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RESEARCH

The comprehension of Italian relative clauses in poor readers and in children with Specific Language Impairment

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Children with Specific Language Impairment (SLI) and children with Developmental Dyslexia (DD) have problems comprehending relative clauses (RCs) and find object RCs more difficult than subject RCs, as do typically developing children. Few studies have compared these groups directly, leaving it unclear whether the problems observed in children with DD are similar to those described in SLI. Work with typically developing children has shown that the comprehension of passive RCs is less challenging than that of object RCs. It is argued that this asymmetry depends on intervention effects as modelized in a Relativized Minimality framework. Since movement is challenging for children with SLI and those with DD, examining and comparing their comprehension of object RCs and passive RCs can broaden our understanding of their language deficits. In fact, both structures involve movement, but the moved element and the movement configuration are different.

In our study we investigated the comprehension of subject RCs, object RCs and passive RCs in 12 Italian monolingual children with SLI (mean age: 7;6), 13 Italian monolingual children with DD (mean age: 10;7) and 50 typically developing controls matched for age, grammar and vocabulary. Results from a picture selection task show that: (i) subject RCs are unproblematic for all children; (ii) object RCs are challenging for children with SLI, children with DD and younger typically developing controls; (iii) passive RCs are better understood than object RCs in all groups, but still problematic for children with SLI and younger typically developing controls. Our data show that intervention effects are found in children with SLI and children with DD and that those with SLI have a deficit in transferring thematic roles to moved elements. Our results point out that some of the children with DD have a mild grammatical deficit that was undetected or escaped standardized tests.

Keywords: relative clause; dyslexia; specific language impairment

1 Introduction

It has been shown that both adults and children, across different languages, from typical and atypical populations, all have greater difficulty comprehending object relative clauses (ORCs) than subject relative clauses (SRCs).

(1) the dwarf that is chasing the witch **SRC**

(2) the dwarf that the witch is chasing **ORC**

Recent studies have shown that Italian speaking typically developing children aged 6 to 8 have greater difficulty comprehending ORCs than passive relative clauses (PRCs) (Contemori & Belletti 2014). These facts have been accounted for in terms of argument

intervention within the Relativized Minimality framework. According to this proposal, ORCs are challenging for children when the relative head moves across an embedded subject endowed with a similar feature set. PRCs avoid this crossing dependency, by moving the verbal chunk including the verb and the object across the underlying subject and promoting the object to a position where the underlying subject is no longer intervening (see examples (5) and (8)).

A comparison of the comprehension of PRCs and ORCs in children with Specific Language Impairment (SLI) can shed light on the nature of their deficit, as both structures involve movement, but of different elements and in different configurations.

Many children with a diagnosis of Developmental Dyslexia (DD) display language problems similar to those manifested by children with SLI (e.g. McArthur et al. 2000; Robertson & Joanisse 2010). Extending the comparison of the comprehension of PRCs and ORCs to these children can foster our understanding of the relation between DD and SLI and the description of different DD subtypes (Castles & Coltheart 1993; Ramus et al. 2003; Castles, Bates & Coltheart 2006; Friedmann & Lukov 2008). It can also offer a linguistic contribution as to the kind of material that may help identify language problems in school-aged children and as to the necessity of an evaluation of grammatical abilities, including RC comprehension, in children referred for a DD diagnosis.

We conducted two studies investigating the comprehension of SRCs, ORCs and PRCs: in Study 1 we investigated RC comprehension in children with SLI, in Study 2 we did the same in children with DD who do not have reported or diagnosed oral language deficits. In the two studies, we used the same materials to investigate possible analogies in the two populations, especially in light of the frequently described behavioral overlapping of DD and SLI (Catts et al. 2005; Cantiani et al. 2015). We examined the comprehension of SRCs, ORCs and PRCs and focused on the impact that intervention or lack thereof has on comprehension in Italian monolingual children with SLI and in Italian monolingual children with a diagnosis of DD. To our knowledge, no study had yet compared the comprehension of these three structures in these populations.

2 The acquisition of RCs in typically developing children and the rationale for our study

RC comprehension and production have been widely investigated in a variety of languages in typically developing (TD) children. These studies find ORCs more problematic than SRCs (Slobin 1971; Sheldon 1974; de Villiers et al. 1979; Tavakolian 1981; Goodluck & Tavakolian 1982; Crain, McKee & Emiliani 1990; Corrêa 1995; Booth, Mac Whinney & Harasaki 2000; Diessel & Tomasello 2000; Kidd & Bavin 2002; Friedmann & Novogrodsky 2004; Arosio, Adani & Guasti 2009; Friedmann, Belletti & Rizzi 2009; Özge, Marinis & Zeyrek 2009; Adani 2011; Arnon 2010; Arosio et al. 2012; Hu et al. 2016). Some studies report that TD children avoid the production of ORCs and tend to produce PRCs instead (Belletti & Contemori 2010; Guasti et al. 2012). One recent study has compared the production and the comprehension of SRCs, ORCs and PRCs, as in (3)–(5), in Italian monolingual TD children in order to better understand their problems with ORCs (Contemori & Belletti 2014).

(3) lo gnomo che insegue le streghe **SRC**
the dwarf that chases the witches
'the dwarf that is chasing the witches'

(4) to gnomo che la strega insegue **ORC**
the dwarf that the witch chases
'the dwarf that the witch is chasing'

(5) lo gnomo che è inseguito dalla strega **PRC**
the dwarf that is chased by-the witch
'the dwarf that is chased by the witch'

In (3), the singular determiner phrase (DP) *lo gnomo* 'the dwarf' agrees with the verb, unlike the embedded plural DP *le streghe* 'the witches', which occurs in a post verbal position. For this reason, the head DP is interpreted as the subject of the embedded verb and the sentence receives a subject interpretation. In (4) the embedded DP *la strega* 'the witch' occurs in a preverbal position and the sentence receives an object interpretation, as in English. In (5), the head DP *lo gnomo* 'the dwarf' is extracted from the verb complement position of a copular passive construction as shown in (8).

