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Narrative abilities in children with Autism Spectrum Conditions

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Abstract

This work addresses macrostructural features of narrative of children with Autism Spectrum Condition (ASC). We analyze indicators of speech planning and use of referential devices. To do this, we compare the narratives of children with Autism Spectrum Conditions (ASC, $n = 18$, range: 7;4-12;6 years old) with typically developing controls (TD, $n = 19$, range: 6;8-12;10 years old). Results show that children with ASC produced less filled pauses and prolongations than controls, which could be related with a lack of speech planning. Also, we predicted an increasing tendency of the use of anaphoric references compared to the use of non-anaphoric and indefinite references as the story unfolds. This tendency resulted to be significant in the TD group, but not in the ASC group, when comparing anaphoric to non-anaphoric references. This shows that children with ASC are less sensitive to ways of connecting utterances with each other in narrative structure.

Keywords (200 characters maximum): ASC, autism, narrative, speech planning, pausing, anaphoric reference, coherence, cohesion.

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1. Introduction

“Words belong to each other”

- Virginia Woolf

Narratives are one of the most pervasive human communication activities. For instance, we can find them in cultural production, education, and daily conversation. Also, they are a primary form of organizing our thought, experience and memories (Brunner, 1991). Thus, we tell ourselves the story of our lives, of our communities and of humanity.

With respect to its discursive structure, a narrative can be defined as a sequential description of related events developed over time and with a goal to be achieved. Although we easily organize and understand information in this way, it turns out that narratives are challenging for many other populations, including people with Autism Spectrum Condition (ASC).

ASC refers to a range of neurodevelopmental disorders, which compromise social behavior and social communication. Regarding communication, people with ASC exhibit highly heterogeneous difficulties. In particular, deficits in narrative abilities have been related to social impairment in the ASC population, and their performance could also reflect difficulties integrating the overall content of a story over time.

To date, one of the most conclusive studies in this regard has revealed that children with High Functioning Autism perform worse than controls (Baixauli, Colomer, Roselló, & Miranda, 2016) in terms of microstructure, macrostructure and internal state language (ISL), where microstructure refers to internal linguistic measures such as productivity and grammar, macrostructure refers to content and hierarchical organization (that is, coherence and cohesive

adequacy), and ISL refers to the vocabulary needed to communicate internal processes and feelings. Interestingly, a larger effect size has been found in narrative macrostructure, which indicates that narratives of children with ASC are less causally connected and coherent than narratives of healthy controls.

Related to macrostructure, McCabe (2013) shows that personal narratives in adults with ASC were poorer regarding high-point and resolution, something also found in children with high-functioning ASC (Goldman, 2008). Besides, some studies have found that people with ASC appears to have problems at grasping the meaning of the story as a whole (Loveland & Tunali, 1994; Diehl et al., 2006), and Weak Coherence Account highlights a detail-focused processing style over a global one (Happé & Frith, 2006), which could also reflect lack of contextual sensitivity (Vermeulen, 2015). These studies emphasize the macrostructural differences in the narratives of people with ASC and the difficulty to integrating their narratives in a coherent and cohesive way.

However, there is no agreement for a unified explanation of these difficulties, as narrating is a cognitively demanding task which involves a range of linguistic competences and social interaction abilities. For instance, Norbury et al. (2013) found that children with language impairment (LI) exhibited similar problems in narrative skills than those of children with ASC. In the same way, Frazier et al. (2013) show that ASC syntactic and semantic abilities in narrative did not differ significantly from a LI group. Thus, there is a need for having better understanding of the underlying processes involved in narrative profiles.

In this work we study narrative macrostructure and assess how the information provided by the utterances that compose a narrative are connected to each other, as global coherence in particular, the ability of establishing connections between different pieces of information, appears

to be impaired in individuals with ASC (Jolliffe & Baron-Cohen, 2000). To do that, first, instead of looking at some of the usual indicators of coherence (components of the story (Losh & Capps, 2003; De Marchena & Eigsti, 2010, Suh et al., 2014) or causal events relationship (Diel et al., 2006; Heilman et al. 2010; Sah & Torng, 2015)), we propose to analyze speech planning viewed as a precursor or indicator of the ability to connect the different utterances in advance, which eventually would lead to a more coherent structure. Second, we propose to study the use of referential devices along the story as another way to establish connection between the utterances in a narrative. This means tracking the use of referential devices as the story unfolds, since we communicate sequentially, and we are limited by the capacity to keep in mind a certain a number of references and connect them through time. For example, the use of indefinites is supposed to introduce an entity that will be referred to again with the story through a definite (Dekker, 2002).

With this, we expect to provide a more sensitive analysis than is provided by the usual coherence indicators, and to emphasize the connection between different pieces of a narrative. Ultimately, speech planning is intended to account for a forward-looking integration of the utterances, and the use of referential devices to account for a backward-looking integration. Thus, both speech planning and the use of referential devices along the story should be responsible for giving coherence and cohesion to the narratives.

In relation with pauses and speech planning, pauses are one of the prosodic features in discourse structure, in general. They are expected to delimit different linguistic components and they also appear associated to non-linguistic aspects such as hesitation. In this regard, it has been shown that pause occurrence and duration depend on a number of different factors, such as the speaker, speech rate, discourse, prosodic structure, phrase length and syntax. Additionally, in spontaneous spoken speech pauses are present not only at grammatical junctures but in the whole

utterance (Goldman-Eisler, 1968). It has been argued that occurrence and duration of the pauses are related to planning in speech production. For instance, Grosjean et al. (1979) have found a correlation between pause duration and syntactic complexity, where the more complex the constituents, the longer the pause. Also, Krivokapi (2007) have shown that the length of utterances and prosodic structure influence pause duration; the length of phrases has an effect both pre and post-boundary, i.e. shorter (larger) phrases occur with shorter (larger) pauses. According to this author, one of the suggested sources of pause duration is information load, where this can be thought of as processing demands of some sort.

