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OBSERVING MULTIMODAL SYNTAX IN CHILDREN WITH AND WITHOUT DEVELOPMENTAL LANGUAGE DISORDER DURING A GUESSING GAME

ABSTRACT · *Children with Developmental Language Disorder (DLD) seem to struggle with the syntactic complexity of their speech, especially subordination. Nevertheless, gestures can enhance the use of more complex syntactic structures. Guessing games can be a playful device that facilitates this gesture-speech complexification. Seventeen children with DLD aged 7 to 10, and 17 age-matched controls were video-recorded in two different situations: a guessing game played with one of their parents and spontaneous conversation. Syntactic complexity was analyzed according to clause types, and gestures according to their form. Results showed that, while TD children complexified more their speech during the conversation, no differences were found during the guessing game in terms of clause types. However, the guessing game led children with DLD to use more gestures and more complex utterances, especially subordinate clauses, which were also more articulated with gestures. This finding highlights the beneficial role of gesture in creating syntactic complexity and the contribution of a new playful device that can also facilitate this complexity.*

KEYWORDS · *Multimodality, Syntax, Gesture, Language disorders, Guessing game.*

I. INTRODUCTION

During language acquisition, children benefit from the adult's input not only at the verbal level but also at the gestural one (Capirci et al. 1996; Capirci & Volterra 2008; Guidetti et al. 2014; Morgenstern 2014) through different situations and interactional settings (Bruner 1983; Veneziano 2000). Thus, the type of activity has a pivotal role since it allows the emergence and diversification of discursive genres adapted to the communicative situation (François 2002; Colletta 2022). It also allows the diversification and complexification of gestures which satisfy the various uses and communicative acts specific to each discursive genre (Colletta & Pellenq 2005; Colletta 2022). For children with Developmental Language Disorder (henceforth DLD), who show a delay of at least 18 months compared to typically developing children (henceforth TD) because of the severity and persistence of the language disorder that hinders language production and/or comprehension at all linguistic levels (Leclercq & Maillart 2014), the orchestration between gesture and speech could also be delayed (Lüke et al. 2020). This delay could depend on the specificities of the linguistic difficulties children with DLD face. For instance, morphosyntactic difficulties result in a non-standard use of pronouns, determiners and morphosyntactic markers such as verb, gender and number agreement (Loeb & Leonard 1991), or a lesser use of complex clauses (Leonard 1998).

When studying children's multimodal linguistic and communicative skills, narrative tasks are often used to observe how children (co-)construct discourse with their parents (Kelly & Bailey 2013; Canut 2014; Cremin et al. 2018). However, little is known about the interplay between gesture and speech during playful settings such as board games during which participants have to give clues about items, restraining themselves to say the word to be guessed. Thus, in this study we ask if gestures help 'players' with and without DLD scaffold speech at the syntactic level, while following the game rules.

II. SYNTACTIC COMPLEXITY IN CHILDREN WITH AND WITHOUT DLD

As far as syntactic complexity is concerned, children with DLD are known to produce simpler and shorter utterances than TD children (Leonard 1998; Im-Bolter & Cohen 2007), and they tend to avoid subordination, especially because of the grammatical deficit they experience. This avoidance could be explained by a lack of functional specification in the grammatical elements required to establish interdependence between clauses and, more generally, utterances (Leonard 1995). Morphosyntactic markers for *wh*-questions that could establish a certain degree of linguistic complexity in the child's utterance also seem to be a factor to consider when assessing language abilities in children with DLD (Cahill et al. 2020). Thus, because of their language delay, children with DLD come to master their first dependence relationships between 5 and 7 years of age (Rice et al. 2000).

Moreover, children with DLD do not seem to master the conventional use of relative pronouns that specify the function of the subordinate clause, based on the position of the linguistic unit it depends on in the referential chain (Schuele & Nicholls 2000; Schuele & Tolbert 2001). For instance, Novogrodsky & Friedmann (2006) analyzed 9-to-14 year-old Hebrew-speaking children's ability to produce relative clauses. The DLD group struggled more with relative clauses, whether they were used in subject or object position, but object relatives were especially difficult to master at all ages. Children with DLD seemed to get around these difficulties by using simpler clauses, independent from one another and not embedded syntactically. They also overgeneralized the use of the subject relative pronoun instead of using the object relative when required. As far as French-speaking children are concerned, Delage et al. (2007) found that, compared to TD children, children with atypical development – namely children with DLD, mild-to-severe hearing-impaired children and children with Rolandic Epilepsy – showed a poorer use of subordinate clauses, especially children with DLD.

Nevertheless, children with DLD seem to gradually move from the use of simpler coordination (de Weck 1993) to the production of more complex structures with first entrenchments, such as pseudo-relative clauses or clefts, and then they complexify the degree of interdependence between clauses, to the point that less divergent behaviors are found between children with and without DLD (Blake et al. 2004). Moreover, associating specific topic conversation, linguistic input and language practice and intervention allows children with DLD to complexify their speech, particularly at the syntactic level, as Owen Van Horne et al. (2023) found in their study on curricular science-topic recast therapy. However, although children with DLD often lack subordination in their speech, they strongly rely on gestures, which scaffold speech either by completing utterances or by replacing some of the linguistic segments children seem unable to express verbally (Blake et al. 2008).

III. GESTURES IN CHILDREN WITH AND WITHOUT DLD

Gesture use varies depending on the nature and structure of discursive genres: narratives mostly involve the use of iconic gestures, descriptions lead to a higher production of deictic gestures, whereas a different array of gesture types can be observed during spontaneous conversations depending on the topic (Colletta & Pellenq 2005).

