

An exploratory study of multimodal self-repairs: New insight into the developmental gap between children with and without language disorder

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The aim of this study is to observe the way children with Developmental Language Disorder (DLD) and typically developing children (TD) use gestures during self-repairs in speech. Children with DLD are considered to be more disfluent and less sensitive to speech failures than TD children, but little is known about the way they monitor these communicative breakdowns with the use of gestures. 22 French-speaking children with DLD between 7 and 10 y.o. and 22 age- and gender-matched controls were video-recorded during a narrative task. Lexical, syntactic, and phonological self-repairs were annotated. Referential, pragmatic, and non-referential beat gestures were coded. The modality used during repairs was also analyzed. Results show that speech-only self-repairs were preferred by the two groups. TD children produced more lexical repairs and children with DLD more syntactic repairs. However, TD children used more non-referential beat gestures during multimodal self-repairs, both lexical and syntactic, while children with DLD used more referential gestures, especially during lexical self-repairs. Thus, the language disorder could account not only for a lesser linguistic maturity in children with DLD, but also a lack of functional specialization of beat gestures, which are known to help speech planning and monitoring.

KEYWORDS: multimodality, self-repairs, gesture, disfluency, developmental language disorder, narratives.

1. Introduction

Self-repairs are a linguistic phenomenon that takes place when a failure in speech occurs (Schegloff *et al.* 1977) and speakers mend their message,

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either by correcting themselves spontaneously (self-initiated repair) or with the help of their conversational partner (other-initiated repair). Several studies have observed repair strategies in typically developing (henceforth **TD**) children (for instance, Evans 1985; Laakso 2010; de Pontonx *et al.* 2019), but little is known about the way children with Developmental Language Disorder (henceforth **DLD**) overcome their failures in speech (Barnes & Bloch 2020), especially by relying on different plurisemiotic resources. Children with DLD show difficulties either with language production or language comprehension, and sometimes both (Leonard 2014) and across all linguistic levels. Their lexicon is reduced and they often lack words to complete their utterances (Leonard & Deevy 2004; Mengisidou & Balladares Hernández 2023); they also show difficulties in the semantic association between words and referents (Drljan & Vuković 2019); morphosyntactic deficits can cause problems in terms of agreement, pronominal use and syntactic complexity (Leonard 2016; Moscati *et al.* 2020; Araya *et al.* 2023); phonological transformations are also common, and this is possibly due to a defective acquisition of the phonotactic constraints of their language, or because of a non-conventional mental representation of the word form (Maillart & Parisse 2006; Mengisidou & Marshall 2019). However, many children with DLD often use gestures to compensate for language obstacles. Although studies have shown heterogeneous results as far as the way children with and without DLD use gestures, the common consensus is that gestures help children with DLD support speech when language difficulties occur in their communication (Bellifemine 2022; Rinaldi *et al.* 2022; Rombouts *et al.* 2023).

Overall, repairs and gestures have been studied independently in children (among others, Salmenlinna & Laakso 2020 for repairs; Howard *et al.* 2012 for gestures) and there has not been a systematic observation of the interaction of gestural cues and repair strategies. Moreover, there is not much research on repairs in children with DLD (Navarro-Ruiz & Rallo Fabra 2015, 2017; Balčiūnienė & Kornev 2023), especially in French. Thus, this study aims to observe how French-speaking children with and without DLD produce repairs, not only in speech but also through gestures.

1.1. Self-repairs in children with and without DLD

Repairs are pragmatically considered as disfluency markers, together with all those phenomena that hinder the perceptual fluency of speech, such as hesitations and pauses (either filled or silent), repetitions, blocks, up to stuttering-like behavior (Postma *et al.* 1990; Shriberg 1994; Lickley 2017). A distinction can be made between overt repairs, characterized by explicit discourse markers such as ‘you know’, ‘well’, ‘I mean’, and covert repairs, which are generally accompanied by filled (‘uhm’, ‘uh’) and/or silent pauses (Levelt

1983). However, Lickley (2017) disagrees with this view and states that filled and silent pauses are too short to be found within covert repair sequences, since the speaker is able to rectify their message quickly. Although disfluency markers generally increase with age, Neuberger & Gósy (2014) found fewer self-repairs in older Hungarian-speaking children between 6 and 13 years old. It can be argued that older children pay less attention to recasting the non-conventional forms produced in their more complex utterances, because the cognitive demands of their language skills are higher (Griffiths *et al.* 2022; Garbarino & Bernstein 2023; Jin *et al.* 2023). Moreover, as they grow older, children switch from egocentric to allocentric discourse and pay more attention to what the conversational partner is saying, thus being also able to initiate other-repairs (Forrester & Cherington 2009; Laakso 2010). Clark (2020) has recently offered a literature review on repairs in several languages during children's development. The author reports the emergence of different types of repairs throughout the child's first years, following the typical developmental trajectory. Indeed, phonological and morphological repairs are most frequent between 2 and 3 years old, whereas syntactic and lexical repairs are more common after 3, when the child starts increasing the complexity of their utterances not only in terms of length but also in terms of syntactic structures and lexical diversity.