The next section addresses the research question and the proposed hypothesis. Section 3 explains the methodology and the variables to measure. Results are shown in section 4 and a discussion of these results is carried out in section 5. Conclusion of the present work are provided in section 6.

2. Present study

“It is like putting a jigsaw puzzle together. It is not done in any particular order.”

- Temple Grandin

2.1 Research question

Our interest is to address the difficulties that children with ASC face at integrating the parts of the story in a coherent whole. We assume that narratives have a goal-oriented structure. This means that a narrative can be characterized as a set of propositions or utterances that are selected to contribute to a main goal. Thus, our approach to analyze the macrostructure of narratives is by looking at the processes underlying the connection between the different utterances that compose a given narrative.

In what follows, we assess how these difficulties at integrating a narrative are related to (1) speech planning and (2) use of referential devices in a (productive) narrative task, since these elements are closely related to coherence and cohesion, being planning an indicator of the awareness of the narrative structure in a forward-looking way, and the use of referential devices an indicator of the awareness in a backward-looking way. As long as the children with ASC would be less sensitive to how different utterances are connected to each other, it would be less likely for them to plan in advance how to connect them or to keep track of references.

To tackle this question, we analyze pause production, syllable prolongation, and referentiality, in the context of a narrative task. We will compare ASC and TD children at producing (empty and filled) pauses and prolonged syllables, which have been proposed to be indicators of speech planning. Referentiality is addressed by studying the distribution of indefinites

and definite (anaphoric and non-anaphoric) references throughout the story, that is, observing the dynamical evolution of their presence as the story progresses.

2.2 Hypothesis

Our basic hypothesis is that children with ASC are less sensitive to the goal-oriented structure of narratives. That is to say, they have difficulties at realizing that different utterances are instances of a single thematic unit, connected through a goal. In other words, they are less sensitive to the fact that the existence of each unit is subject to the existence of the following instances and to the existence of a global meaning. Especially in a task where children have to produce a narrative, TD children should be aware that each utterance they produce is a necessary condition for the utterances after it. As a result, this *telescopic awareness* would be responsible for giving coherence and cohesion to the speech, and it should be present in the speech production, mostly as planning and dealing with references that once they are presented are reused later (anaphoric reference).

Following the above, we hypothesize first, that the speech planning of a (productive) narrative task is affected in children with ASC; in particular, we predict that they will produce less indicators of planning than healthy controls. Second, the distribution of different types of referring expressions does reflect the evolution of the story in children with ASC, less than it does in controls, as measured through an increase in anaphoric references and the decrease in non-anaphoric references. At the syntactic level, this would show that in children with ASC utterances are less connected and integrated into a whole.

3. Methodology

3.1 Participants

The participants were 18 children (mean age: 9;11, range:7;4-12;6 years old) diagnosed with ASC and 19 children with Typical Development (TD) (mean age: 9;9, range: 6;8-12;10). All children were native speakers of Spanish and Catalan. ASC children were recruited from juvenile mental health clinics in the Baix-Llobregat county of Barcelona. This recruitment as a part of the study on “Comprehension and production of referential expressions across Autism Spectrum Conditions” (Schroeder, 2019). Autism spectrum diagnosis was necessary to recruit them. The inclusion criterion consisted of scoring positive for ASC in either Autism Diagnostic Observation Schedule (ADOS) or the Autism Diagnosis Interview- Revised (ADI-R). Also, the ASC participants passed WISC to ensure that their non-verbal IQ was above the threshold for intellectual disability ($IQ \geq 70$). Children were matched based on verbal IQ, measured by the Peabody Picture Vocabulary Test (PPVT), and chronological year of age.

3.2 Procedure

Following the studies of Rumpf et al. (2012) and Suh et al. (2014), that use the narratives collected as a part of the ADOS procedure, we compare the narrative performance of children with ASC with their TD peers. The participants were asked to narrate a story from the picture storybook *Tuesday* (Weisner, 1991), which was presented to them. The task was recorded on video and

transcribed. According the ADOS procedure when using this, the examiner begins the narrative and then asks to the child to continue until the final pages, when the examiner takes over again.

The book consists only of pictures without text, except for a few words indicating temporal information (e.g. ‘Next Tuesday. 7:58 pm’)¹. The book presents the story about a group of frogs that, one Tuesday night, begin to levitate on their lily pads and fly towards a nearby town, where certain events take place. When the day arrives, the frogs lose their ability to fly and return to their swamp. That day, the police try to solve the mystery of the lily pads scattered throughout the town. At the end, the following Tuesday, pigs start flying at about the same time.

3.3 Computational tools

The collection of narratives was transcribed and annotated using CLAN (Computerized Language Analysis). The output was a file for each transcription in CHAT format (Codes for the Human Analysis of Transcripts). The analysis was carried out using Python through the library PyLangAcq (Lee et al., 2016) and self-developed ad hoc functions. The narratives were divided into different utterances, defined as grammatically independent unit contributing new information. Also, each utterance and each word were indexed in order to count and access them. Finally, the statistical tests were run in Stata.

¹ The other text are “Tuesday evening, around eight”, “11:21 pm” and “4:38 am”

3.4 Coding

Regarding our measures of planning and referentiality, the following variables were coded: pauses, prolonged syllables, and anaphoric and non-anaphoric noun phrases (NP).

We specifically coded pause production, distinguishing between filled pauses and empty pauses (only pauses longer than 0.5 seconds were considered). Duration of empty pauses was annotated with numerical values in parentheses, for example, there is a 1.2 seconds pause within the following utterance:

*CHI: Había una abuela que tenía allí a un gato (1.2) y estaba mirando la televisión .