According to Contemori and Belletti's (2014) study, the production and comprehension of PRCs is less challenging than that of ORCs for Italian monolingual TD children 6 to 8 years of age. This asymmetry has been explained in a featural approach to Relativized Minimality (Friedmann, Belletti & Rizzi 2009; Contemori & Belletti 2014). The Relativized Minimality Principle constrains syntactic computations (Rizzi 1990; 2004) such that, in a configuration like the one in (6), where X is a target, Z an intervener and Y an origin, a local relation between X and Y cannot be established if Z has the same features as Y.

(6) X ... Z ... Y

According to the Relativized Minimality approach to RC processing, in an ORC as in (4), a local relation between the DP head and the origin must be established across the lexical embedded subject, an intervening element endowed with a subset of features of the head (the +N feature of the noun phrase (NP) contained in both the head and the intervener). In this configuration, the operation of distinguishing the two sets of features of X and Z might be computationally costly, since the feature set of the embedded DP is included in the feature set of the head. This is because the RC head (the attractor) is endowed with the ⟨+R, +N⟩ feature set, while the embedded DP (the intervener) is endowed with the set ⟨+N⟩, as shown in (7)[1].

(7) [lo gnomo]$_1$ che [la strega] insegue t$_1$ **ORC**
[the dwarf]$_1$ that [the witch] chases t$_1$
+R +NP +NP
X Z Y
target intervener origin

A number of studies has shown the benefit of a feature mismatch between the target and the intervener in the comprehension of ORCs in both adults and children. Friedmann et al. (2009) found that when the target and the intervener were structurally dissimilar in terms of lexical-NP restriction, the comprehension of ORCs improved in Hebrew-speaking TD children aged 3;7–5;0. Adani et al. (2010) found an improvement with a number mismatch, but not with a gender mismatch in Italian-speaking TD children. This result follows from the consideration that, while number is part of the Phi-feature set attracting the subject and is relevant for Relativized Minimality in Italian, gender is not. Arosio, Guasti and Stucchi (2011) described an advantage with animacy mismatch in 9-year-old Italian-speaking TD children. An advantage with animacy mismatch was also reported in aphasia patients by Garraffa and Grillo (2008). This same advantage was also described in studies

[1] +R is the relative feature triggering movement of the head. There are clearly other features associated with these constituents but, as will be discussed later, not all are relevant for Relativized Minimality.

with adults (Mak, Vonk & Schriefers 2002; Traxler et al. 2005; Lowder & Gordon 2014). In studies with adults, Gordon and colleagues (Gordon, Hendrick & Johnson 2001; Gordon, Hendrick & Levine 2002) found an advantage with the mismatch of a lexical-NP restriction. According to Gordon et al., there is a memory load in ORCs with matching feature sets: in both adults and children, the greater the difference between the feature sets of the target and the intervener, the weaker the interference effects in the comprehension of ORCs. By contrast, according to the Relativised Minimality approach, children have problems establishing whether the feature sets of the RC head (target) and of the embedded subject (intervener) are distinct, given that their computational resources are still under development. In PRCs, there is no intervening element between the head (target) and the gap (origin). In fact, according to a *smuggling* analysis of passives (Collins 2005), in PRCs the verbal phrase (VP) chunk containing the verb and the object moves to a higher position across the vP subject and finally the object moves to the RC head position, as shown in (8) (see Contemori & Belletti 2014).

(8) [CP [lo gnomo]$_1$ che [TP pro$_{expl}$ è [VP inseguito t$_1$]$_3$ [da [vP [la strega] t$_3$]]]] **PRC**
[CP [the dwarf]$_1$ that [TP pro$_{expl}$ is [VP chased t$_1$]$_3$ [by [vP [the witch] t$_3$]]]]
+R +NP +NP
X Y Z
target origin intervener

According to this analysis, we find an expletive *pro* in the TP subject position and the embedded DP does not intervene between the origin and the target. In fact, in this structure, we find the expletive *pro* as possible intervener, an element whose features are not included in the feature set of the head. For this reason PRCs are easier than ORCs (Contemori & Belletti 2014).[2] Children with SLI and children with DD are notoriously poor in their comprehension of structures involving movement, especially when the extracted element is the object (see the discussion below). Both PRCs and ORCs involve movement of the object and formation of a chain that ensures the interpretation of the moved element. Under the view that movement of the object and formation of chains is impaired in children with SLI and DD, we expect poor performance in both ORCs and PRCs. By contrast, under the featural Relativized Minimality approach, it is not movement per se that

[2] Italian also allows ORCs with a post verbal subject as in (i).

(i) i gatti che insegue il cane
the cats that follows the dog
'the cats that the dog is following'

In (i) there is no lexical NP intervention. As sketched in (ii), according to the smuggling analysis proposed by Belletti and Contemori (2010), the VP chunk containing the verb and the object is moved to the immediate left periphery of vP, the TP subject position is filled by an expletive *pro* and the object is finally moved to the RC head.

(i) [CP [i gatti]$_1$ che [TP exp-pro$_1$ [insegue t$_1$]$_2$ [vP il cane t$_2$]]]
[CP [the cats]$_1$ that [TP exp-pro$_1$ [chases t$_1$]$_2$ [vP the dog t$_2$]]]

Although in (i) there is no lexical NP intervention, Italian speaking children have a problem comprehending such sentences until the age of 9 and find them more challenging than ORCs with a preverbal subject as in (4), where there is intervention (Arosio et al. 2009). This asymmetry in comprehension has been explained in terms of different subject-verb agreement operations found in the two structures (Volpato & Adani 2009; Volpato 2010). While in (4) agreement is a robust relation that is double checked under the AGREE operation and under a local spec-head checking operation (Guasti & Rizzi 2002; Franck et al. 2006), in (i) it is fragile and is only checked once under a non local AGREE operation. In fact, in Italian we find optional number agreement between the verb and a post-verbal subject in matrix sentences (Guasti & Rizzi 2002). Notice that, when the RC head and the post verbal subject share the same number features, structures like (i) are ambiguous between an SRC and a ORC interpretation. We did not consider these structures in our study since they are still difficult for older Italian TD speakers.

is taxing, but movement across another element with "similar" features. Thus, we expect greater difficulties with ORCs than with PRCs, since in the latter case no intervener is present. The first aim of our study is to seek evidence for one of these two approaches and thus to characterize the language deficit in the two impaired populations. The second aim is to establish whether the two populations differ as to their language problems and thus provide a characterization of their underlying language disorders. Many (Italian) children with SLI go unidentified in preschool and their language deficits emerge dramatically when they start learning to read. At that time, they eventually receive a diagnosis of DD but their language deficits may remain unrecognized since the standardized tests evaluating language abilities are not linguistically sophisticated enough to tap into those abilities that may still be challenging. The third aim of our study is to offer an explicit description of the language weakness found in some of the children with DD and some suggestions as to the linguistic materials that may help identify language deficits in school-aged children.