Repairs have also been studied under the lens of interactionist approaches with a particular focus on parents' strategies to initiate other-repair sequences while interacting with their children, showing how adults' recasts help children become more aware of their monitoring process (Laakso & Soininem 2010; Morgenstern *et al.* 2013). Several studies also observed parents' scaffolding moves to help children with DLD repair their utterances. For instance, Salmenlinna & Laakso (2020) found that young Finnish children with DLD master other-initiated repairs (initiated by the listener) as well as adults and typically developing children during adult-child play or speech therapy sessions. Other authors highlighted how combining recasts, other-repairs and different scaffolding strategies can facilitate children's language learning and increase self-repair strategies during language intervention (Soto *et al.* 2020; Cooper *et al.* 2021). In French, Rezzonico *et al.* (2014) studied mothers' recasts during parent-child interaction, focusing on children with and without DLD. The authors found similar behaviors between the two groups, even though children with DLD were helped slightly more by their mothers, who oversimplified their speech and addressed more clarification requests to them. In addition, adults often use nonverbal clues when initiating repair sequences with children with communication disorders, especially during prosodic marking to focalize either the word to be repaired or the repair itself (Fasulo *et al.* 2021). Thus, this study is anchored in interactionist and dialogical approaches

that can highlight how children and adults align their knowledge and establish common ground during conversation (Clark 2018a).

Self-repairs in children with DLD have mostly been studied in a much larger scale within the research field of (dis)fluency (Gósy *et al.* 2006; Befi-Lopes *et al.* 2014). Many authors found that children with DLD are more disfluent than typically developing children, especially during narratives, and regardless of the language they speak (Boscolo *et al.* 2002 for English; Balčiūnienė & Kornev 2016, 2023 for Russian; Navarro-Ruiz & Rallo Fabra 2015, 2017 for Spanish). For instance, Balčiūnienė & Kornev (2016) observed more hesitant speech mostly characterized by filled pauses in Russian-speaking children with DLD, and more so during narratives than spontaneous conversation. In a more recent study, these authors observed more lexical self-repairs in 6 year old children with DLD than typically developing children, who produced more grammatical morphosyntactic repairs, even though no significant differences were found between the two groups (Balčiūnienė & Kornev 2023). In Spanish, Navarro-Ruiz & Rallo Fabra (2015, 2017) found that, during spontaneous conversation, self-repairs were less frequent and more time-delayed in children with DLD than control children, aged between 1 and 5. Moreover, the first group produced more morphosyntactic repairs, whereas TD children produced more pragmatic repairs. This could mean that the type of activity and discourse genre could also have an influence on self-repair strategies. In contrast, Lara Galindo & Rojas-Nieto (2017) did not find any differences in the amount of self-repairs produced by 6-year-old Spanish children with and without DLD during spontaneous conversation, but they found that children with DLD took more time to complete their repair sequences, regardless of the type of segment to correct, and that they initiated more covert repairs marked by silent pauses. To the best of our knowledge, there is not any research on self-repairs in French-speaking children with DLD, thus creating a gap in the literature.

1.2. The use of gestures during self-repairs

Children's multimodal development is marked by progressive changes in the way information is conveyed in their utterances (Morgenstern & Goldin-Meadow 2022). The orchestration between gesture and speech is a work in progress, whereby these two facets of language stabilize gradually in a complementary fashion (Grebelsky-Lichtman 2016; Clark 2018b; Alghowinem *et al.* 2021; Vilà-Giménez *et al.* 2021). As children complexify their language, gestures change in forms and functions also based on the type of activity and discourse genre (Colletta 2022). Although gestures facilitate speech planning and word retrieval, especially in adults (Alibali *et al.* 2000), their relation to disfluency is still being explored (Kosmala *et al.* 2019; Arslan

& Göksun 2022) and sometimes disputed (Kısa *et al.* 2022). For instance, Dressel (2020) observed that speakers deployed a large array of multimodal resources – especially gaze, as well as referential and pragmatic gestures – during repair sequences, either self- or other-initiated. Moreover, gestures tend to be suspended or held during adults' disfluent speech for some authors (Seyfeddinipur 2006; Graziano & Gullberg 2018). In children they help reduce disfluencies during narratives, both in monolingual and bilingual contexts (Arslan *et al.* 2023). This could also be the case during repair sequences. Wu (2022) suggested the term 'gestural repair' when a gesture is used to initiate self-repairs. The author observed that adults mostly produced referential iconic gestures when starting a repair sequence. However, the term 'multimodal self-repair' could be more suitable to highlight the temporal synchronization between gesture and speech during repairs. For instance, Özkan *et al.* (2023) studied adults' bodily movements synchronized with self-repair sequences, by using an automatic detection of disfluent speech and repairs. They found that speakers raised their hands and their head upwards on the vertical axis very fast when repairing a segment of their utterance.