Respecting their syntactic position, it was indicated whether the empty pauses were produced as an initial pause before utterance or within utterance. Filled pauses were annotated with the character & before the expression, as in &ah, &eh, &hm. Prolonged syllables were annotated with a colon within the word as in:

*CHI: y los sapo:s volaban .

NPs were classified as definite or indefinite, identifying additionally whether definite NPs were anaphoric or non-anaphoric. By doing this, we counted the definite anaphoric NP and the definite non-anaphoric NP. Also, we calculated two ratios: (1) definite anaphoric to indefinites and (2) definite anaphoric to definite non-anaphoric. Finally, we measured the evolution of these ratios over the story, distinguishing a first and a second half², specific to each participant. We also

² For example, one participant produced 30 NP, so we calculated a ratio for the first 15 instances and a ratio for the last 15 instances, meanwhile other participant produced 42 NP, so both halves have 21 instances.

calculated these ratios as a continuous variable through time, calculated as the cumulative ratio at each instance³.

The variables were normalized either by the total number of words or by the total number of utterances according Table 1. To obtain the proportion of each type of pause, they were normalized by the total number of pauses. A summary of the variables is shown in Table 1, where tp is the total number of pauses, tw the total number of words, and tu the total number of utterances. In this way, the proportion of filled pauses versus empty pauses is obtained by comparing nfp/tp and nep/tp , and their presence in the narrative can be measured by observing nfp/tw and nep/tw . Likewise, $nepb/tp$ indicates the proportion of empty pauses before utterances with respect to the total number of pauses, and $nepb/tu$ allows to measure their presence with respect to the total number of utterances.

Table 1. Summary of variables

Type variable	Measure	Normalized variable
Pauses	Number of filled pauses (nfp)	$\frac{nfp}{tp}, \frac{nfp}{tw}$
	Number of empty pauses (nep)	$\frac{nep}{tp}, \frac{nep}{tw}$
	Length of empty pauses (lep)	Mean length of empty pauses ($mlep$)
	Number of empty pauses before utterances ($nepb$)	$\frac{nepb}{tp}, \frac{nepb}{tu}$

³ For example, the definite anaphoric to indefinites ratio was calculated as $da/(ind + 1)$ (to avoid diving by zero). After five instances corresponding to three definite anaphoric and two indefinites, the ratio was one. Being the next instance an indefinite, the ratio drops to 0.75.

	Length of empty pauses before utterances (<i>lpb</i>)	Mean length of empty pauses before utterances (<i>mlpb</i>)
Prolonged syllables	Number of prolonged syllables (<i>nls</i>)	$\frac{nls}{tw}$
Noun Phrases	Ratio of definite anaphoric NP to definite non-anaphoric NP	$\frac{da}{dna}$
	Ratio of definite anaphoric NP to indefinites NP	$\frac{da}{ind}$

4. Results

After providing some descriptive statistics of the TD and ASC groups, the main results of the study are shown. Only significant group differences are reported (p-value less than 0.05). Independent t-test were run to compare the mean of the variables between TD and ASC groups.

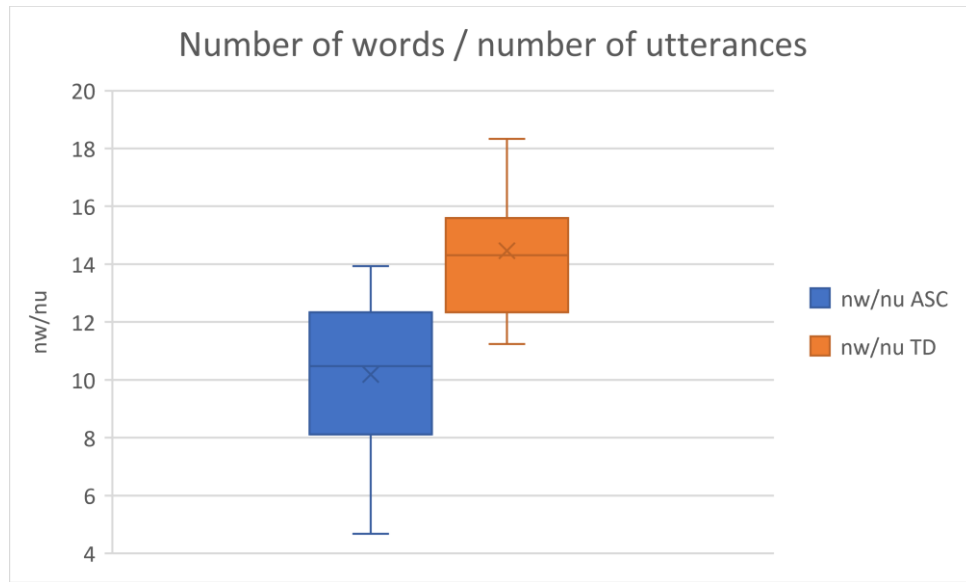
4.1 Descriptive statistics

Table 2. Demographic features of ASC and TD groups.

Group	Number of participants	Male participants	Age	Verbal IQ
ASC	18	17	9;11 (7;4-12;6)	99.3
TD	19	17	9;9 (6;8-12;10)	99.4

Although both groups produced a similar number of words, the TD group produced more words per utterance, i.e. utterances produced by the ASC group were shorter than those produced by the TD group (ASC: $mean = 10.19$; TD: $mean = 14.46$; $t(35) = 4.9033$, $p = 0.0001$).

Figure 1. Number of word to number of utterances ratio, for ASC and TD groups.

