

Figure 1 reports the raw numbers concerning the occurrence of pronouns and d-pronouns in each condition introduced in Section 2 (following the examples in (2)), i.e., SUBJ-SUBJ, NONSUBJ-SUBJ, SUBJ-NONSUBJ and NONSUBJ-NONSUBJ.
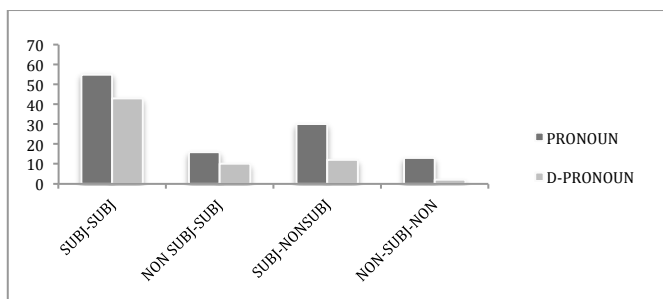

Figure 3: Distribution of pronouns and d-pronouns across the four conditions SUBJ-SUBJ, NONSUBJ-SUBJ, SUBJ-NONSUBJ, NONSUBJ-NONSUBJ.

The two referential forms do not differ from each other in their distribution ($\chi^2(2) = 6.9$, p > .05). The great majority of d-pronouns (either in subject or in non-subject position) is used to refer to a subject in previous discourse (55 instances, amounting to 82% of the total number of d-pronouns). For example, in (4) the d-pronoun *die* in U2 picks up the referent *Elefantina* in subject position in U1. (5) shows a case in which the dative d-pronoun *dem* refers to a subject antecedent, i.e., the young rabbit Haso (written in parentheses because the referential expression *Haso* appears in the first conjunct).

(4)   U1:   Elefantina   hat   ihn   angeschaut
            Elefantina   AUX.3SG.PRES.   PRON.3SG. MASC.SING.   see.PPT.
            Elefantina has looked at him

      U2:   weil   die   kein Spielzeug hatte.
            because   D-PRON.FEM.SING.   no   toy   have.3SG.PAST
            because she had no toy

                                                                    (CH2; 9.4)

(5) U1: und (Haso) fragte   nach dem
          and   Haso ask.$_{3SING.PAST}$ for   ART.$_{DAT.MASC.SING.}$
          schönsten   Ballon
          beautiful.$_{ADJ.SUP.\ DAT.MASC.SING.}$ balloon
          and (Haso) asked for the most beautiful balloon

     U2: aber der Hase sagt   dem
         but the rabbit say.$_{3SING.PRES.}$ D-PRON.$_{DAT.MASC.SING.}$
         but the rabbit told him

                                                    (CH4; 9.8)

(4) and (5) are instances of non-adult like use of d-pronouns. The children produce only few d-pronouns (either in subject or in non-subject position) referring to a non-subject antecedent (12 instances, i.e., 18%) in accordance with the adult pattern, as exemplified in (6), where the d-pronoun *die* (in U3) picks up the dative argument *der Mutter* (the mother) occurring in U1.

(6) U1&2: und der Mutter   erzählt was passiert
           and the mother.$_{DAT.FEM.SING.}$ tell.$_{PPT.}$ what happen.$_{PPT.}$
           ist.
           AUX.$_{3SING.PRES.}$
           and he told the mother what happened

     U3: und dann hat   die   uhm [//]
          and then AUX.$_{3SING.PRES.}$ D-PRON.$_{NOM.FEM.SING.}$
          war   die   einverstanden.
          AUX.$_{3SING.PAST}$ D-PRON agree.$_{PPT.}$

                                                    (CH1; 10.5)

The correlational analysis reveals that the (infelicitous) use of d-pronouns referring back to subject antecedents correlates negatively with the scores obtained in the digit backwards task (r = -52.3, p < .05) – see Figure 2: the lower the score in the EF task, the greater the frequency of d-pronouns referring to subject antecedents[5]. Furthermore, to control for age effects, we correlated the use of d-pronouns with age and, as expected, we found no significant effect (r = -28.4, p > .05).
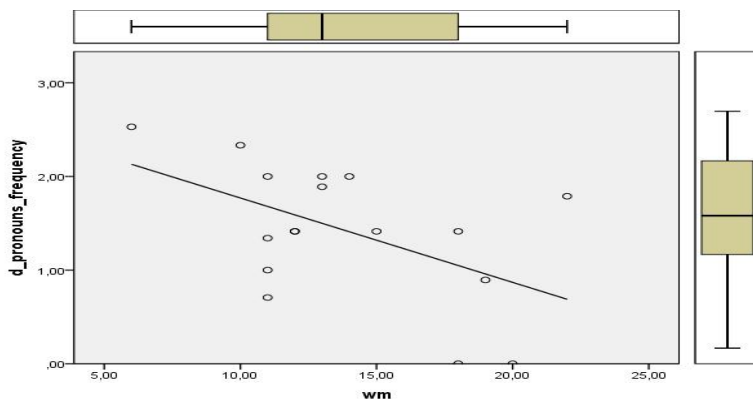
Figure 4: Dispersion graph between the normalized frequency of d-pronouns having a subject antecedent and scores in the EF task.