As far as children are concerned, Bellifemine (2024) conducted a study on multimodal self-repairs in typically developing French-speaking children aged from 7 to 10. Contrary to adults' use of iconic gestures that Wu (2022) observed in her study, the author found that children mostly used non-referential beat gestures to signal repairs multimodally. The same result was found by Kısa *et al.* (2024) who observed the use of referential and non-referential gestures during adults' fluent and disfluent speech. This function of beat gestures was previously observed by Cassel (1988) but was surprisingly put aside for many years. Hence, if we compare these results to the study by Özkan *et al.* (2023), we can identify similarities in the speed of the gestural component of the repair, since we know that beat gestures are quite fast, but there are differences in the direction of the movements, since non-referential beat gestures are generally produced in a downwards-to-upwards direction (Loehr 2007). Moreover, beats have also different configurations as some authors observed (Prieto *et al.* 2018; Bellifemine 2024): they can be produced manually by one hand, or only the index finger, or both hands, and they can also originate from head movements.

In the field of clinical linguistics focusing on speech and language pathologies, a recent study by Tetnowski *et al.* (2023) showed that the use of gestures was beneficial for patients with acquired aphasia and that some gestures served as nonverbal cues to initiate repair sequences, especially during moments of word search. As for children with DLD, several studies show an important spontaneous use of referential gestures, regardless of the presence of a repair, during different tasks such as narratives (Blake *et al.* 2008; Mainela-Arnold *et al.* 2014), spatial descriptions (Blake *et al.* 2008; Bellifemine

2019). Furthermore, Bellifemine (2022) found that children with DLD rely on referential gesture to facilitate not only lexical access but also syntactic complexity within discourse elaboration. However, except for the study by Bellifemine (2024) who focused on TD children's multimodal self-repairs and their use of non-referential beats, we could not find any research addressing the use of gestures during repairs in children with DLD. Thus, we do not know if there could be a systematic pattern specific to these children. Since non-referential beat gestures are strongly linked to the rhythmic and prosodic features of discourse (Rohrer *et al.* 2019), and since repairs are also linked to prosody (Levelt & Cutler 1983; Crible & Pascual 2020; Kazemi 2020) is possible that, because children with DLD have difficulties with prosodic processing and focus marking (Sabisch *et al.* 2009; Calet *et al.* 2021), they rely less on non-referential beats during repair sequences and more on referential gestures to monitor their speech.

2. Current study¹

Overall, the abovementioned studies all show heterogeneous results as far as the use of self-repairs and gestures in children with and without DLD. Moreover, research on self-repairs in French-speaking children with and without DLD, and the way they use gestures during these moments, is even more sparse. Thus, the present study aims at filling this gap in the literature. We analyzed multimodal self-repairs in the narratives of 44 French-speaking children with and without DLD aged between 7 and 10. We asked two main questions:

- (a) Are there any differences between children with and without DLD in terms of self-repair frequency and type? Based on what previous studies observed, we predict to find fewer self-repairs in the DLD group, because the language disorder could hinder the way children with DLD monitor their speech.
- (b) Are there any differences between the two groups in terms of gesture types used during multimodal self-repairs? Since studies showed that children with DLD seem to produce more gestures – especially referential ones – than TD children, to compensate for the language disorder, we predict to find more non-referential gestures in the TD group and more referential gestures in the DLD group.

2.1. Participants

22 typically developing (TD) children (mean age: 8;9, SD: 0.95) and 22 children with expressive DLD (mean age: 9, SD: 1.04) participated in this study. They all were L1 French speakers. However, 2 children with DLD could

understand respectively Georgian and Filipino, and one child spoke Russian as his second language, whereas TD children were all monolingual. Each group was composed of 18 boys and 4 girls. All children with DLD received an official diagnosis² by a speech-language pathologist at least 2 years prior and were doing speech therapy. Children had mainly phonological (phoneme omission or substitution) and morphosyntactic (passive structures, subordinate clauses, function words) difficulties; fewer children showed lexical difficulties (word retrieval). Exclusion criteria (hearing problems, affective and attention disorder, comorbidity with other non-developmental pathologies) were assessed through interviews with children's parents beforehand. Three children with DLD were also affected by developmental dyslexia and writing difficulties, but these disorders did not influence their performance in the present study. TD children did not have any history of language impairment.

2.2. Material and procedure

Children were asked to recount an episode of a Tom & Jerry cartoon ('Hatch up your troubles') after watching it on a computer screen. Children were videorecorded while retelling the story to one of their parents, who had not watched the episode with them. Parents were not given instructions on how they should behave other than to just listen to their child. Sometimes they asked questions in order to better understand the child's narrative. Gesture use was not mentioned when giving instructions in order not to influence children's multimodal behaviors, therefore they used nonverbal cues spontaneously. The excerpt has five main narrative sequences and goes as follows: (i) after a woodpecker knits a blanket and leaves searching for some food, one of its eggs falls from the nest and rolls down to Jerry's house; (ii) the egg hatches while the mouse is sleeping; (iii) the baby woodpecker starts to peck all of Jerry's furniture; (iv) Jerry gives the bird a biscuit, but it keeps on pecking all the wood; (v) Jerry brings the little woodpecker back to its nest.

2.3. Coding gestures and self-repairs

Each videorecording was transcribed and annotated in ELAN (Sloetjes & Seibert 2016). The principal investigator coded all the data. Children's utterances were annotated based on Tomasello's definition, which states: "An utterance is a linguistic act in which one person expresses towards another, within a single intonation contour, a relatively coherent communicative intention in a communicative context". (Tomasello 2000: 63) combined with Parisse & Le Normand's (2007) utterance annotation system which includes syntactic and prosodic features.