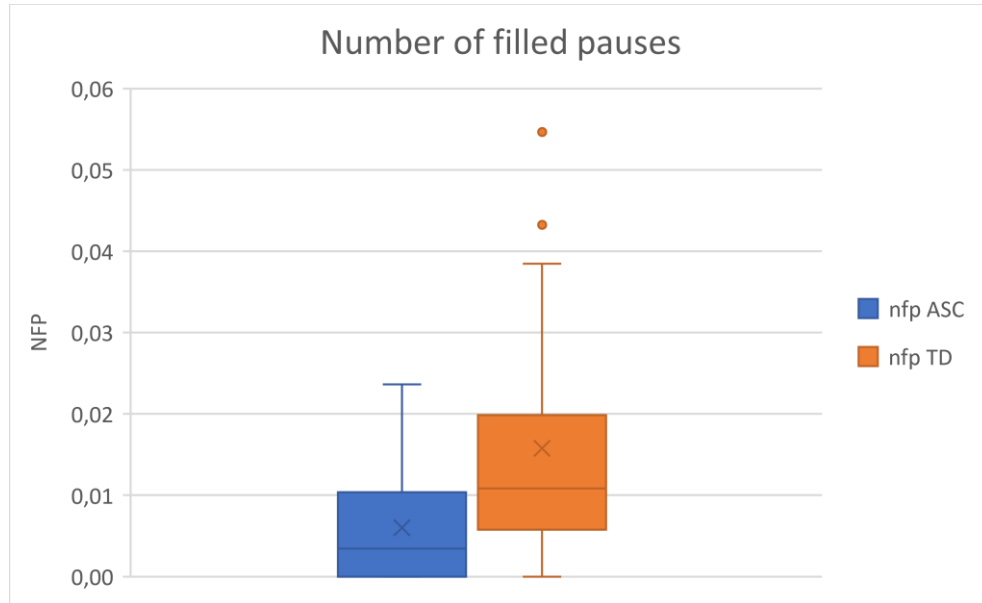


4.2 Pause production

Regarding the variables related with pause production, there were no significant differences in the number of empty pauses (within and between utterances). However, the number of filled pauses differed significantly. Moreover, the respective proportions of filled and empty pauses (out of the total of pauses produced), showed a very different distribution in both groups. While in the ASC group, only a 12% of the pauses were filled (88% of empty pauses), in the TD group this proportion corresponded to 34% (66% of empty pauses).

Figure 2 shows the number of filled pauses produced in the story by both groups and Figure 3 shows the mean length of empty pauses before utterance in both groups. As Figure 2 shows, both groups differed significantly in the number of filled pauses they produced throughout the story (ASC: 0.00599 ± 0.00180 ; TD: 0.01577 ± 0.00345), $t(35) = 2.4734$, $p = 0.0184$.

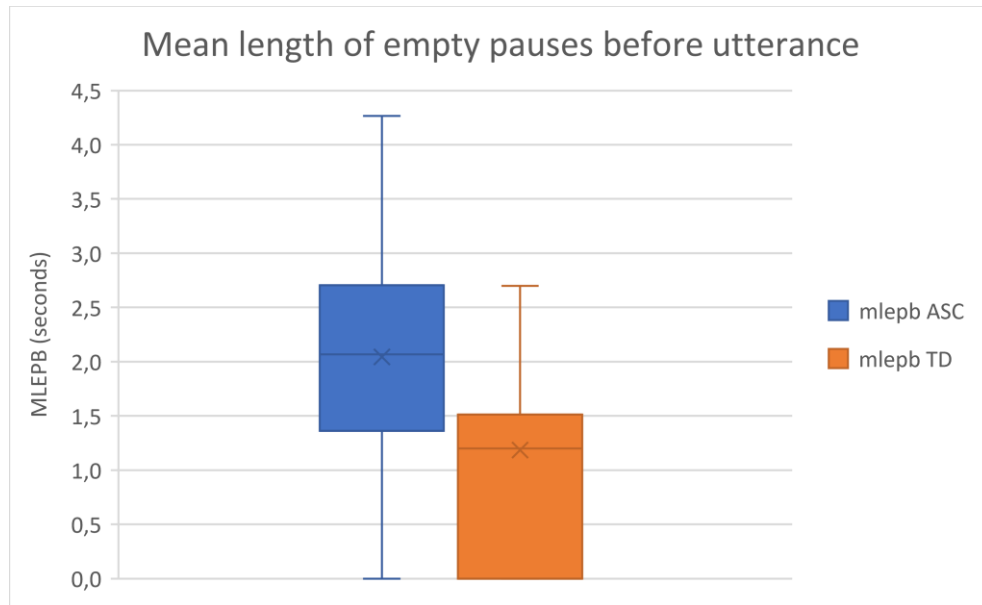
Figure 2. Number of filled pauses for ASC and TD groups⁴.



As can be seen in Figure 3, ASC group produced significantly longer empty pauses before utterance than TD group (ASC: 2.04433 ± 0.30446 ; TD: 1.18355 ± 0.19808), $t(35) = -2.3952$, $p = 0.0221$. Considering that the groups did not differ in the number of empty pauses (before or within utterance), this result could reflect planning difficulties instead of more planning, when dealing with the new information to deliver and presented through the pictures.

⁴ Normalized by the total number of words.