The use of gestures constitutes an important communicative aid, either to facilitate lexical access or to help conceptual planning and structuring (Alibali et al. 2000). The joint action of gesture and speech reduces the cognitive load shared by two modalities during discourse elaboration (Kopp & Bergmann 2017). However, studies on gesture use by children with DLD show heterogeneous results. Some studies found that these children used more gestures (especially iconic ones), which completed or replaced some elements of speech, than TD children (Botting et al. 2010; Mainela-Arnold et al. 2014; Bellifemine 2019). Other studies showed similar gestural behaviors that varied according to the child's profile, the severity of the disorder and the type of task carried out (Wray 2017; Volpin 2021; Bellifemine 2022). For instance, during a picture naming task, Botting et al. (2010) found that English-speaking children with DLD relied more on referential gestures when they lacked lexicon but they also produced more gestures when comprehension was affected. The same results were also obtained by Lavelli & Majorano (2016), who observed gesture use in Italian-speaking children with DLD between 3 and 5 years of age during spontaneous conversation.

When playing board games with specific settings and rules, such as guessing games, de Weck et al. (2010) found that French-speaking children with DLD between 4 and 6 years used more gestures than TD children and they relied more on iconic and deictic gestures often replacing speech, although all children preferred the speech-only modality. Bellifemine (2019), who used a guessing game during which French-speaking children with and without DLD aged from 8-to-11 were shown picture cards of the item they had to give clues about, found two different phenomena. Children with DLD significantly used more gestures than TD children, especially referential iconic gestures. Moreover, although TD children produced fewer gestures, these were mostly non-referential in nature, thus contributing to the conceptual planning of clues.

Games are more and more exploited during children's speech therapy sessions, since they can create a playful context that hides the need to perform. Also, this type of task allows the study of different kinds of linguistic behaviors, not only in children but also in adults, thus highlighting their scaffolding strategies (Ingold et al. 2008; Salazar Orvig & de Weck 2008; Rezzonico 2013; Da Silva 2019; Volpin 2021).

IV. CURRENT STUDY¹

We know little about the benefits children with and without DLD can get from playful devices in order to overcome language difficulties or complexify discourse at the syntactic level, also multimodally. Therefore, we

¹ An Ethics Committee (Sorbonne Nouvelle University) validated the protocol of this study for feasibility (CER-USN-01-2021).

asked if there were differences in speech and gesture use between children with and without DLD. We also asked whether the guessing game created specifically for this research, could influence multimodal syntax in the two groups of children.

Participants

Two groups of children participated in this study, namely 17 children with expressive DLD between 7 and 9 y.o. (mean age: 8;9, SD: 1.02, 4 girls and 13 boys) and 17 age and gender matched TD children (mean age: 9;0, SD: 1.05). All children were all born full-term and were L1 French speakers, although one child with DLD was bilingual (French and Russian) and another could understand Lithuanian. Children with DLD were all previously diagnosed by a Speech pathologist and matched exclusion criteria (no hearing loss, intellectual deficit or acquired brain injury, normal nonverbal IQ, no personality disorder), and they were all doing speech therapy.

Material and procedure

Each child was videorecorded at their home or in a room of their school during two activities. First, they played a guessing game (“The frog guessing game”) with one of their parents. The game is composed of a board on which 21 numbered boxes in the form of hexagonal ponds are placed to create a path leading to a cup full of flies (Figure 1).



Figure 1: the frog guessing game board

The child or the parent moves manually a frog-shaped pawn from box to box every time the child gives clues about an item presented on a computer screen and the parent guesses the target word. The child has access to

the picture of the item as well as to a pre-recorded voice that gives instructions for each item through headphones (“give clues about the item X. Be careful, do not say the word of the item”). The parent is facing the child and does not see the computer screen nor hears the pre-recorded voice. Before starting the game, the game rules were explained examples were given to each participant. No mention of the possibility of using gestures was made since we did not want to bias the children’s gestural behaviors.

Because the average length of the guessing game was 20 minutes, this task was compared to a 20-minute spontaneous parent-child interaction, to see if the game had an influence on the use of multimodal syntax.

Coding

Gesture and speech were annotated on ELAN transcription tool (Sloetjes & Seibert 2016). Below we report the coding methods used for the two modalities.

Utterances and clauses

Utterances were annotated based on syntactic and prosodic criteria used by Parisse & Le Normand (2007), namely a) expression of a full meaning in the utterance, b) presence of a silent pause of at least 400 milliseconds between utterances, c) intonation contours. For each utterance annotated on ELAN we coded its syntactic complexity, thus:

- SIMPLE if it contained only one clause following the canonic SVO order (e.g. “it’s green and yellow”).
- COMPLEX, if it contained at least one dependent clause². In this case, we coded the type of clauses in the utterance, based on the work of Goldberg (1976), Galichet (1980) and Audet (1996):
 - JUXTAPOSED clauses (e.g. “we can play with it [JUXT] it’s for girls”).
 - COORDINATE clauses (e.g. “you can play music with [COORD] and it has many holes on it”).
 - INFINITIVE clauses (e.g. “you use it [INF] to open doors”).
 - CLEFT structures (e.g. “it’s what we do during a ball”).
 - SUBORDINATE clauses (e.g. “what do you do [SUBO] when you turn pages in a dictionary?”).
 - MIXED utterances consisting of different types of clauses (e.g. “it lives in the sea [COORD] and it hunts fish [INF] to eat”).