3 Relative Clauses in children with SLI

A number of studies have shown RCs to be particularly hard for children with SLI and have attributed this difficulty to the hierarchical structural complexity found in these constructions. Analogously to TD children, children with SLI have more difficulties with ORCs, as in (2), but to a deeper degree and for a longer time; moderate difficulties are reported with SRCs as in (1).

The sources of the structural complexity causing these problems have long been debated. According to one view, the difficulties depend on the inability to build a full-fledged RC syntactic structure to its highest node (Leonard 1995; Håkansson & Hansson 2000; Schuele & Tolbert 2001). This view finds its rationale mainly in production data from spontaneous speech and from elicitation tasks. For instance, according to a number of production studies by Schuele and colleagues (Schuele & Nicholls 2000; Schuele & Tolbert 2001; Schuele & Dykes 2005), 6- to 8-year-old English speaking children with SLI produce SRCs later than TD peers and tend to omit an obligatory RC marker.[3] The authors also noticed that, in the few ORC attempts that they make, children with SLI tend to produce an incorrect (optional) RC marker (wh word or conjunction). The omission of the RC marker in young children with SLI has also been observed in 4- to 6-year-old Swedish speaking children (Håkansson & Hansson 2000) and in 5-year-old Italian speaking children (Contemori & Garraffa 2010).[4] These data have led the authors to suggest that the problems children with SLI have with RCs depend on their inability to build a syntactic tree to its highest node, the CP node, or to lexicalize it with a functional word. Under this account, the problems children with SLI have with RCs are characterized as a structure building deficit. However, a number of studies with older children report no omission of the RC marker. For English, Hesketh (2006) reports no omission in spontaneous and elicited SRC productions of a large group of children with SLI aged 6;00 to 11;11 years. Novogrodsky and Friedmann (2006) examined the elicited productions of 12-year-old Hebrew speaking children with SLI and found that they tend to avoid RCs and produce declaratives instead. The authors report that the low number of RCs that children produced mainly consisted of SRCs, with some PRCs and only a few ORCs. Among the errors that children made when they attempted to produce an ORC, the authors describe thematic role reversals (transforming an ORC into

[3] Oetting and Newkirk (2008) report omission of the RC marker in children with SLI across different English dialects at age 6.

[4] For Italian, Cipriani et al. (1998) report the total absence of RCs in the spontaneous productions of Italian speaking children with SLI, collected from 6;2 years to 13;5 years in a longitudinal study; the authors also report problems in the comprehension of RC sentences included in a standardized test for the evaluation of grammatical abilities in Italian (TCGB, by Chilosi & Cipriani 1995).

an SRC) and relative head doubling, but no omission of the RC marker or any structural error. In a study using the same experimental materials with younger Danish speaking children with SLI aged 6;3 years, Jensen De Lopez and colleagues (Jensen De Lopez et al. 2014) found analogous results. In addition, two studies with Greek speaking children with SLI (Stavrakaki 2002, with children aged 7;4; and Mastropavlou & Tsimpli 2011, with younger children aged 4;2 to 5;9 years) report no RC marker omission. A more recent study on syntactic priming in SRC production with 4- to 6-year-old children confirms that young children with SLI can have access to RC abstract syntactic structures and have no structure building deficit (Garraffa, Coco & Branigan 2015). According to this study, young Italian speakers with SLI increased their productions of SRCs after listening to a priming SRC built with different lexical material. However, in Garraffa et al.'s study children with SLI still perform less well than TD controls in SRC production and unfortunately the authors do not report what children produced when they failed to produce an SRC.

As Novogrodsky and Friedmann (2006) observe, these findings suggest that while RC structure building might still be under development in children with SLI and only achieved at a later age, the failure to realize movement straightforwardly and to transfer thematic roles to moved elements is a persistent problem. Concerning the differences between the various studies, it is of note that consistent individual differences reported in some of the studies (Mastropavlou & Tsimpli 2011; Jensen De Lopez et al. 2014)[5] and differences in the severity of the language impairment might have had an impact on the discrepancies described. Additional factors that might have determined the different results are the various experimental methods used in the studies described (preference elicitation paradigm vs description elicitation paradigm vs analysis of spontaneous speech) and the distinct challenges that different languages might pose to children with SLI in RC acquisition.

RC comprehension has also been shown to be problematic for children with SLI across languages. In the aforementioned study with Swedish, Håkansson and Hansson (2000) investigated SRC comprehension and observed that comprehension problems are milder than production difficulties. Contemori and Garraffa (2010) compared RC comprehension and production in their study and found that while children tend to avoid both SRC and ORC production, they have no problems comprehending SRCs, but critical difficulties comprehending ORCs. Interestingly, ORC comprehension problems in the SLI group were comparable to those observed in age controls and language controls. Presumably, this surprising result depends on the very high variability found in the very small sample of children tested in this study (only four children with SLI) and on their youth (5 years old), considering that ORC comprehension still constitutes a problem for 5-year-old Italian TD children (Arosio, Adani & Guasti 2009; Adani 2011). In fact, in a study comparing SLI and DD in a larger sample of older English speaking children (aged 8;11 to 11;9 years), Robertson and Joanisse (2010) report that ORC comprehension was lower in children with SLI than in age controls and language controls, and that all groups were at ceiling in their comprehension of SRCs. Jensen De Lopez and colleagues (2014) found similar results in a larger sample of Danish speaking children (age range 5 to 8;4 years). These results confirm previous findings by Friedmann and Novogrodsky (2004) reporting that while the comprehension of SRCs is at ceiling for older Hebrew speaking children with SLI (aged 7;3 to 11;2 years) and for two younger control groups of TD children (aged 6 years and 4 years, respectively), the comprehension of ORCs is at chance for all children with SLI and for younger TD children. Summing up, while most of the studies report that SRC comprehension is not particularly problematic for children with SLI, their comprehension

[5] The information about individual differences is missing in most of the studies.

of ORCs is dramatically impaired and problems are persistent, at least until adolescence. Results suggest that problems concern movement and thematic role transfer to moved elements. To our knowledge, no other study has investigated PRC comprehension in children with SLI and compared it to SRC and ORC comprehension. By comparing these structures our study will investigate whether the problems children with SLI have with ORCs concern movement of the object per se or movement of the object across a similar element.