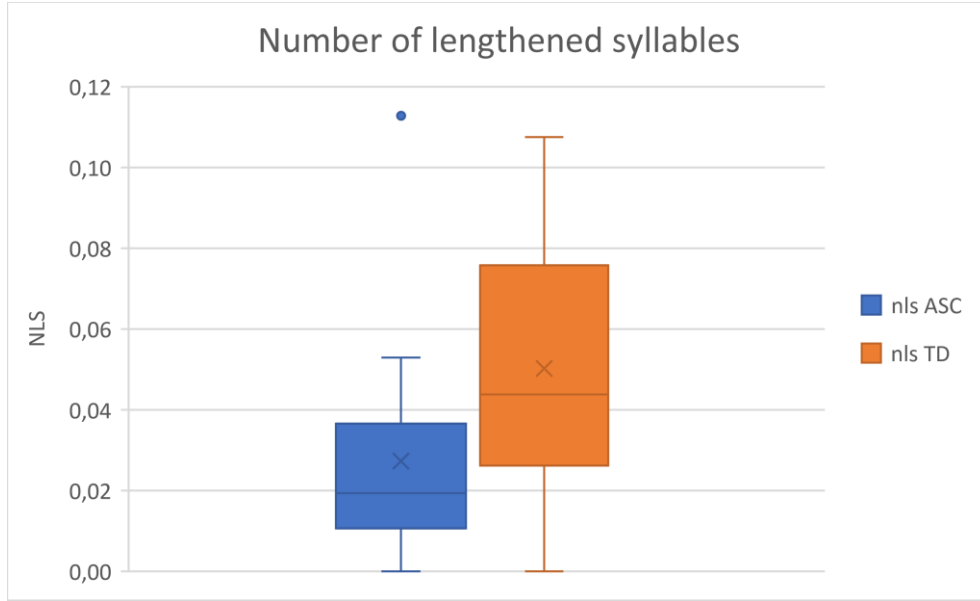
Figure 3. Mean length of empty pauses before utterance for ASC and TD groups.



4.3 Prolonged syllables

Figure 4 shows the number of prolonged syllables produced in the story by both groups. This shows that both group differ significantly in the number of prolonged syllables they produced throughout the story (ASC: 0.02726 ± 0.00627 ; TD: 0.05022 ± 0.00682), $t(35) = 2.4713$, $p = 0.0185$. This result goes in the same direction as that shown in Figure 2. Both the number of filled pauses and the number of prolonged syllables could be reflecting more planning in the TD group.

Figure 4. Number of prolonged syllables for ASC and TD groups⁵.



4.4 Referentiality

Figure 5 shows a box-plot graph of the ratio da/dna (definite anaphoric to definite non-anaphoric) for the ASC and TD groups. This variable was calculated considering the number of instances produced of each type with respect to the total of them produced in each half. This shows there was a noticeable increase in the ratio for TD children, from the first to the second half (TD_1 : 2.57903 ± 0.36509 ; TD_2 : 3.90159 ± 0.26820 ; $t(35) = -2.8933$; $p = 0.0065$). The difference between first and second half is significant for TD children, while the same difference is not significant for ASC children (ASC_1 : 2.78073 ± 0.36034 ; ASC_2 : 3.78333 ± 0.81996 ; $t(31) = -1.0954$; $p = 0.2818$). In other words, the dynamical distribution of the use of these references is different at comparing both groups. For the ASC group, this means that the production of definite

⁵ Normalized by the total number of words.

anaphoric references increases less throughout the story, in relation to the production of definite non-anaphoric references, than in TD group.

Figure 5. Definite anaphoric to definite non-anaphoric ratio for ASC and TD groups at first and second half⁶.