5. Discussion and conclusive remarks

Reference production and comprehension requires EF resources, which are necessary for calculating the referent's activation and updating it in the unfolding discourse. German d-pronouns provide a relevant empirical domain to assess the role played by EFs in reference production. The adequate use of d-pronouns involves "backwards-processing" of the features associated with the referent in previous discourse (the grammatical role of the antecedent, in particular) and "forwards- processing" related to discourse updating due to topic shift (Schumacher et al. 2015).

With respect to the acquisition of reference, the aim of this study was to investigate if children use d-pronouns in an adult way (as described in the studies reviewed in Section 2) and to determine if possible differences are motivated by limited EF abilities. In particular, we formulated the hypothesis that better executive functions should be reflected in a more adult-like production of d-pronouns.

The results of our study suggest that children tend to use d-pronouns to refer back to subject antecedents and do not distinguish personal and d-pronouns in their conditions of use (Figure 1 in Section 4), contrary to what has been found for adults (cf. Section 2 and Torregrossa, submitted). Furthermore, we found that the children's performance in EFs is a good predictor of accuracy in the production of d-pronouns: the better the performance in EF tasks, the more felicitous the use of d-pronouns. Age correlates neither with the scores in the EF task nor with the (adequate)

use of d-pronouns. This result confirms the appropriateness of our choice of the age group: in the age span at issue, there seems to be no significant development progression in EFs, which is reflected in the absence of a developmental trend in the felicitous use of d-pronouns.

Our study argues in favor of the hypothesis that the development of EFs plays a crucial role in the acquisition of reference. More in general, it supports the idea that referential resolution processes rely on attentional and EF resources.

Notes

[1] German has several types of demonstrative pronouns (in addition to the demonstrative pronoun *der*), e.g., *dieser* (this), *jener* (that), *derjenige* (the one who), *derselbe* (the same), etc. (Bosch et al. 2003). In this paper, we take into account only the acquisition of *der*, given its pattern of complementary distribution with respect to the personal pronoun *er* (Section 2).

[2] Bosch et al. (2003) identify the notion of topic with the notion of subject (i.e., a constituent that is nominative marked). However, other types of constituents can be topics, e.g., left-dislocated accusative-marked constituents. In this paper, we follow the analysis of Bosch et al. (2003), since the narratives of our corpus mainly comprise SVO sentences, in which the informational category of topic aligns with the grammatical function of subject.

[3] (3a) and (3b) can easily account for the structure of singular masculine and neuter personal pronouns and d-pronouns in the nominative, dative and accusative case, abstracting away from some spelling differences (Wiltschko 1998: 149). The other forms in the paradigm exhibit some idiosyncrasies, which Wiltschko discusses in depth (*ibid.*:150-156). For example, the morpheme *s-* occurring in the singular feminine personal pronoun *sie* in the nominative and accusative case is analyzed as a support morpheme (and crucially not as D°, as is the case of the corresponding d-pronoun *die*). Also, the apparent irregularities of the genitive paradigm (personal pronouns: *seiner*/*ihrer*/??*seiner*; d-pronouns: *dessen*/*deren*/*dessen*) can be attributed to the 'defective' nature of the genitive agreement ending. In the case of d-pronouns, the genitive agreement marker *–es* in F° cannot license the empty NP in its complement, and the agreement ending *–en* is added to save the structure. With personal pronouns, the expected genitive form *es*/*er*/*es* (which cannot be spelled out by itself) attaches to the possessive determiner, resulting in a full DP. Finally, Wiltschko analyzes the *–en* suffix which appears in the dative plural forms of personal pronouns (*ihnen*) and d-pronouns (*denen*) respectively as a cliticization on F°. In all cases, the analysis of Wiltschko is also supported by diachronic data, with special reference to the transition from Middle High German to New High German.

[4] Many studies have shown that the use of referential expressions is sensitive to the animacy of the corresponding referent (a.o., Fukumura & van Gompel 2010). Therefore, children may tend to associate one type of referential expression (e.g., pronouns) to animates and another type (e.g., d-pronouns) to inanimates. By

considering only animates, our analysis eliminates animacy as an interfering factor.
[5] The correlational analyses concern only 17 children among the 21 included in the study, since 4 children did not produce d-pronouns.

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