4 Relative Clauses in children with DD

A moderate behavioral overlap between SLI and DD has been frequently reported, with a described reciprocal incidence varying between 50% and 60% in the two populations, depending on the study (McArthur et al. 2000; Catts et al. 2005). Syntactic deficits have been observed in children with DD. For instance, Waltzman and Cairns (2000) observed that 8-year-old children with DD have problems applying principle B in pronoun interpretation; Joanisse and colleagues (Joanisse et al. 2000) describe problems with English *-ed* past verb marking and *-s* plural marking and a number of studies, with both behavioral tasks (Rispens, Roeleven & Koster 2004; Rispens & Been 2007) and neurophysiological measures (Cantiani et al. 2015), report problems in the processing of spoken sentences displaying subject verb agreement errors. Concerning complex syntactic structures, children with DD have manifested problems with object control adjectival constructions, where they tend to erroneously interpret an overt subject as the underlying subject of the embedded verb (though-constructions: *This bird is easy to bite;* Byrne 1981);[6] moreover, studies have shown mild problems in the comprehension of passive sentences and complex conjunct sentences in Hebrew (Leikin & Assayag-Bouskila 2004) and in Italian (Reggiani 2010).[7]

RCs have been intensively investigated in children with DD. Bar-Shalom, Crain and Shankweiler (1993) report marginal problems in production and more severe difficulties in comprehension for 7- to 8-year-old English speaking children. Their difficulties were mainly restricted to ORC production and comprehension. A number of studies with English speaking children reports consistent deficits in ORC comprehension, with differences presumably depending on the varying ages of the participants of the different studies (Byrne 1981; Mann, Shankweiler & Smith 1984; Stein, Cairns & Zurif 1984; Smith et al. 1989; Bar-Shalom, Crain & Shankweiler 1993). Similar results have been found for Hebrew (Leikin & Assayag-Bouskila 2004) and French (Casalis, Leuwers & Hilton 2013). In their study comparing DD and SLI, Robertson and Joanisse (2010) also investigated the impact of working memory demands on RC comprehension in English speaking children (aged 9;1–12;1 years) in a picture selection task, where the sentence length and the delay of presentation between the offset of the sentence and the picture stimuli were manipulated across sentence types. The results show that while children with DD have problems comprehending ORCs under a high working memory load, children with SLI exhibit problems independently of memory load differences. Studies report no problems in SRC comprehension with some minor difficulties when they are center embedded (*The boy that is calling the girls has a red t-shirt*). Summing up, while the comprehension and production of SRCs are not problematic for children with DD, the production of ORCs is marginally impaired and their comprehension is problematic in younger and older children.

[6] Macaruso et al. (1992) observed that short term memory resources impact the comprehension of object control adjectival constructions in children with DD.

[7] Stein, Cairns and Zurif (1984) report that English-speaking children with DD did not have problems with passive sentences, but this result probably depends on the class of verbs they used, since Reggiani (2010) shows that 9-year-old Italian-speaking children with DD have problems with passives based on reversible non-actional verbs.

According to Robertson and Joanisse's (2010) results, children with DD are better at RC production and comprehension than children with SLI, but their performance lags behind that of typical readers at oral ORC comprehension under a high working memory load. To our knowledge no other study has investigated PRC comprehension in children with DD and compared it to SRC and ORC comprehension. As with children with SLI, our study will also investigate whether problems children with DD have with ORC concern the movement of the object per se or the movement of the object across a similar element and it will allow for a comparison of the comprehension of these different structures between children with DD and those with SLI.

5 Study 1: the comprehension of RCs in Italian speaking children with SLI

5.1 Participants for Study 1

Twelve school-aged Italian monolingual children with SLI (6 females, mean age 7;6 years (SD 18 months), range 6;1–10;2 years) participated in Study 1. Children were administered a picture selection task investigating their comprehension of RCs. They were also given the standardized receptive vocabulary test PPVT (Dunn & Dunn 2000; Italian version by Stella, Pizzioli & Tressoldi) and the standardized Raven's Coloured Progressive Matrices test (Raven, Court & Raven 1998; Belacchi et al. 2008), to obtain a standardized measure of their lexical and non-verbal cognitive abilities. In addition, children with SLI were given the norm-referenced *Test di Comprensione Grammaticale per Bambini* (TCGB; Chilosi & Cipriani 1995), to obtain a standardized measure of their grammatical competence. The TCGB is a grammar comprehension test similar to the English *Test for Reception of Grammar* (TROG) by Bishop (1982). Children with SLI were recruited from speech therapy centers in the Milan (Italy) metropolitan area. They had been diagnosed as being specifically language impaired based on standard inclusion and exclusion criteria by certified expert clinicians following the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10; World Health Organization 2004). They were receiving clinical services during our study. In order to participate in the study, children with SLI had to score less than 2 SD below the mean score for their age on the TCGB test. All children had nonverbal IQ within normal limits (IQ > 85 at Raven). Individual data for the SLI participants are reported in Table 1.[8] As we can observe from Table 1, the SLI group is fairly homogeneous since all the children have a severe grammar comprehension disorder and most of the children lag behind age peers in lexical proficiency.