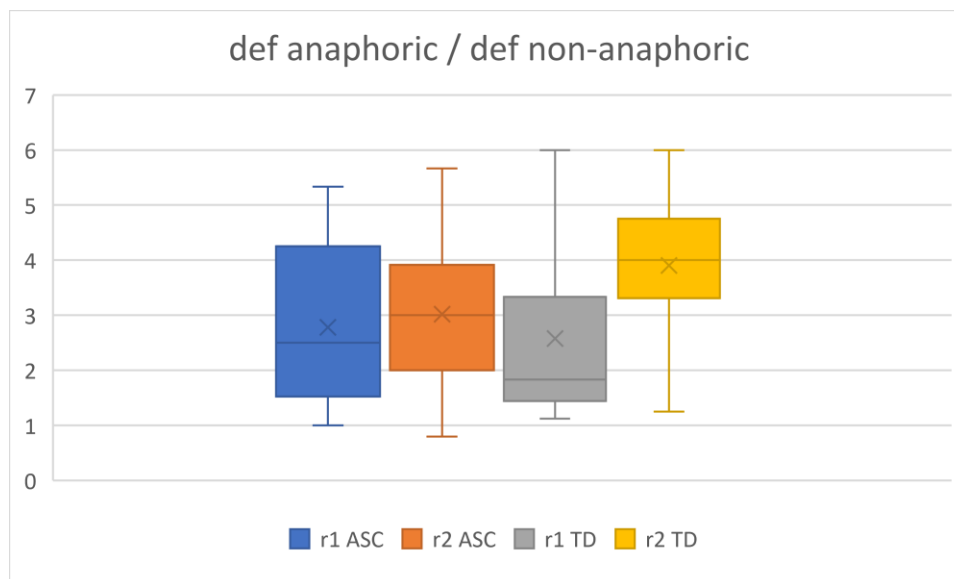


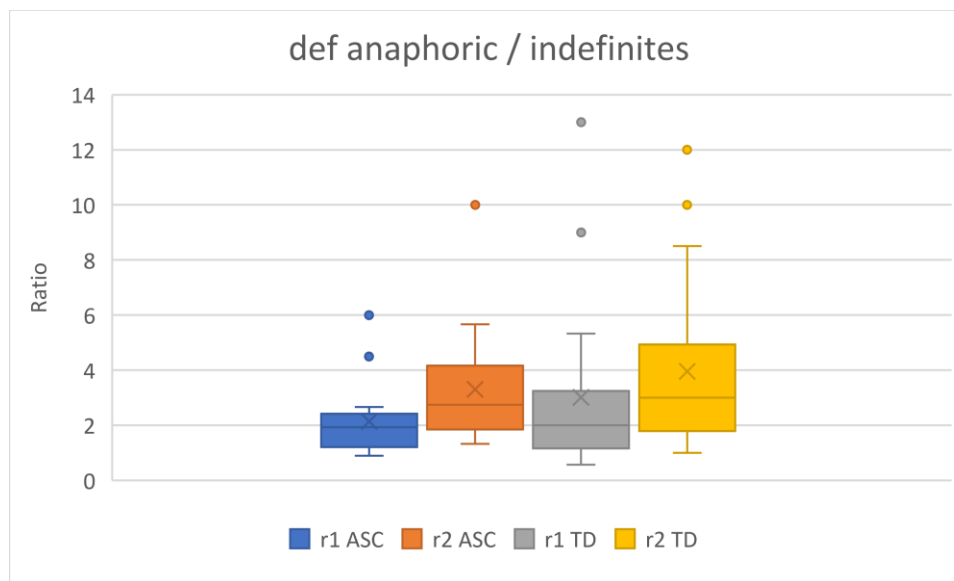
Figure 6 shows a box-plot graph of the ratio da/ind (definite anaphoric to indefinites) for ASC and TD groups. Unlike in Figure 5, which shows the ratio da/dna , the ratio da/ind increased in both groups over time, although not significantly⁷⁸. That is to say, in this respect the stories of both groups share a similar dynamical distribution.

⁶ One observation with a score ratio of 16 for the ASC group, in the second half, was excluded for graphic purposes. The analysis of the results does not change.

⁷ $ASC_1: 2.14665 \pm 0.30206$; $ASC_2: 3.30324 \pm 0.49483$; $t(34) = -1.9950$; $p = 0.0541$.

⁸ $TD_1: 3.01493 \pm 0.72190$; $TD_2: 5.28079 \pm 1.17565$; $t(36) = -1.6424$; $p = 0.1092$.

Figure 6. Definite anaphoric to indefinite ratio for ASC and TD groups at first and second half.



The previous results can be generalized a little more and made more accurate. To do this, we calculated the cumulative ratio at each instance, for each participant. To make the different ratios between different participants comparable, we partitioned the instances into smaller sets of instances, and calculate the average ratio at each one. This is shown in Figure 7, for the ratio *da/ind*. Although Figure 7 shows an increasing tendency of the ratio in both groups, there was no significant increase from one unit to another (i.e. there was no statistically significant difference between consecutive ratios). However, it shows three relevant findings: (1) there is a similar shape of increase, (2) in the first thirty percent of the instances, both groups differ in the *speed* at which the ratio evolves, and (3) the ratio is consistently lower for ASC group than for TD group.

Figure 7. Average ratio of definite anaphoric to indefinites along the story.

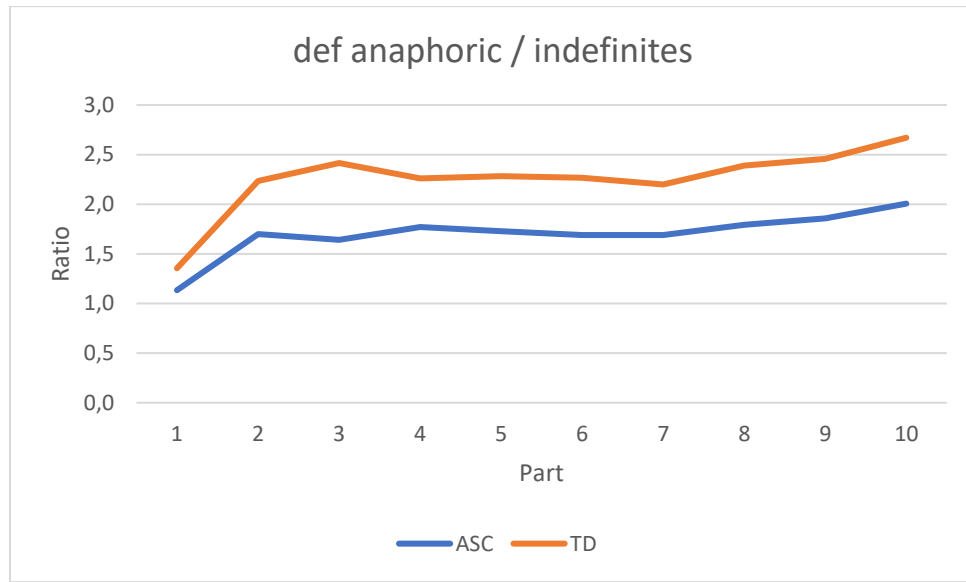


Figure 8 and 9 complement the previous analysis, by showing the cumulative ratio *da/ind* for each participant. Also, similar results, on a different scale, are observed when calculating the cumulative ratio *def/ind* (all definite NPs to indefinites). The latter is shown in Figures 10, 11 and 12.

Figure 8. Ratio of definite anaphoric to indefinites along the story, for each ASC participant.