Based on Schegloff's (1977: 361) definition of self-repair ("correction by the speaker of that which is being corrected"), we coded self-repairs according to the three main categories by Bear *et al.* (1993):

- LEXICAL SELF-REPAIRS, occurring after word repetitions to stall for time while searching for a word, or during reformulations to convey the target word.
 - a. *la [/] la petite souris a trou(vé) a vu le lit [/] le nid qui vivait (+) le petit oisillon*
 - b. *the [/] the little mouse fou(nd) saw the bed [/] the nest that lived (+) the little bird*

- MORPHOSYNTACTIC SELF-REPAIRS, including pronominal use revisions, changes in the utterance project, modifications of determiners or auxiliaries used to introduce respectively nouns and verbs, and corrections in gender, number and verb agreement.
 - a. *c'est détruit l'arai(gnée) [/] la toile d'araignée (+) elle s'est cassée*
 - b. *it broke the spid(er) [/] the spiderweb (+) she* broke*

- PHONOLOGICAL SELF-REPAIRS, namely the revision of the pronunciation of a target word, initially mispronounced.
 - a. *il destruis(ait)* [/] il détruisait it wresk(ed)* [/] it wrecked*
 - b. *[ildestɹɪz(ɛ) [/] il detɹɪzɛ]*

For each self-repair, we specified the modality children used, namely SPEECH-ONLY if the child did not produce any gesture during the revision of their utterance, or GESTURE-SPEECH combination if a bodily component was mobilized during the repair sequence and the stroke of the gesture was produced within the repair sequence.

We coded gestures, defined as movements of the upper body (head, shoulders, hands) which occur with speech, according to three categories based on the taxonomies established by McNeill (1992) and Kendon (2004):

- REFERENTIAL GESTURES, including iconic gestures, representing concrete referents; metaphoric gestures, giving form to abstract concepts; and deictic gestures, including pointing and locative gestures related to spatial features of speech.
- NON-REFERENTIAL BEAT GESTURES, which do not carry any semantic meaning but help structure discourse and emphasize certain linguistic elements within the utterance.
- PRAGMATIC GESTURES, also called recurrent gestures (Bressem & Müller 2014; Müller 2017; Ladewig 2014), which have conventional forms and meaning, such as the Palm Up Open Hand (PUOH), the shrug, the cyclic gesture, or the thinking gesture.

2.3. Inter-rater reliability and statistical analysis

We asked another researcher, specialized in gesture and disfluency, to code 10% of our data in terms of self-repairs and gestures for inter rater reliability (Cohen 1960). We found an almost perfect agreement for gesture types ($k = 0.94$) and a strong agreement ($k = 0.88$) for self-repair types.

We used non-parametric tests (Mann & Whitney 1947) for inter-group comparisons, z tests (Welch 1947) for quantitative analysis on proportions, and generalized mixed models (Baayen *et al.* 2008) to weight the effect each factor taken into account had on our data.

3. Results

Overall, we found a total number of 689 utterances and 449 gestures in the DLD group and 636 utterances and 450 gestures in the TD group. Gesture rates, namely the overall frequency of the number of gestures on the total number of utterances, were similar for the two groups (DLD = 0.65, SD = 0.46; TD = 0.71, SD = 0.56), and no significant difference was found ($W = 236.5$, $p = .90$). Children also used the same types of gestures during their narratives: almost half of them were referential gestures (DLD: 79,07%; TD: 74,44%), then non-referential beat gestures (DLD: 11,80%; TD: 15,12%) and pragmatic gestures (DLD: 9,13%; TD: 10,44%). Thus, they showed similar multimodal behaviors at the quantitative level.

We also identified 102 self-repairs for the DLD group and 173 for the TD group. Figure 1 shows the self-repair rate out of the total number of utterances, for each group. TD children produced almost a self-repair per three utterances ($M = 0.27$, $SD = 3.97$), whereas children with DLD produced one self-repair per ten utterances ($M = 0.14$, $SD = 3.45$). Statistical analysis revealed that TD children produced more self-repairs in their narratives ($W = 93.5$, $p = .0005$). Moreover, one child in the DLD group did not produce any self-repairs, contrary to TD children who all produced at least one. This means that, possibly because of the language disorder and/or due to task complexity, children with DLD were less sensitive to repairing their speech than TD children.

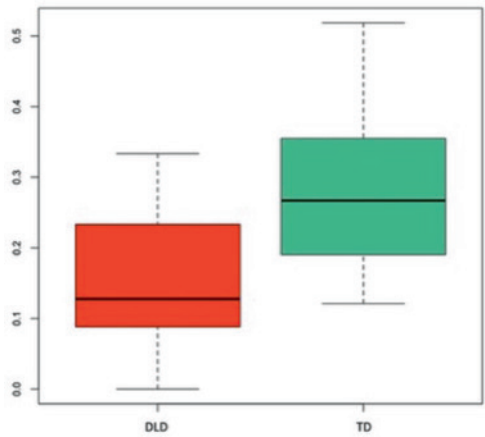


Figure 1. Rate of self-repairs out of the total number of utterances, for each group.