Children with SLI were matched to a group of twelve TD children of the same chronological age (± 3 months, CA control group) and another group of twelve TD children of the same grammatical age as measured in terms of their TCGB test scores (± 3 points, GA control group). The mean age of the GA group was 5 years (SD 12 months) and the range was 3;5–6;7 years. The CA group was provided in order to evaluate the severity of RC comprehension deficit in children with SLI with respect to TD children of the same age. The GA group was provided in order to evaluate RC comprehension in children with SLI with respect to TD children who have comparable linguistic abilities in a relevant linguistic domain. Since RC comprehension crucially relies on grammatical competence, children with SLI participating in our study were matched to TD children who have comparable grammatical abilities according to their raw TCGB test scores. TD control children were recruited from schools and kindergartens in the same residential areas as the children in the SLI group. All TD children scored within 1 SD from the mean score for their age on the TCGB and the PPVT tests. No child was receiving clinical services and

[8] S2, S3 and S11 from the SLI group are over 8, the oldest age for which the TCGB has norms. As seen in Table 1, their Z points are reported as lower than the Z points.

	AGE	PPVT Z Points	TCGB Z Points	Raven percentiles
S1	75.00	−0.53	−4.18	50< x <75
S2	121.00	<−2.33	<−3.47	25
S3	118.00	−1.87	<−2.29	75
S4	73.00	−1.40	−3.76	25< x <50
S5	89.00	−2.13	−6.42	75< x <95
S6	80.00	<−2.33	−2.65	50< x <75
S7	102.00	<−2.33	−4.05	25
S8	73.00	<−2.33	−2.93	50
S9	99.00	−0.73	−8.76	25
S10	73.00	0.13	−2.02	25< x <50
S11	111.00	−1.40	<−2.59	50< x <75
S12	89.00	−1.00	−9.57	50

Table 1: Age in months, Z points on the TCGB test and the PPVT test, and Raven's percentiles of children with SLI. Z points for children over 8 were calculated on the MEAN and SD of 8-year-old children.

	AGE in months mean (SD)	PPVT raw score mean (SD)	PPVT Z point mean (SD)	TCGB raw score mean (SD)	TCGB Z point Mean (SD)	Raven raw score mean (SD)
SLI	91.92 (17.99)	72.92 (18.33)	−1.52 (0.84)	16.79 (8.74)	−4.39 (2.52)	22.42 (4.42)
CA	91.33 (18.13)	117.33 (17.96)	0.49 (0.71)	5.81 (2.59)	−0.37 (0.69)	23.67 (6.23)
GA	60.08 (12.29)	71.92 (27.05)	−0.23 (0.66)	17.38 (9.42)	0.03 (0.49)	16.17 (3.16)

Table 2: Mean age (SDs) in months, means of raw scores (SDs) and Z points (SDs) on the PPVT and TCGB. Means of raw scores (SDs) on the Raven's test of children with SLI and their TD controls.

they all had a nonverbal IQ within normal limits (IQ > 85 at Raven). All children with SLI were individually matched to TD peers; gender matching was also observed. No differences between the SLI group and the TD control groups were found in a number of one-way ANOVAs: no age differences between children with SLI and age TD controls (CA) ($p = 0.9281$), no differences in the TCGB raw scores between children with SLI and grammar TD controls (GA) ($p = 1$).[9] Group data of children with SLI and their TD controls are represented in Table 2 above.

Informed consent was collected from the children's parents prior to testing. Parents, educators and speech therapists were informed of the results of the study. The study was approved by the Ethics committee of the University of Milano-Bicocca according to the standards of the Helsinki Declaration (1964).

[9] Nor were there differences in the PPVT raw scores between children with SLI and GA ($p = .8636$).

5.2 Materials

In our study we tested the comprehension of SRCs as in (9), ORCs as in (10) and PRCs, as in (11).

(9) Fammi vedere il cane che insegue il cavallo. **SRC**
Let-me see the dog that chases the horse
'Show me the dog that is chasing the horse.'

(10) Fammi vedere il cane che il cavallo insegue. **ORC**
Let-me see the dog that the horse chases
'Show me the dog that the horse is chasing.'

(11) Fammi vedere il cane che è spinto dal cavallo. **PRC**
Let-me see the dog that is pushed by-the horse
'Show me the dog that is pushed by the horse.'

Since we know that number and animacy mismatch improves ORC comprehension, RC heads and embedded DPs were definite singular DPs denoting animate characters across all conditions: we kept the type of intervening features constant across conditions and we manipulated intervening configurations. All sentences were semantically reversible. For these reasons, SRCs were potentially ambiguous between a subject and an object interpretation since Italian allows post verbal subjects. In fact, in (9) both the DP *il cane* 'the dog' and the DP *il cavallo* 'the horse' are singular and potentially agree with the singular embedded verb *insegue* 'follow' (see discussion in footnote 2). However, despite their grammatical ambiguity, SRCs like (9) have been shown to be straightforwardly and exclusively interpreted as SRCs, unless the context makes available the object interpretation (Carminati et al. 2006). ORCs as in (10) were disambiguated by the preverbal position of the embedded DP, as in English. PRCs were unambiguous copular passive constructions with an agentive by phrase in the post-verbal position. For the experimental sentences, we used 30 lexical transitive verbs denoting reversible actions; 10 of these were randomly selected to construct PRCs, such as the one in (11). The remaining 20 verbs were used to build 20 SRCs and 20 ORCs, such as those in (9) and (10). We then created two different lists so that each verb was present in each list in one condition only.

Since we did not want to test the comprehension of potentially ambiguous and unambiguous structures in the same session, because it might be confusing for the children, we decided to divide the experiment into two sessions: in session one we tested their comprehension of the 10 SRCs, with 10 fillers (RCs with intransitive verbs); in session two, the comprehension of 10 PRCs, 10 ORCs and 20 fillers. Sentences were randomly ordered; we added 3 practice sentences to each list. The experimental sentences were introduced by the lead-in *fammi vedere* 'show me' and were digitally recorded by a female native speaker of Italian at a natural pace and prosody. Participants were randomly assigned to lists.

5.3 Procedure

Children were tested individually, in two different sessions on different days in different weeks within one month. TD children were tested in a quiet room at their schools, children with SLI at their speech therapy centers. RC comprehension was investigated using a picture selection task administered through a portable computer. Before the children heard a sentence containing an RC, two pictures appeared on the screen of the computer, one representing the correct RC meaning and one representing the reversed meaning. The researcher administrating the task introduced the characters depicted in the pictures by using the DPs occurring in the RCs in order to reduce the children's lexical access

difficulties (Adani 2011; Arosio et al. 2012). Afterwards, the children heard an RC played through loudspeakers connected to the portable computer. The side of the screen where the matching picture appeared was counterbalanced across trials; the order of presentation of the characters was also counterbalanced across trials. The children were asked to indicate which picture represented the sentence meaning by pointing at one of the pictures.