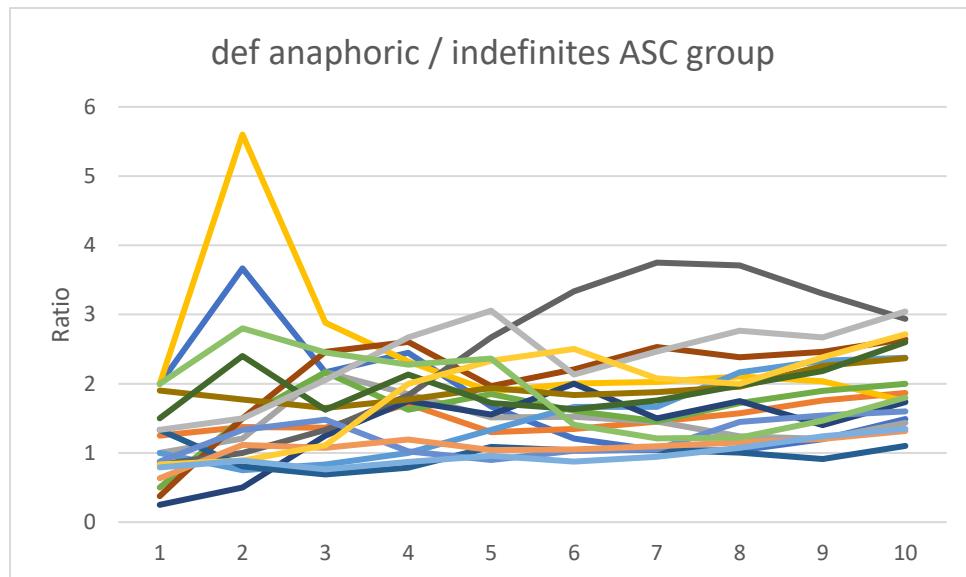


Figure 9. Ratio of definite anaphoric to indefinites along the story, for each TD participant.

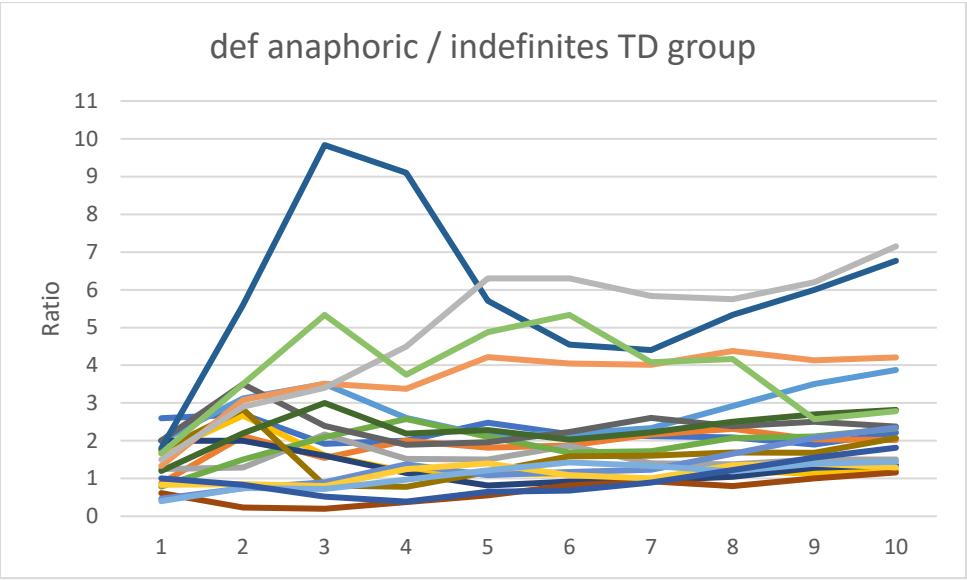


Figure 10. Average ratio of definite to indefinites along the story.

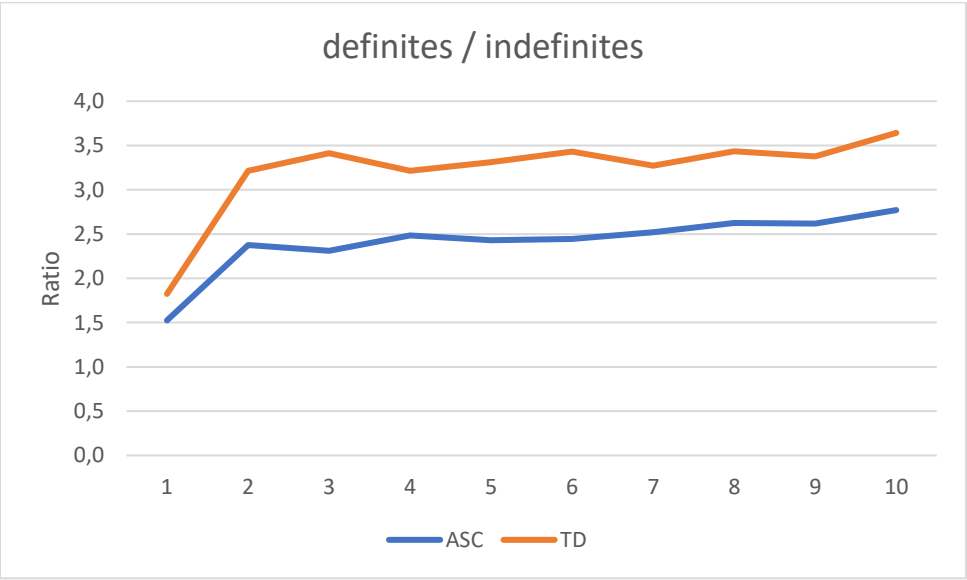


Figure 11. Ratio of definite to indefinites along the story, for each ASC participant.