As for the modality used during self-repairs, Table 1 shows the proportion of SPEECH-ONLY self-repairs and GESTURE-SPEECH self-repairs, for the two groups.

	DLD		TD			
	M (SD)	Range	M (SD)	Range	z score	p value
Speech-only	60,78% (1.96)	0-100	64,16% (2.64)	0-100	-0.5601	0.57
Gesture-speech	39,22% (2.14)	0-100	35,84% (1.25)	0-100	0.5601	0.57
Total (= 100%)	102		173			

Table 1. Proportion of speech-only and gesture-speech self-repairs out of the total number of self-repairs, for each group.

Overall, speech-only self-repairs were preferred. There was no significant difference when comparing the two groups on the type of modality used to express repairs in children’s narratives, since the proportions obtained and reported in Table 1 are similar. However, within-group analysis revealed significant differences. Indeed, TD children produced significantly more speech-only self-repairs than gesture-speech repairs ($z = 5.2685$, $p < .0001$). Similarly, children with DLD also produced more speech-only self-repairs than multimodal ones ($z = -3.0806$, $p = .002$). Since multimodal self-repairs were less frequent than speech-only repairs, we can assume that gestures were mostly used to structure children’s narrative and embody the characters’ actions.

3.1. Types of self-repairs

We also looked at the types of self-repairs produced by the two groups of children. Table 2 below shows the percentage of each type of repair (LEXICAL, SYNTACTIC, PHONOLOGICAL) for each group.

	DLD		TD		z score	p value
	M (SD)	Range	M (SD)	Range		
Lexical	53% (2.36)	0-100	74% (3.04)	0-100	-3.563	0.003
Syntactic	45% (2.14)	0-100	26% (1.72)	0-100	3.249	0.001
Phonological	2% (0)	0-33.3	0	/	1.845	0.06
Total (= 100%)	102		173			

Table 2. Percentage of self-repairs based on their type.

Overall, the two groups produced more lexical self-repairs, followed by syntactic self-repairs, whereas phonological repairs were rare. In fact, only children with DLD produced phonological repairs (2%).

At the quantitative level, TD children produced more lexical repairs (74%) than children with DLD (53%) and this difference was significant ($z = -3.563$, $p = .003$). Example (1) below shows a lexical self-repair, from Arthur's narrative.

- (1) Lexical self-repair (Arthur, 9 y.o. – TD)
- a. *(en)fin il tombe et il se pose dans une toile d'araignée qui casse sous le poids (+) [//] sous l'effet du poids*
- b. I mean it falls and goes into a spiderweb that breaks under the weight (+) [//] under the effect of the weight

In (1) Arthur produces several disfluency markers when he recounts the moment the egg falls from the nest and goes into a spiderweb before rolling into Jerry's house. The child produces a lexical self-repair, in his subordinate clause, to be as precise as possible when giving this information to his mother. He specifies that, because the egg is too heavy, the spiderweb breaks as a result. Thus, his recast includes the word *effet* ('the effect') presenting the breaking of the spiderweb as a consequence. The repair produced is covert, since it is preceded only by a silent pause followed by a recast of the noun phrase.

As for syntactic self-repairs, they were more frequent in the DLD group (45%) than the TD group (26%) and this difference was also significant ($z = 3.249$, $p = .001$). Example (2) below shows a syntactic self-repair, from Bryan's narrative.

- (2) Syntactic self-repair (Bryan, 10 y.o. – DLD)
a. *après et [/] et il y a aussi la souris il s'(est) euh [/ /] qui [/] qui est réveillée du coup bah (+) bah du coup [/] bah du coup l'œuf s'est éclaté du coup le petit est qui est sorti*
b. then and [/] and there's also the mouse *it* w(akes) uhm [/ /] that [/] that wakes up so well (+) well so [/] well so the egg hatched so the little one is that got out*

Throughout Bryan's whole utterance we can observe several occurrences of disfluencies such as filled pauses and repetitions, but what is of interest here is the moment he tries to produce a cleft structure. Bryan shows a pronominal misuse of the subject relative *qui* (that), required to complete the cleft to explain that the mouse wakes up after the egg rolls under it. First, he produces a pseudo-cleft by omitting the relative pronoun (*il y a aussi la souris Ø il s'*), then he aborts this construction and utters a filled pause (*euh*) before using the target relative pronoun to complete the cleft. He tries to produce another cleft structure right after but he overgeneralizes its syntactic form by producing the correct second part of the cleft (*qui est sorti*) but not the first part, where a presentative *il y a* (there is) or *c'est* (it is) is required.

3.2. Gesture use and self-repairs

Finally, we analyzed how gestures and self-repairs interacted in children's narratives. We used generalized mixed models to see whether the two groups used different types of gestures when repairing their utterances. The 44 children constituted the random effect of the model; gesture type accompanying multimodal repairs (non-referential, pragmatic, referential) was the dependent variable for each model. The group (TD vs DLD) was the independent variable. We did not find any significant results when focusing on pragmatic gestures, but we found differences in relation to non-referential beat gestures (Table 3) and referential gestures (Table 4).