² Clauses are syntactic units composing the sentence, at the grammatical level, and the utterance, in the oral form. Thus, clauses are parts of an utterance usually built around a verb and accompanied by elements related to it, namely the subject and its complements (Gardes-Tamine 1997).

Gestures

We coded hand/arm/shoulder gestures based on the following three categories, inspired from McNeill's (1992) classification and Müller and colleagues' (Müller 2017; Bressem & Müller 2014; Ladewig 2014; Ladewig & Bressem 2013):

- REFERENTIAL GESTURES, which include: DEICTIC gestures, such as pointing and locative gestures, linked with space; REPRESENTATIONAL gestures, such as metaphoric and iconic gestures, representing respectively abstract and concrete concepts;
- NON-REFERENTIAL GESTURES, namely BEAT gestures which are up-and-down fast biphasic movements that help structure discourse and give rhythm to speech, as they do not convey semantic meaning;
- PRAGMATIC GESTURES, that have recurrent forms and convey conventional meaning like the locutor's stance about what is said in speech, such as the PALM UP, the SHRUG, the CYCLIC GESTURE, and the THINKING GESTURE.

The syntactic clause the gesture accompanied was also coded to see how many gestures were produced for each type of clause.

Inter-rater agreement and statistical analysis

In order to verify the accuracy of our coding, an inter-rater agreement (Cohen 1960) was carried out. 10% of our data (7 video-recordings out of 68) was coded by a researcher, specialized in multimodality. An almost perfect agreement was reached for syntactic structure coding (clause types, >95%; $k=0.892$) and for gesture type coding (>95%; $k=0.830$). We used non-parametric tests (Mann & Whitney 1947) to confirm possible inter-group differences, one-way ANOVA on ranks (Kruskall & Wallis 1952) for within-group differences, and generalized mixed models (Bates et al. 2015) to observe the weight each factor considered had on the use of multimodal syntax.

V. RESULTS

Gesture rate

During the guessing game, we annotated 2619 utterances for the DLD group and 1650 for the TD group. Children with DLD produced 947 gestures and TD children produced 460 gestures. During spontaneous conversation we annotated 2426 utterances and 592 gestures for the DLD group and 2224 utterances and 821 gestures for the TD group. Figure 2 shows the gesture-speech rate for each group and activity, out of the total number of utterances.

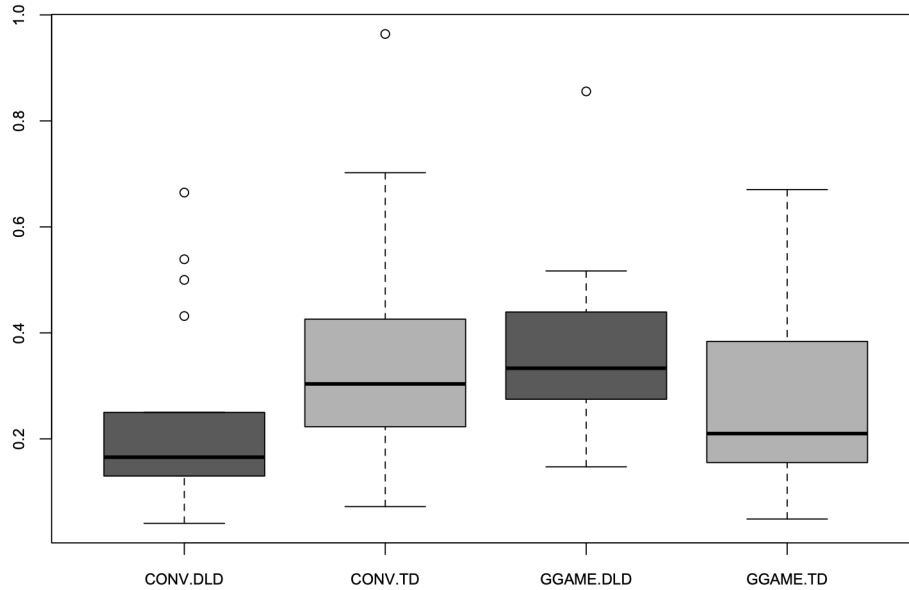


Figure 2: Gesture-speech rate for each group and activity

Although the rate values show that both groups produced almost one gesture per 3 utterances during the guessing game, children with DLD showed a tendency ($W=200$, $p=0.05$) to produce more gestures (rate: 0.32; SD: 0.15) than TD children (rate: 0.27; SD: 0.16). During spontaneous conversation, children with DLD produced significantly ($W=81$, $p=0.02$) fewer gestures (rate: 0.24; SD: 0.18) than TD children (rate: 0.36; SD: 0.22), namely one gesture per 5 utterances for the DLD group and one gesture per 3 utterances for the TD group.

Within-group comparisons revealed that children with DLD used significantly more gestures during the guessing game ($W=65$, $p=0.006$) compared to spontaneous conversation, whereas we did not find any significant differences for the TD group ($W=180$, $p=0.23$). Thus, at the quantitative level, the type of activity had an influence on gesture use only for children with DLD.

Gesture types

We also analyzed the types of gestures used by the two groups in each task, as Figure 3 shows.