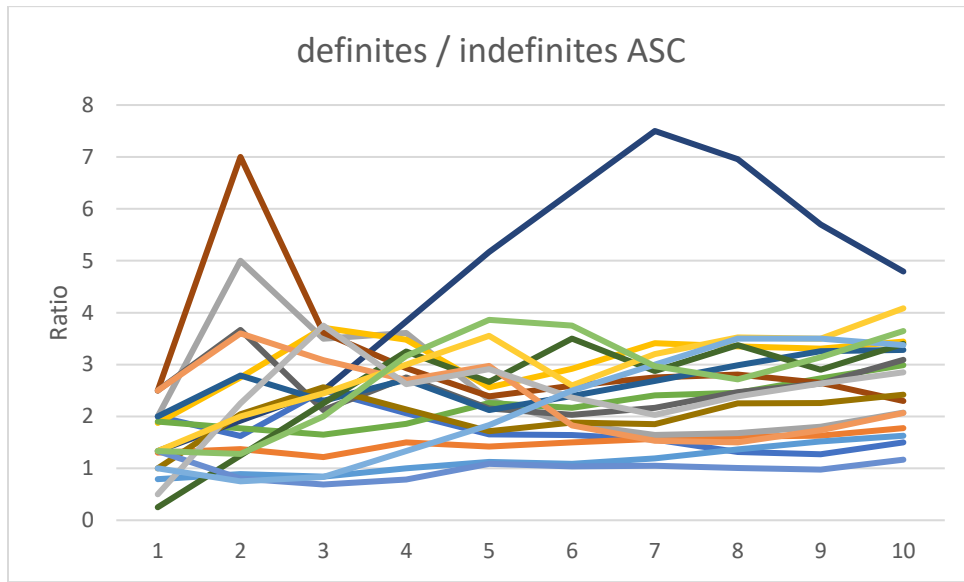
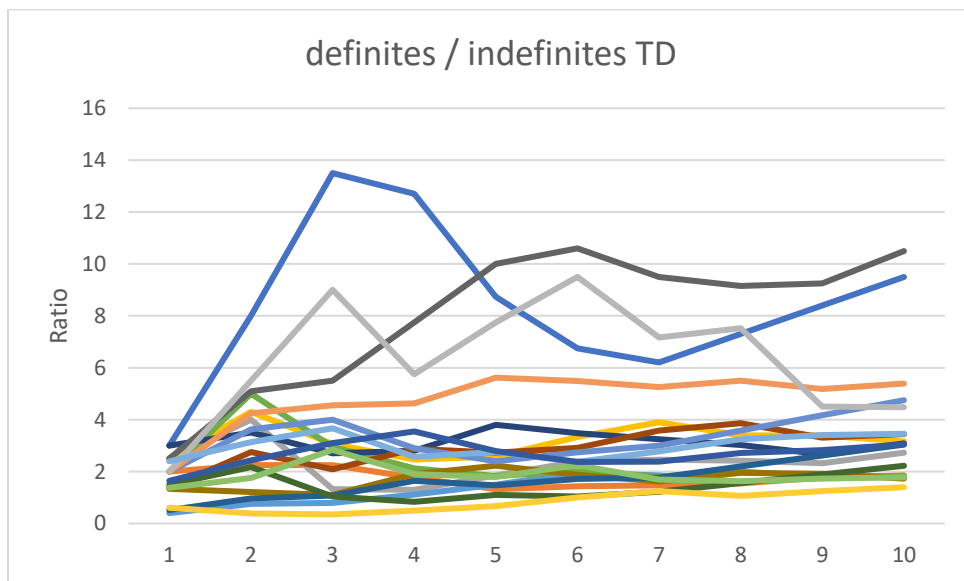


Figure 12. Ratio of definite to indefinites along the story, for each TD participant.



5. Discussion

5.1 Pause production, prolonged syllables and planning

Regarding pause production and prolonged syllables, the results are aligned with the prediction of the hypothesis. That is, children with ASC produce more filled pauses and prolonged syllables, which would indicate a lower level of speech planning.

It is also interesting to note that, meanwhile both groups produced a similar number of empty pauses, the empty pauses before utterance were longer in ASC group. This could reflect a difficulty at coping with the information just presented or simply a different speech planning strategy. We are inclined for the first option because, in many cases, these long pauses were produced just after the stimulus of the pictures was presented (when turning the page). Also, overload and working memory deficits in high-functioning adolescents with autism spectrum disorders have been found through neuroimaging (Barendse et al., 2013).

On the other hand, there are some things that could contaminate the results and that would be necessary to control in similar experiments. First, interviewer interaction styles (there were four interviewers) could have some effect on the production and duration of pauses. For example, to sustain the attention, some interviewers also produced filled pauses during the empty pauses of some children. Second, to induce the narrative, some few cases rather resembled a question-answer structure than a narrative one.

5.2 Referentiality

Regarding the use of referential devices over time (or story development), the analyzed ratios (da/dna and da/ind) show an increasing tendency. This is rather intuitive: as the story progresses, more anaphoric references and less non-anaphoric references appear. However, this tendency is only significant in the TD group (when partitioning the instances in two halves) in relation to the da/dna ratio. As the only difference between these ratios is the denominator (number of definite anaphoric references and number of indefinites, respectively), we can suggest that problems arise in relation to sustain the connection between references instead of the use of appropriated syntactical rules.

In order to generalize these results and understand the dynamical distribution of these ratios, similar studies with different stories should be carried out, to be able to rule out that the differences are due to the story or the type of task (to read from a picture book instead of narrating personal experiences, for example).

Exophoric reference also could confound the interpretation of the results. Since the references of the story are introduced by pictures, it is possible to refer to them as definite non-anaphoric without have introduced them before by an indefinite reference, as it would be the case at narrating a story without a visual support. Also, given the nature of the visual support used to induce the story-telling (the children have to turn the pages so they can see their content), it is also possible to induce the production of utterances only contextual to each pair of pages observed at the same time. Thus, it would be unusual to find complete utterances referring different pages.

6. Conclusions

In this work we have addressed speech planning and use of referentiality in narratives from children with ASC and with TD. We consider these indicators as responsible for giving coherence and cohesion to the narratives, a measure of how much the produced utterances are related to each other. The groups were compared in order to verify the hypothesis, that is to say, less indicators of speech planning in the ASC group and a different use of referentiality throughout the development of the story. These results show that children with ASC would be less sensitive to the way of connecting utterances with each other in a narrative structure, where each utterance is intended to contribute to the main goal.

Further studies in this line should also address the understanding of narratives in the population with ASC and try to assess which features are related to a better performance, both in understanding and producing narratives.

Besides, further research should include a comparative analysis of the dynamical evolution the ratios defined in this work. We believe that longer stories and corpus data would improve the significance of these results.

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