Fixed Effects	Est*	S.E.	z	p	Random Effects	Var.	S.D.	C-Value
Beat gestures								0.83
Intercept	-1.3402	0.3073	-4.362	<.0001	Children	0.6981	0.8355	
Group: DLD	-2.1905	0.6303	-3.476	0.0005				

Number of obs: 288, groups: CHILD, 44

Table 3. Generalized mixed model – Beat gestures used for self-repairs.

As for non-referential beat gestures, the best model obtained by regression revealed that children with DLD produced significantly fewer multimodal self-repairs with this type of gesture, although the two groups showed on

average a similar use of beats at the quantitative level. Indeed, given that TD children produced a total of 68 beat gestures, 31 of them were used for self-repairs, out of the 61 multimodal self-repairs, contrary to children with DLD, who produced only 4 beats during their repair sequences, out of a total number of 53 beat gestures coded in their narratives.

Fixed Effects	Est*	S.E.	z	p	Random Effects	Var.	S.D.	C-Value
Referential gestures								0.71
Intercept	-1.06453	0.20610	-5.165	<.0001	Children	0.1048	0.3238	
Group: DLD	0.90282	0.28930	3.121	0.001				

Number of obs: 288, groups: CHILD, 44

Table 4. Generalized mixed model – Referential gestures used for self-repairs.

Conversely, a second model revealed that children with DLD used significantly more referential gestures with self-repairs. Again, no differences were found between the two groups regarding the use of referential gestures in children's narratives. Out of the 40 occurrences of multimodal self-repairs produced by children with DLD, 34 of them were accompanied by referential gestures (out of a total number of 355 referential gestures), contrary to TD children who produced 18 referential gestures (total number: 335 occurrences) out of the 61 multimodal self-repairs.

These results were also confirmed by z-tests when comparing the proportions of each multimodal self-repair based on gesture type (Table 5).

	DLD		TD		z score	p value
	M (SD)	Range	M (SD)	Range		
Non-referential	10% (15.01)	0-100	50% (1.44)*	0-100	-4.2162	<.0001
Pragmatic	5% (8.66)	0-25	19.67% (1.25)	0-100	1.7231	0.08
Referential	85% (35.18)*	0-100	29.51% (1.28)	0-100	5.4574	<.0001
Total (= 100%)	40		61			

Table 5. Percentage of multimodal self-repairs based on gesture type.

Indeed, TD children produced more non-referential beat gestures (50%) than children with DLD (10%) and this difference was significant ($z = -4.2162$, $p < .0001$). Conversely, children with DLD produced significantly

($z = 5.4574$, $p < .0001$) more referential gestures (85%) than TD children (29,51%). In line with what we found using regression models, we did not find any significant differences when comparing the two groups on the use of pragmatic gestures, but we only found that TD children showed a tendency ($z = 1.7231$, $p = .08$) to produce more pragmatic gestures (19,67%) than children with DLD (5%) during self-repairs.

We also analyzed the types of gestures produced during each type of self-repair. We focused on lexical and syntactic repairs, since we only found 2 occurrences of phonological repairs in the DLD group.

TD children produced significantly more non-referential beats with lexical repairs ($W = 348$, $p = .003$) and syntactic repairs ($W = 299$, $p = .03$) than children with DLD. Example (3), taken from Hanna's narrative, and example (4) from Leo's, show these results.

- (3) Non-referential beat with lexical self-repairs (Hanna, 9 y.o. – TD)
a. *et donc du coup bah (+) il va dehors avec l'oiseau (en)fin le (+) [/] le (+) l'oisillon*
b. and then so well (+) he goes outside with the bird I mean the (+) [/] the (+)
baby bird

[BEAT]

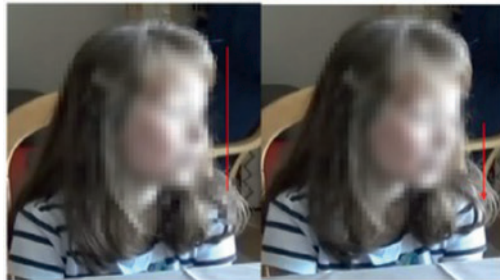


Figure 2. Non-referential head-beat produced during a lexical self-repair.

In (3) Hanna, a 9 y.o. girl from the TD group, is recounting the final sequence of the Tom & Jerry cartoon, during which the mouse takes the baby woodpecker back to its nest. The overt lexical repair is signaled by the discursive marker *enfin* ('I mean') followed by a repetition of the definite article, which is surrounded by silent pauses. With this repair, Hanna aims at making a distinction between the woodpecker mama of the story we see at the beginning of the excerpt and the little bird that was inside the egg before it hatched. In order to clarify the referent in her narrative to her mother, after using the referring expression 'bird' (*l'oiseau*) she signals the repair to her interlocutor, multimodally. Indeed, while repairing the lexical choice used to

refer to the little bird, she produces a head-beat by moving her head up and down, to emphasize the segment that is being repaired.

- (4) Non-referential gesture with syntactic self-repairs (Leo, 9 y.o. – TD)
- a. *après il tombe dans une euh [//] sur une fleur et ça va jusqu'à la maison de Jerry*
 b. then it falls in a uh [//] on a flower and it goes up to Jerry's house
 [BEAT]

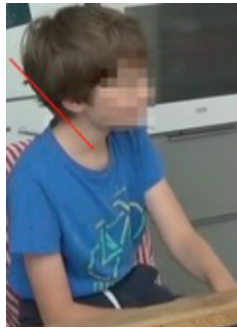


Figure 3. Non-referential head-beat produced during a syntactic self-repair.