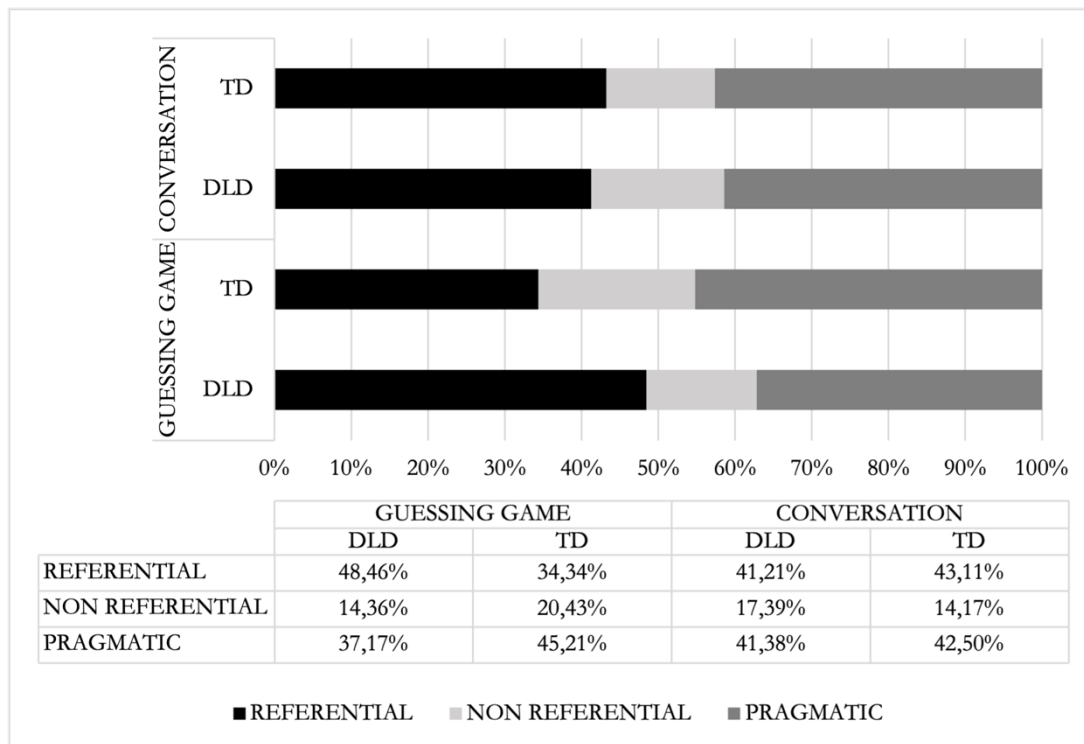


Figure 3: percentage of gesture types (referential, non-referential, pragmatic) based on group and activity

Overall, all children mostly used referential and pragmatic gestures. When comparing the two groups for each activity, statistical analysis only confirmed that the DLD group used more referential gestures than the TD group ($W=218$, $p=0.01$) during the guessing game but no differences were found during spontaneous conversation. Moreover, within-group comparisons did not reveal significant differences in relation to the type of activity. In other words, the two groups of children did not use the three types of gestures differently from one activity to another.

However, we found a significant effect of gesture type within each activity. During the guessing game, children with DLD ($\chi^2_{(2)}=26.98$, $p<0.0001$) produced more referential gestures than beats ($W=280$, $p<0.0001$) and pragmatic gestures ($W=213$, $p=0.01$), but more pragmatic gestures than beats ($W=38.5$, $p=0.0002$). We also found a significant effect of gesture type ($\chi^2_{(2)}=15.06$, $p=0.0005$) for TD children. Indeed, they produced more referential gestures ($W=217$, $p=0.01$) and pragmatic gestures ($W=248$, $p=0.0003$) than beats, but only showed a tendency to produce more pragmatic than referential gestures ($W=200$, $p=0.05$). We also found a significant effect of gesture type in the DLD group ($\chi^2_{(2)}=15.33$, $p=0.0004$) and the TD group ($\chi^2_{(2)}=26.55$, $p<0.0001$) during the conversation. Children with DLD produced more referential ($W=47.5$, $p=0.0008$) and pragmatic gestures than beats ($W=46$, $p=0.0007$) but no difference was found between pragmatic and referential gestures ($W=152.5$, $p=0.79$). TD children also produced more referential ($W=12$, $p<0.0001$) and pragmatic gestures ($W=20.5$, $p<0.0001$) than beats, but no difference was found between pragmatic and referential gestures

($W=126$, $p=0.54$). Thus, we can conclude that the two groups of children showed similar gestural behaviors during the two activities.

Syntactic complexity

To study syntactic complexity in children’s speech, we analyzed the proportion of COMPLEX and SIMPLE utterances for the two groups in each activity (Figure 4).