5.4 Results of Study 1

Since SRCs as in (9) exclusively receive a subject interpretation, unless the context provides strong pragmatic cues, we conventionally classified SRC responses as correct when children associated a subject interpretation to those sentences, as done in the standard experimental procedure. Proportions of response accuracy for RC comprehension in children with SLI and their TD controls are reported in Table 3 and Figure 1 below.

As we can observe, all children are at ceiling in their comprehension of SRCs. Namely, they all interpret them as subject RCs, as expected. Concerning ORCs and PRCs, accuracy decreases in all groups, but more drastically in children with SLI.

We carried out a number of repeated measure logistic regression analyses in a mixed model using a backward elimination procedure to compare the goodness of fit of the models (Baayen 2008). All statistical analyses were conducted using R (version 2.13.1; R Core Team (2013)); LanguageR package (version 1.4; R Core Team 2013) was used for mixed modeling (Baayen 2011).

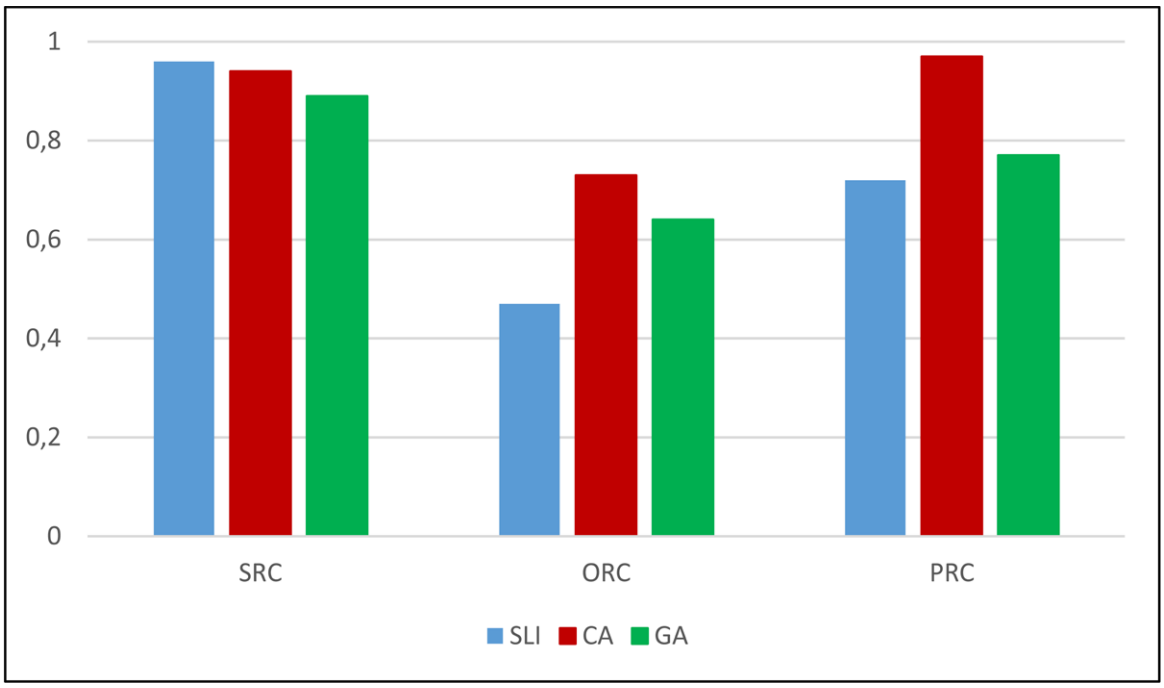

Figure 1: Response accuracy in RC comprehension in children with SLI and TD controls.

	SRCs mean (SD)	ORCs mean (SD)	PRCs mean (SD)
SLI	0.96 (0.20)	0.47 (0.50)	0.72 (0.45)
CA	0.94 (0.23)	0.73 (0.44)	0.97 (0.22)
GA	0.89 (0.31)	0.64 (0.48)	0.77 (0.42)

Table 3: Proportions of raw score (SDs) of response accuracy in RC comprehension in children with SLI and TD controls.

RC_TYPE	Estimate	SE	Z	p
SRC – ORC	–2.2593	0.2448	–9.231	< 0.001
SRC – PRC	–1.1068	0.2592	–4.271	< 0.001
ORC – PRC	1.1470	0.1804	6.359	< 0.001
GROUP				
SLI – CA	1.2262	0.2753	4.454	< 0.0001
SLI – GA	0.3224	0.2518	1.280	0.2 ns
INTERACTIONS				
SLI-CA : SRC-ORC	1.5461	0.6746	2.292	0.0219
SLI-GA : SRC-ORC	1.7797	0.6159	2.889	0.0038
SLI-CA : SRC-PRC	2.7964	0.8311	3.365	0.0008
SLI-GA : SRC-PRC	1.3105	0.6321	2.073	0.0381
SLI-CA : ORC-PRC	1.2504	0.6262	1.997	0.0458
SLI-GA : ORC-PRC	–0.4692	0.4043	–1.160	0.2458 ns

Table 4: Estimated coefficients for GROUP, RC_TYPE and their interaction in children with SLI and TD controls.

First we conducted an analysis with LIST (List1, List2) as a fixed factor, SUBJECT and ITEM as random factors and ACCURACY as a dependent variable. Since no LIST effect was found, we collapsed the data of the two lists. Successively, we carried out the analyses with RC_TYPE (SRC, ORC, PRC) and GROUP (SLI, CA, GA) as fixed factors, SUBJECT and ITEM as random factors and ACCURACY as a dependent variable. According to the analyses, we found an effect of GROUP, an effect of RC_TYPE and interactions between the two factors. Estimated coefficients, standard errors, Z-values and associated p-values for the RC_TYPE, GROUP factors and their interactions are summarized in Table 4.