In (4) Leo is recounting to his mother the moment the egg falls from the tree and goes into the spiderweb that breaks under its weight, after which the egg lands on a flower before rolling into Jerry's house. Leo uses the preposition *dans*, which means 'inside' in French. Thus, the child acknowledges his misuse of the preposition right away. This is repaired first by the filled pause *euh*, then by using the target preposition *sur* followed by the noun 'flower', the prepositional phrase being synchronized with a non-referential head beat towards the child's right side when he establishes the repair.

Children with DLD used more referential gestures than TD children during lexical self-repairs ($W = 327, p = .02$). On the contrary, we did not find any significant inter-group differences as far as referential gestures produced during syntactic repairs ($W = 230, p = .73$). Example (5) shows one of Norman's lexical repairs produced with a referential gesture.

- (5) Referential gesture with lexical self-repairs (Norman, 10 y.o. – DLD)
- a. *après elle a sorti (+) une (+) [/] une espèce de bousso(le) (+) [//] une espèce de petite montre (+) qu'on tient comme ça*
 b. then she took out (+) a (+) [/] a sort of compa(ss) (+) [//] a sort of little watch (+) that you hold like that
 [ICO]



Figure 4. Referential iconic gesture produced during a lexical self-repair.

Norman is recounting the moment the woodpecker mama looks at its watch because it is time to go find some food. The child uses the referring expression ‘compass’, since in the cartoon the bird has a pocket watch, which is similar in shape to a compass. However, he soon realizes it is not the correct word to refer to the type of watch we can see in the excerpt. Thus, he stops the production of this word and uses the complex noun phrase *une espèce de petite montre* (‘a sort of little watch’), which is accompanied by an iconic gesture with his left hand. This gesture is complementary to the linguistic form used by the child, since it conveys the form of the watch, which is also specified verbally by the adverbial locution ‘like this’ following the subordinate clause ‘that you hold’.

These examples are different in several ways. On the one hand, the gestures used during the three children’s multimodal self-repairs are different: Hanna and Leo, from the TD group, use a non-referential head-beat while Norman, from the DLD group, uses an iconic referential gesture during his repair sequence. On the other hand, the way the three children produce their self-repairs is slightly different: Hanna uses an overt repair with a discursive marker, silent pauses and repetitions, Leo uses a filled pause to signal his repair sequence, while Norman aborts the production of the first word which is then repaired. In other words, these finer qualitative analyses suggest that TD children seem to be more sensitive to their conversational partner’s alignment to follow the narrative sequences and the messages conveyed by the young narrator, while children with DLD seem to produce more subtle self-repairs that the interlocutor would have to catch by paying more attention to the child’s recounting of the story.

4. Discussion

The aim of this exploratory study was to observe the use of self-repairs by children with and without Developmental Language Disorder during a

narrative task, and to determine if gestures have a key role in signaling these repairs, multimodally.

Our first question sought to see whether there were any differences between the two groups of children. We predicted that children with DLD would be less likely to produce self-repairs. Although previous findings showed that children with DLD are not more disfluent than TD children in regards to pause production (Bellifemine & Kosmala 2024), in this study TD children produced significantly more self-repairs than children with DLD. This is not surprising because the presence of the language disorder could possibly hinder the way children with DLD monitor their speech. Thus, our hypothesis was confirmed. Contrary to what Lara Galindo & Rojas-Nieto (2017) found in their study, namely no significant differences in the frequency of self-repairs in children with and without DLD, our results are in line with what Navarro-Ruiz & Rallo Fabra (2015, 2017) found in Spanish-speaking children with and without DLD, namely fewer self-repairs in the DLD group.

We also observed that both groups produced mostly speech-only self-repairs. Multimodal self-repairs were less frequent, and this result differs from what has been previously found in studies on bilingual adults (Canals 2021). However, we found differences in the types of self-repairs: TD children produced more lexical repairs and children with DLD produced more syntactic repairs. Phonological repairs were absent in the TD group and rare in the DLD group. In a previous study, Bellifemine (2024) already came to the conclusion that TD children master language at the phonological level. In the present study, we observed that children with DLD sometimes have difficulties with certain phonological forms, although we did not find any significant differences between the two groups. Overall, these findings converge with what has been reported in literature (Clark 2020), that is lexical and syntactic repairs are the most frequent types of repairs found in older children's speech. Our results diverge from those found by Balčiūnienė & Kornev (2023), who observed more lexical repairs in the DLD group and more grammatical ones in the TD group. On one hand, this could depend on the fact that, in our study, children with DLD were possibly aware of their lexical difficulties and they tried to be more careful with the choice of the linguistic forms used in their narratives. Moreover, children with DLD were also possibly aware of their morphosyntactic difficulties due to presence of the language disorder. On the other hand, the difference in our results could be explained by the fact that French and Russian are two different linguistic systems and Russian lexical forms follow very specific context-driven rules. Furthermore, the children in Balčiūnienė and Kornev's study were younger than the children who participated in our study. Therefore, it is also possible that age could have had a key role in the way the children in our study monitored their speech at the linguistic level. Our results also confirm the presence of morphosyntactic difficulties

which are specific to DLD (Bedore & Leonard 2005). In addition, Navarro-Ruiz & Rallo Fabra (2015, 2017) also found more morphosyntactic self-repairs in Spanish-speaking children with DLD. Despite the fact that the children in their study were much younger, we found the same results. Again, this could depend on the type of language observed, Spanish being more similar to French than Russian.