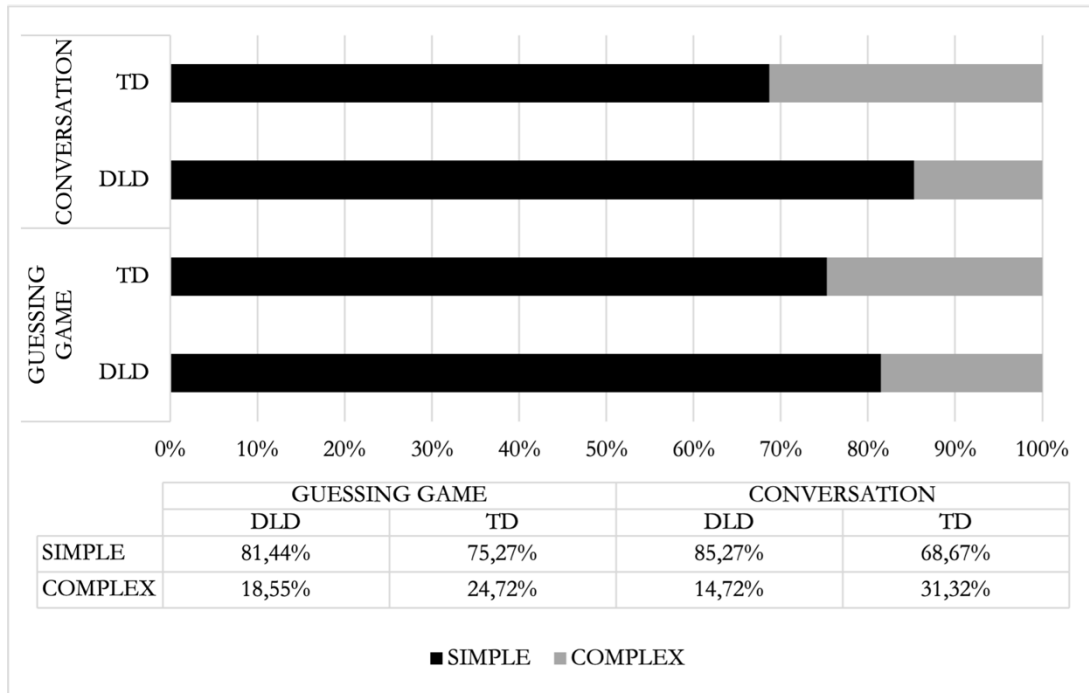


Figure 4: percentage of COMPLEX and SIMPLE utterances for each group and activity

Overall, although all children preferred simple utterances, TD children produced more complex utterances than children with DLD during conversation ($W=25$, $p<0.0001$) but not during the guessing game ($W=98.5$, $p=0.11$). Within-group comparisons across activities showed that TD children used more complex utterances during the conversation compared to the guessing game ($W=212.5$, $p=0.02$). Conversely, the DLD group did not show any differences between the two activities as for complex utterances ($W=107$, $p=0.20$). Thus, at the quantitative level, they were able to complexify their speech syntactically to the same degree, whereas TD children complexified slightly more their utterances while interacting with their parents.

To see whether there were any differences in the use of clause types within children’s complex utterances, we counted the actual number of clauses by disassembling especially MIXED utterances that contained different clause types, as well as complex utterances with more than one dependent clause of the same type. Table 1 shows the rate for each type of clause out of the total number of utterances. The p values reported were obtained from the comparison between activities for each group.

Table 1: clause type rate for each group and activity

	DLD					TD				
	GUESSING GAME		CONVERSATION			GUESSING GAME		CONVERSATION		
	M (SD)	Range	M (SD)	Range	p	M (SD)	Range	M (SD)	Range	p
JUXTAPOSED	0.03 (0.03)	0-0.13	0.03 (0.03)	0-0.12	0.73	0.03 (0.03)	0-0.08	0.06 (0.03)	0.02-0.13	0.01*
COORDINATE	0.04 (0.02)	0-0.07	0.04 (0.04)	0-0.10	0.74	0.05 (0.03)	0-0.13	0.07 (0.02)	0.05-0.12	0.01*
INFINITIVE	0.04 (0.02)	0-0.08	0.03 (0.01)	0-0.08	0.28	0.05 (0.02)	0-0.1	0.07 (0.04)	0.02-0.20	0.09
CLEFT	0.04 (0.06)	0-0.08	0.009 (0.01)	0-0.03	0.58	0.05 (0.02)	0-0.1	0.02 (0.02)	0-0.11	0.03*
SUBORDINATE	0.10 (0.14)	0-0.52	0.05 (0.04)	0-0.17	0.04*	0.16 (0.06)	0.03-0.29	0.19 (0.11)	0.07-0.38	0.45

As for inter-group comparisons, since we know that TD children complexified more their utterances than DLD children during spontaneous conversation, we found significant differences for all clause types (JUXTAPOSED: W=63, p=0.005; COORDINATE: W=63, p=0.005; INFINITIVE: W=23.5, p<0.0001; CLEFT: W=81, p=0.02; SUBORDINATE: W=26, p<0.0001).

During the guessing game, the two groups had similar behaviors in terms of clause types as the rate values show little differences, and statistical analyses confirmed the absence of inter-group differences. Examples (1) and (2) below illustrate this result. 9 y.o. Max, with DLD, and 9.o. Hanna, TD, give clues about the item ‘balloon’.

(1) Max, DLD

CHI3: *ça peut être gonflé et ça peut être explosé*
it can be inflated **and it can be exploded**
MOT2: *ça sert à quoi ?*
what is it for?
CHI4: *on peut gonfler et si on utilise quelque chose*
You can inflate **and if you use something**
ça peut exploser
it can explode
MOT3: *un ballon ?*
a balloon?

(2) Hanna, TD

CHI3: *c'est quelque chose où on peut gonfler dedans*
it is something **where you can inflate inside**
MOT2: *on peut gonfler ou on gonfle la chose ?*
you can inflate or you inflate the thing?
CHI4: *on gonfle et euh (+) c'est souvent pour les*
you inflate **and hum (+) it is often for**
anniversaires
birthdays

Max uses a coordinate clause to give two distinct clues about the object his mother has to guess, whereas Hanna uses a subordinate clause to give a single clue about the salient feature of the balloon. However, these clues are not enough for both mothers to immediately guess the item, and they ask for clarifications: Max’s mother asks about the use of the object, probably because the boy used the pronoun *ça* (‘it’) which does not have any particular meaning without context; Hanna’s mother requests to have a more precise semantic definition of the verb *gonfler* (‘inflate’), particularly about the agent who does the action. The two children then give more precise information in their following answer: Max uses a coordinate clause in which we can find an embedded subordinate clause adding a new clue through the expression of a hypothetical situation, while Hanna uses a coordinate clause to link the first segment of her answer through which she gives more precise information

about the verb ‘inflate’, and the moment in time when the object is used. Thus, we can see that the same types of clauses are used by the two children to give clues about the same item.