As indicated by the coefficients reported in Table 4, accuracy in PRC comprehension is better than in ORC comprehension for all groups, with some differences. In fact, while the comprehension of ORCs in children with SLI is different from the two TD groups, the comprehension of PRCs is different from CA but not from younger GA children. Moreover, while the comprehension of ORCs is at chance in children with SLI and above chance in all the TD groups, the comprehension of PRCs is above chance in all groups.[10] In order to investigate whether age is an influential factor for RC comprehension in children with SLI (aged 6;1 to 10;2 years) and in TD controls, we performed a number of repeated measure logistic regression analyses in a mixed model, with subjects' AGE and GROUP (SLI vs CA) as independent fixed factors, SUBJECT and ITEM as random factors, and ACCURACY as a dependent variable. These analyses did not reveal any effect of age nor any interaction between AGE and GROUP. Additional analyses with age clusters did not reveal any AGE effect nor any interaction between AGE and GROUP. Our data confirm that TD speakers of Italian have no problems with RC comprehension after age 6 and show that problems affect children with SLI in our group regardless of their age, indicating that it is a long lasting problem.

Since both ORC comprehension and PRC comprehension are problematic for children with SLI as a group, in order to better understand the individual severity of the deficit we

[10] As we can see from Table 3, the mean of the GA group's raw scores of response accuracy in SRC comprehension is a bit lower than that of the SLI and CA groups. This difference is not statistically significant.

considered individual mean scores in ORC and PRC comprehension and examined their deviations from the mean scores of the CA group (Z points). Concerning ORCs, all children with SLI scored below the mean score of their CA group, with 10 out of 12 children scoring more than 1 standard deviation (SD) below the CA mean. Concerning PRCs, three children with SLI scored 0.93 SD below the CA mean and six children more than 2 SDs. These are the children who had the lowest scores in ORC comprehension.

5.5 Discussion for Study 1

Study 1 confirms previous findings that RC comprehension is challenging for children with SLI. Moreover, by investigating their comprehension of PRCs and ORCs, it suggests that interference effects, as modelized by a featural approach to Relativised Minimality, are found in children with SLI. Since their comprehension of PRCs is above chance and less problematic than their comprehension of ORCs it indicates that the problems children with SLI have with RC comprehension do not mainly depend on a structure building deficit. Rather they depend on interference effects that impact challenging thematic role assignment operations found in sentences with non-canonical orders of verbal arguments. In PRCs, interference effects are absent but the computation of complex structural relations is still required in order to assign a theta role to the verb argument moved to the subject position. This is presumably the source of the difficulties encountered by children with SLI in PRC comprehension; this explanation is not new; it was proposed to account for deficits in the interpretation of full verbal passive sentence in 11-year-old English speaking children with SLI (van der Lely 1996). The fact that children with SLI in our study are not different from younger GA controls in their comprehension of PRCs is unsurprising since TD children aged 6;5–6;11 years still have problems with PRCs. This was shown by Contemori and Belletti (2014) who report 76% accuracy for these structures at that age, a percentage very similar to our 77%.[11] Interestingly, our statistical analyses pointed out that PRCs are more easily understood than ORCs in all groups and that the difference between PRC and ORC comprehension in children with SLI is not distinct from the difference between PRC and ORC comprehension in children in the GA group. These results are consistent with the findings by Contemori and Belletti (2014). In ORCs, in addition to the computation of complex structural relations required to assign a theta role to the object in a non-canonical position, we find interference effects. In this case, children have to compute whether the feature sets of the head and of the embedded subject are distinct. Since the feature set of the embedded subject is included in the feature set of the head, this computation is costly, particularly challenging for children with SLI, and it adds to the cost of computing a theta role assignment to an argument moved to a non-canonical and non-local position. For these reasons, ORCs are particularly challenging for children with SLI. Interestingly, Study 1 shows that the interference effects found in children with SLI are analogous to those described in TD children by Contemori and Belletti (2014) and suggests that SLI is a problem related to the processing of complex structural relations (van der Lely 1998). Of course, this hypothesis needs further evidence by investigating ORC and PRC comprehension in children with SLI with different types of intervening embedded subjects and with measures of subjects' computational resources (working memory and short term memory). Finally, data from the individual analysis suggest that the failure to understand ORCs is a phenomenon that should be broadly investigated as a potential clinical marker for SLI in Italian.

[11] Notice that difficulties in PRC comprehension in GA controls does not seem to entirely depend on problems in mastering passives in general, since Italian speaking children can master the passive structure earlier, at the age of three and four, as shown by Manetti (2013) and Volpato, Verin and Cardinaletti (2015).

6 Study 2: the comprehension of RCs in Italian speaking children with DD

6.1 Participants for Study 2

Thirteen Italian monolingual children with DD (2 females, mean age 10;7 years (SD 15 months), range 8;7–13;3) participated in our study. They were recruited from the speech therapy centers where children with SLI were recruited and they were diagnosed as having DD on standard criteria by certified expert clinicians (ICD-10; World Health Organization 2004). These children had no diagnosed or reported speech problems, language difficulties, nor hearing deficits; they were enrolled in a dyslexia therapy program. In order to participate in the study, they had to have age-appropriate lexical abilities, grammatical abilities and nonverbal cognitive abilities. In order to satisfy these selection criteria, the children with DD participating in our study were given the Raven's test, a grammar comprehension standardized test (TCGB, TROG-2), and the PPVT test. All children had a nonverbal IQ within normal limits (IQ $>$ 85 at Raven). The PPVT test has norms up to 11;6 years and two children with DD and their age controls were older than 11;6 when we administered it (the children with DD were 13;4 years old, the age controls were 13;3 and 13;6). For them, the administration of the test started at item 90, indicated in the PPVT manual as the starting point for children who are 12 years old.[12] The children had age appropriate scores on the PPVT. Concerning grammar proficiency, at the time the study started the only standardised test available for Italian was the TCGB, which has norms up to age 8. In Italy, developmental dyslexia is diagnosed at the end of second grade, typically after age 8, an age at which the use of TCGB is not very telling. However, in order to have a measure of grammatical abilities, the first four children with DD who participated in the study were administered the TCGB. Their scores were at ceiling. The rest of the children with DD, who participated later, were administered the TROG-2 (Bishop 2009), a standardised test including norms for children over 8, which was available at that later time. Their scores were age appropriate. The children with DD were additionally given the standardized proficiency reading test DDE-2 (Sartori, Job & Tressoldi 2007) including a word reading task and a pseudoword reading task. Individual data for the DD participants are reported in Table 5.