Moreover, qualitative analyses revealed that TD children produced more overt self-repairs than children with DLD, which is in line with what Lara Galindo & Rojas-Nieto (2017) found in their study. Thus, TD children seem to be sensitive to the way they convey information to their conversational partner in order to establish common ground, whereas the presence of the language disorder in children with DLD hinders their discourse efficiency and they seem to pay more attention to the grammatical and morphosyntactic dimension of their speech rather than their interlocutor's comprehension of the narrative.

We know that research on the use of gestures by DLD children reveals heterogeneous results, since some studies found differences in gesture use between children with DLD and TD children during narratives (Iverson & Braddock 2011; Mainela-Arnold *et al.* 2014) while others found similar multimodal behaviors (Blake *et al.* 2008). In our study, children with DLD did not use more gestures than TD children while repairing the non-conventional forms used in their narratives, and their multimodal behaviors were similar to the control group at the quantitative level. In our study, gestures were produced by the two groups mostly to support their speech planning and to represent the characters' actions, regardless of the presence of the language disorder or a failure in speech. In both groups, gestures helped children structure their narratives and convey information in a richer way, thanks to multimodality. However, we found significant differences as far as the types of gestures accompanying self-repairs. In line with previous studies (Bellifemine 2024), we found that non-referential beat gestures were more frequent in TD children's self-repairs, both lexical and syntactic. On the contrary, children with DLD used significantly more referential gestures, especially with lexical repairs. Even though the two groups produced almost the same number of referential gestures, children with DLD produced more iconic gestures to express self-repairs. This could be associated to the lack of vocabulary and frequent problems with word finding due to the language disorder (Leonard & Deevy 2003; Bragard & Schelstraete 2007). Since referential gestures are known to facilitate lexical retrieval (Krauss *et al.* 1995), it is possible that children with DLD relied on these gestures during their repair sequences for this reason. However, this result should be nuanced based on Pragmatic Signaling Hypothesis supported by Kisa *et al.* (2024), who found no particular relation between referential gestures and disfluent speech – especially when gestures

are not visually accessible by the interlocutor – contrary to non-referential gestures which seem to have a pragmatic role in signaling disfluency.

If TD children showed more linguistic maturity, and they used non-referential beat gestures as a means of signaling repairs to their interlocutor, in association with the prosodic marking of the repair sequence (Rohrer *et al.* 2019; Crible & Pascual 2020), children with DLD do not seem to master this type of gesture yet and they do not make full use of it. This shows a potential gap between children with and without DLD in their multimodal behaviors. Lüke *et al.* (2020) already confirmed that children with DLD have a delay in gesture development during their early years. Our research seems to be in line with this result and possibly offers new insights into this nonverbal delay, in older children with DLD. Moreover, besides this delay in language and gestural development, it is also possible that the differences in self-repair frequency, as well as their type, were influenced by the complexity of the task. Narratives are a complex discursive genre, since the speaker has to take into account different parameters, such as the degree of shared knowledge with the interlocutor, the narrative structure of the story, the contrast between visual access and mental representation of the story (Kern 1997). Thus, children have to manage their cognitive load not only to retrieve the narrative sequences, the syntactic and lexical constructions to use to establish temporal and causal relations between the events, but also the moments during which the formulating process of the narrative generates failures in speech, which have to be repaired. Hence, children with DLD probably have more difficulties managing all these parameters at once. This pragmatic dimension, at the crossroad of other linguistic levels, could be a source of improvement during speech therapy, as some authors already observed (Merrison & Merrison 2005).

To conclude, although this is an exploratory study and more participants should be included to confirm the multimodal patterns found in our analyses, our study gives new information about the way children with and without Developmental Language Disorder use gestures to signal repairs in their speech. Despite the presence of the language disorder which creates a developmental gap in the use of multimodality during speech failures, the orchestration between the linguistic forms and gestures still helps children convey meaning in a multimodal fashion. Children are able to adjust their speech during those moments in which repairs are required through the use of different modalities, highlighting the children's socio-pragmatic skills to adapt their speech to the interactional situation and context, as well as their sensitivity to language and communication at all linguistic levels.

Notes

¹ An Ethics Committee validated the protocol of this study to be carried out (CER-USN-01-2021).

² For privacy reasons we cannot share specific information about the degree of severity of the language disorder nor the scores obtained by speech pathologists during official language assessment.

Abbreviations and transcript conventions

DLD = Developmental Language Disorder; M = Mean; SD = Standard Deviation; TD = Typically Developing.

(+) = silent pause; [/] = repetition; [/]/ = recast; text (*underlining*) = repair sequence.

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