Focusing now on within-group comparisons across activities, TD children produced more juxtaposed ($W=215$, $p=0.01$) and coordinate clauses ($W=213$, $p=0.01$) as well as cleft structures ($W=203$, $p=0.03$) during spontaneous conversation compared to the guessing game. On the contrary, children with DLD showed lesser variability across activities and the only statistical difference we found concerned subordinate clauses ($W=87$, $p=0.04$) which were double in frequency during the guessing game. Thus, we can conclude that the guessing game helped children with DLD complexify slightly more their utterances.

Multimodal syntax

Lastly, we focused on multimodal clauses to determine if gestures helped the establishment of syntactic complexity. Since we know that children with DLD struggle with subordination, we expected to find more gestures accompanying these syntactic structures. We used regression models to see which factors influenced the use of gestures. The 44 children represented the random effect of the model; the production of a gesture was the dependent variable. Independent variables were: group type (TD vs. DLD), age (7-8, 9, 10), utterance complexity (simple vs. complex), clause type and the activity (conversation vs. guessing game).

Table 2: regression model – gesture production

Fixed Effects	Est*	S.E.	z	p	Random Effects	Var.	S.D.	C-Value
Gesture production								0.74
Intercept	-2.17134	0.98452	-2.205	0.02*	Children	0.4307	0.6562	
Group: DLD	0.09959	0.23358	0.426	0.669				
Age	0.09318	0.10835	0.860	0.38980				
Utterance: Complex	0.76151	0.06018	12.654	<.0001***				
Clause: Subordinate	18.11958	5.87596	3.084	0.002**				
Activity: Game	0.20862	0.05325	3.918	<.0001***				

Number of obs: 8879, groups: CHILD, 34

The best fitted model showed a significant effect due to syntactic complexity ($p<0.0001$). Children used more gestures when producing complex utterances, especially containing subordinate clauses ($p=0.002$). Moreover, the type of activity influenced significantly the use of gestures ($p<0.0001$). Indeed, compared to the conversation, children produced more gestures during the guessing game, confirming what we previously found. Conversely, the model did not show any effect of group or age.

Then, we conducted finer analyses by calculating a gesture-clause rate out of the total number of each clause type (Table 3).

Table 3: gesture-clause rate based on group and activity

	DLD					TD				
	GUESSING GAME		CONVERSATION			GUESSING GAME		CONVERSATION		
	M (SD)	Range	M (SD)	Range	p	M (SD)	Range	M (SD)	Range	p
MAIN	0.28 (0.22)	0-0.93	0.16 (0.15)	0-0.38	0.008*	0.18 (0.26)	0-1	0.20 (0.16)	0-0.55	0.38
JUXTAPOSED	0.23 (0.36)	0-1	0.17 (0.24)	0-0.66	0.14	0.09 (0.15)	0-0.5	0.31 (0.27)	0-1	0.01*
COORDINATE	0.36 (0.28)	0-1	0.31 (0.31)	0-1	0.07	0.26 (0.23)	0-0.66	0.29 (0.24)	0-0.75	0.38
INFINITIVE	0.20 (0.14)	0-0.8	0.17 (0.22)	0-0.5	0.62	0.13 (0.31)	0-1	0.20 (0.18)	0-0.71	0.27
CLEFT	0.20 (0.28)	0-1	0.29 (0.19)	0-0.66	0.45	0.11 (0.08)	0-0.28	0.49 (0.58)	0-1.33	0.01*
SUBORDINATE	0.47 (0.35)	0-1.5	0.27 (0.25)	0-0.69	0.006**	0.27 (0.39)	0-1.6	0.34 (0.27)	0-0.95	0.59

Inter-group comparisons revealed that, although all children relied on simpler utterances during the guessing game, and even though we did not find any significant difference between the two groups as far as clause types are concerned, children with DLD produced more gestures accompanying all types of clauses. However, statistical differences were found only for juxtaposed ($W=203.5$, $p=0.02$) and subordinate ($W=212$, $p=0.02$) multimodal clauses produced by the DLD group (JUXTAPOSED: 0.23, SD: 0.36; SUBORDINATE: 0.47, SD: 0.35), compared to the TD group (JUXTAPOSED: 0.09, SD: 0.15; SUBORDINATE: 0.27, SD: 0.39). During spontaneous conversation, even though TD children complexified more their utterances and produced more gestures than children with DLD, statistical analysis revealed that they only produced more multimodal main clauses ($W=87$, $p=0.04$) and multimodal subordinate clauses ($W=84.5$, $p=0.03$).

Within-group comparisons varied across groups. TD children produced more multimodal juxtaposed clauses ($W=209$, $p=0.01$) and multimodal cleft structures ($W=203.5$, $p=0.01$) during the conversation. This result is potentially linked to differences in the discursive and dialogical sequences established during this activity, which has a higher degree of freedom in terms of conversational topics. As for children with DLD, they produced more multimodal main clauses ($W=68$, $p=0.008$) and multimodal subordinate clauses ($W=65.5$, $p=0.006$) during the guessing game.

Example (3) illustrates the use of multimodal subordinate clauses in children with DLD during the game.

(3) Clara, DLD

CLA12: *tu sais le truc qu'on prend avec qu'on p(rend)*

[ICO]

you know the thing that you take with that you t(ake)

[ICO]

CLA13: *les trucs dans les fêtes qui éclatent si jamais (+) tu le mets quand ça pique*

[ICO]

[MET]

[LOC]

[ICO]

the things at parties that explode if (+) you put it* when it pinches

[ICO]

[MET]

[LOC]

[ICO]'

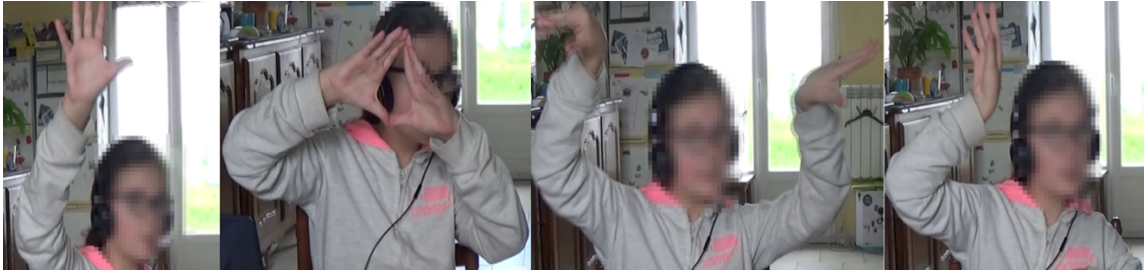


Figure 5: gestures accompanying subordinate clauses

Clara has to give her mother clues about the item ‘balloon’. The noun phrases used in her main clauses are each followed by subordinate clauses. In CLA12, the child hesitates when giving her first clue, and produces an iconic gesture within the subordinate clause which is then interrupted when Clara struggles to plan her speech. Supposedly the balloon represented by the iconic gesture is attached up on the ceiling, so she moves her right arm upwards, the palm of her hand facing her interlocutor. Then, in CLA13, she gives information about where you can find the object – at parties – and what it does – it explodes. She produces another iconic gesture reproducing the shape of the balloon with the noun phrase *fêtes* (‘parties’) in the main clause, thus giving complementary nonverbal clues through her gesture. In the following entrenched subordinate clauses, she specifies her clues and says that ‘it explodes’: she synchronizes the verb ‘to explode’ with a metaphoric gesture materializing the explosion of the balloon. Finally, in the second subordinate clause expressing hypothetical circumstances, she produces a deictic anaphoric gesture with the verb ‘to put’: she places the balloon, embodied with her right hand, in the same spot she produced her first iconic gesture in CLA12.

In conclusion, our main results put subordination in the spotlight, since it is the type of clause that is most frequently accompanied by more gestures in the two groups. If TD children produce gestures with subordinate clauses to reinforce the content of their utterances, children with DLD seem to use them to overcome grammatical and morphosyntactic difficulties, probably due to the language disorder, that could hinder the planning of subordinate clauses.

VI. DISCUSSION

The goal of our study was to determine whether gestures and speech articulate differently in 7-to-10-year-old French-speaking children with and without Developmental Language Disorder during a guessing game compared to spontaneous conversation with their parents. The ultimate aim was to see if the guessing game could facilitate a multimodal syntactic complexification of children’s speech.

In terms of gesture use, children with DLD showed a tendency to produce more gestures than TD children during the guessing game, whereas they used fewer gestures than TD children during the conversation. Because we only found a tendency, our result is not sufficient to support what Botting et al. (2010) observed during their naming task, that is no difference between children with and without DLD, nor what de Weck et al. (2010)

and Bellifemine (2019) found in their studies using a guessing game, namely significantly more gestures in the DLD group. However, when comparing the two types of activities in this study, statistical analyses showed that children with DLD used indeed more gestures during the guessing game than during spontaneous conversation. This result seems to suggest that the degree of freedom of the conversation did not induce children with DLD to rely on more gestures, since their verbal abilities potentially sufficed when interacting with their parents. Indeed, it is possible that these children relied on what they could actually produce in terms of conversational topics and syntactic structures – which were mainly simple utterances – following their Zone of Proximal Development (Vygotsky 1978). Conversely, the guessing game could be considered as a more complex task in terms of rules and constraints that children had to follow, therefore they could rely on more gestures when speech became more complex at the pragmatic level, as stated by de Ruiter et al. (2012). However, it is also possible that the visual stimuli presented during the guessing game influenced the use of gestures by children with DLD, who relied on visual cues to describe the items to be guessed. Qualitative analysis showed that the two groups used more referential gestures than beats and pragmatic gestures, but no real difference was found across activities, except for the abundant use of referential gestures by children with DLD during the guessing game. Indeed, representational gestures helped children with DLD convey especially abstract and concrete concepts that seemed difficult to put into words when gestures were used in a complementary fashion, whereas they reinforced the meaning conveyed verbally in TD children's speech. Overall, our results align with previous studies that show a higher use of referential gestures by children with DLD (Blake et al. 2008; Botting et al. 2010; de Weck et al. 2010; Mainela-Arnold et al. 2014; Lavelli & Majorano 2016; Bellifemine 2019). Conversely, our results diverge from what de Weck et al. (2010) found in their game task, namely more deictic gestures by children with DLD. This could be due to the fact that the selected items they used were printed on the game board, therefore children could point the pictures, whereas in our study the items were displayed on a computer screen. Thus, it could also be argued that the type of material used could influence children's gestural behaviors during the task.

As for syntactic complexity, the two groups showed a similar use of simple and complex clauses during the guessing game whereas TD children complexified their speech slightly more while interacting with their parents. On the contrary, no difference was found within the DLD group across activities. Overall, children with DLD are indeed able to complexify their speech, compared to TD children, regardless of the type of clauses used in their utterances. Based on this general result, our findings converge with what Blake et al. (2004) found in their study on spontaneous language while children narrated a cartoon and described their classroom, namely that no quantitative difference distinguished the two groups of children. However, several differences were found when analyzing clause types across activities. Indeed, based on the fact that TD children complexified more their spontaneous speech, they produced significantly more juxtaposed and coordinate clauses as well as cleft structures, compared to the guessing game task. Thus, it is possible that their clues were more precise, concise and better structured during the guessing game throughout the use of simpler utterances addressed to their

parents. Conversely, during parent-child interaction, they diversified more their clauses depending on the conversational topic, also being free of using whatever structure they wanted to recount past experiences or relating information about the conversational theme. As for children with DLD, they produced significantly more subordinate clauses during the guessing game than the spontaneous conversation with their parents. This finding can be the first 'clue' to suggest that the game helped children with DLD complexify their speech at the syntactic level. Moreover, we did not find any differences between the two groups in relation to the use of subordinate clauses during the guessing game. This finding indicates that children with DLD reached a syntactic level which was close to TD children's. This partly contradicts what other studies found on syntactic complexity in children with and without DLD (de Weck 1993; Delage et al. 2007), namely fewer subordinate clauses during narratives and spontaneous language by children with DLD. Once again, it is possible that the type of activity might have had an influence on children's speech, thus formulating their clues with the same syntactic subordinate structure. Indeed, the planning and phrasing of clues could also follow a specific pattern, that is the topicalization of a referent in the main clause, and the attribution of a quality expressed in the subordinate clause which adds information about the referent. Despite great interindividual variability for the DLD group, we can conclude that the children in our study did not avoid subordination during the game.

Furthermore, if TD children produced more gestures with main and subordinate clauses than children with DLD during spontaneous conversation, during the guessing game children with DLD used significantly more gestures with juxtaposed and subordinate clauses than TD children. As far as juxtaposed clauses are concerned, this finding is surprising since studies show that children with DLD speak at a slower rate than TD children (Scott & Windsor 2000; Redmond 2004). However, using juxtaposed clauses allowed DLD children to give more clues within the same utterance, and to repeat some of the clues they gave beforehand when initiating the item-guessing sequence, especially when parents could not guess the item immediately. Moreover, juxtaposing independent clauses could also reduce the cognitive load in children with DLD to plan more subordinate clauses than needed, thus avoiding the use of grammatical subordinate markers. As for multimodal subordinate clauses, even if our findings show that children with DLD were able to produce subordinate as TD children did, we can hypothesize that their use was backed up by gestures. Therefore, in our study gestures helped establish subordination between clauses, since the gesture-subordinate clauses rate was higher for children with DLD. At the same time, the fact that TD children produced fewer gestures with subordinate clauses could highlight how well they could master speech at the verbal and syntactic level without the support of gestures. This finding can be the second 'clue' to confirm that children with DLD use gestures as a compensatory strategy to support speech and discourse complexity, or as Gullberg (2013:39) said: 'a compensatory tool to bridge the gap between communicative intention and available expressive means'. Even if gestures and speech are strictly interwoven (McNeill 1992), they are not always hindered when speech is hampered in its linguistic planning and conceptualization, or as Gullberg (2013:41) also stated: 'when speech stops, gesture starts. [...] if you do

not know the word for, say, *key*, you perform a gesture in silence pretending to manipulate a key to open a door’.

To sum up, even though we know that narratives usually promote a higher degree of discourse complexity through the establishment of causal and temporal relations between clauses (Kern 2000; Sánchez & Makdissi 2019), the guessing game created for this study enhanced children’s complexification and diversification of syntactic structures as well, especially for children with DLD. However, we should nuance these findings due to the small sample of children in this study. Perhaps, including more participants could either show greater differences between groups, or attenuate them. The degree of severity of the language disorder is also another factor that could influence the group performance, since we know that children with DLD show heterogeneous profiles because not every child struggles with all linguistic levels and in the same manner (Wray et al. 2016; Bellifemine 2022).

In this study, the guessing game – with its own tools and rules, and its linguistic and extra-linguistic features that have to be mastered – helped children with DLD produce more gestures thanks to the visual access to item pictures. For children with DLD, gestures are an aid to complexify speech, while in TD children they facilitate the structure phrasing and reinforce their already complex speech. This possibly means that the game equipment facilitated mental representation, both at the speech and gestural level, thus accessing lexicon through the use of nonverbal clues too. Therefore, possible implications for using a guessing game during speech therapy can be discussed. Communicative experience by children with DLD is supported not only through the interaction with the adult, who can scaffold and reinforce the child’s linguistic skills, but also through gestures (Masson et al. 2017). If the presence of the language disorder affects greatly children with DLD’s communicative abilities, they could potentially be stuck in the use of simpler structures and would not experience syntactic complexity. This could be the same in speech therapy, during which children work to improve the structural dimension of language throughout exercises and strategic devices. Our guessing game represented a situation that children with DLD were less used to, but they still were able to reach syntactic complexity thanks to the use of multimodality in a playful situation that can potentially be part of their everyday life throughout their young years.

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