Children with DD were initially matched to 13 TD children of the same chronological age ($\pm$ 3 months), according to the same matching criteria used in the SLI matching. Although they had age appropriate scores on the PPVT test, a one-way ANOVA revealed a significant difference between scores on the PPVT of the children with DD and their CA controls ($p = .01$).[13] For this reason, children with DD were also matched to a group of 13 TD children of the same vocabulary (VA control group) as measured by the PPVT test ($\pm$ 3 points). This made it possible to compare RC comprehension in a group of slightly younger TD children of a comparable vocabulary, as measured by the PPVT test. The mean age of the VA group was 9;2 years (SD 15 months) and its range was 7;8–11 years. According to a number of one-way ANOVAs there were no age differences between children with DD and the CA controls ($p = .31$) and no PPVT raw score differences between children with DD and VA controls ($p = .81$). Group data of children with DD and their TD controls are represented in Table 6 below.

As for the participants in the DD group and their controls, informed consent was collected from children's parents prior to testing. Parents, educators and speech therapists were informed of the results of the study. The study was approved by the Ethics committee

[12] As reported in Table 5, the Z points of the two children with DD are reported as lower than Z points corresponding to age 11;6 years.

[13] Vocabulary size has been reported to be deficient in young speakers with DD (see Snowling & Melby-Lervåg 2016). Clearly, exposure to written language improves vocabulary size, especially in young learners. However, DD participants had age appropriate scores, as shown in Table 5.

	AGE	PPVT Z Points	TCGB raw scores or TROG-2 Z points	Raven percentiles	WORD Reading accuracy Z points	WORD Reading speed Z points	NON WORD Reading accuracy Z points	NON WORD Reading speed Z points
S1	129	–0,66	1.0^{TCGB}	75	–1.1	–2.3	–1.1	–0.1
S2	125	–0.93	0.5^{TCGB}	75	–2.1	3.8	–3.0	–2.3
S3	129	0.20	0.53^{TROG2}	75< x <95	–4.3	–3.5	–4.0	–2.6
S4	129	–0.26	0.53^{TROG2}	75< x <95	–2.6	–1.2	–2.2	–1.0
S5	160	<–0.80	0.5^{TCGB}	75< x <95	–3.0	–3.9	–3.0	–3.6
S6	136	–0.66	0.5^{TCGB}	50	–1.9	–2.6	–3.0	–3.6
S7	118	0.41	0.2^{TROG2}	75< x <95	–1.7	–3.0	–2	–3.2
S8	160	<–0.40	0.47^{TROG2}	95	–3.0	2.4	–1.6	–1.8
S9	126	1.06	1.27^{TROG2}	25< x <50	–0.3	–2.1	–0.5	–1.5
S10	126	1.40	1.27^{TROG2}	95	–1.0	–2.1	–1.0	–1.7
S11	127	1.26	0.86^{TROG2}	25< x <50	–1.3	–3.0	–2.1	–2.3
S12	104	0.40	–0,86^{TROG2}	25< x <50	–1.5	–2.0	–1.2	–2.0
S13	118	1.00	0.47^{TROG2}	25< x <50	–3.0	–1.4	–1.0	–0.2

Table 5: Age in months, Z points at PPVT, TCGB raw scores or TROG-2 Z points, Raven's percentiles and Z points for reading accuracy and speed for words and non-words of children with DD.

	AGE months Mean (SD)	PPVT raw score mean (SD)	PPVT Z points mean (SD)	Raven raw score mean (SD)	Word reading		Non word Reading	
					Accuracy mean (SD)	Speed mean (SD)	Accuracy mean (SD)	Speed mean (SD)
DD	129.77 (15.46)	132.92 (15.45)	0.16 (0.83)	31.00 (4.04)	–2.06 (1.08)	–1.61 (2.24)	–1.94 (1.07)	–2.01 (1.11)
CA	130.46 (15.41)	147.38 (13.85)	0.79 (0.56)	32.31 (3.99)	–	–	–	–
VA	110.92 (15.26)	132.38 (16.26)	0.70 (0.31)	30.23 (3.56)	–	–	–	–

Table 6: Mean age (SDs) in months, means of raw scores (SDs) and Z points (SDs) on the PPVT of children with DD and their TD controls. Means (SDs) of raw scores on the Raven's test of children with DD and their TD controls. Means of Z points (SD) on the word reading and pseudoword reading tasks of children with DD.

of the University of Milano-Bicocca according to the standards of the Helsinki Declaration (1964).

6.2 Materials

Children with DD were administered the same RC comprehension task that was administered to the children with SLI participating in Study 1

6.3 Procedure

In Study 2 we made use of the same procedure used in Study 1.

6.4 Results of Study 2

Proportions of response accuracy for RC comprehension in children with DD and TD controls are reported in Figure 2 and Table 7 below.

As we can observe, all the children are at ceiling in their comprehension of SRCs, namely they all interpret the sentence as an SRC. All the children are almost at ceiling in their comprehension of PRCs. Concerning ORCs, accuracy is at ceiling in CA controls and it decreases in younger VA controls, and even more drastically in children with DD.

We carried out the same statistical analysis previously carried out for children with SLI and their controls and we collapsed the data of the two lists, since no list effect was found. We found an effect of GROUP, an effect of RC_TYPE and an interaction between these factors. Estimated coefficients, standard errors, *Z*-values and associated *p*-values for RC_TYPE, GROUP and their interactions are summarized in Table 8.

As indicated by the coefficients reported in Table 8, children with DD interpreted SRCs as subject RCs and made more errors than both control groups did, mainly in their comprehension of ORCs. A number of repeated measure logistic regression analyses showed that age was not an influential factor for RC comprehension in children with DD or in TD controls.

Analogously to Study 1, in order to evaluate the severity of the deficit we considered individual mean scores on ORC comprehension and examined their deviations from the mean scores of the CA group (Z points). Results show that 10 out of 13 children with DD scored below the mean score of their CA group. Interestingly 8 children scored more than

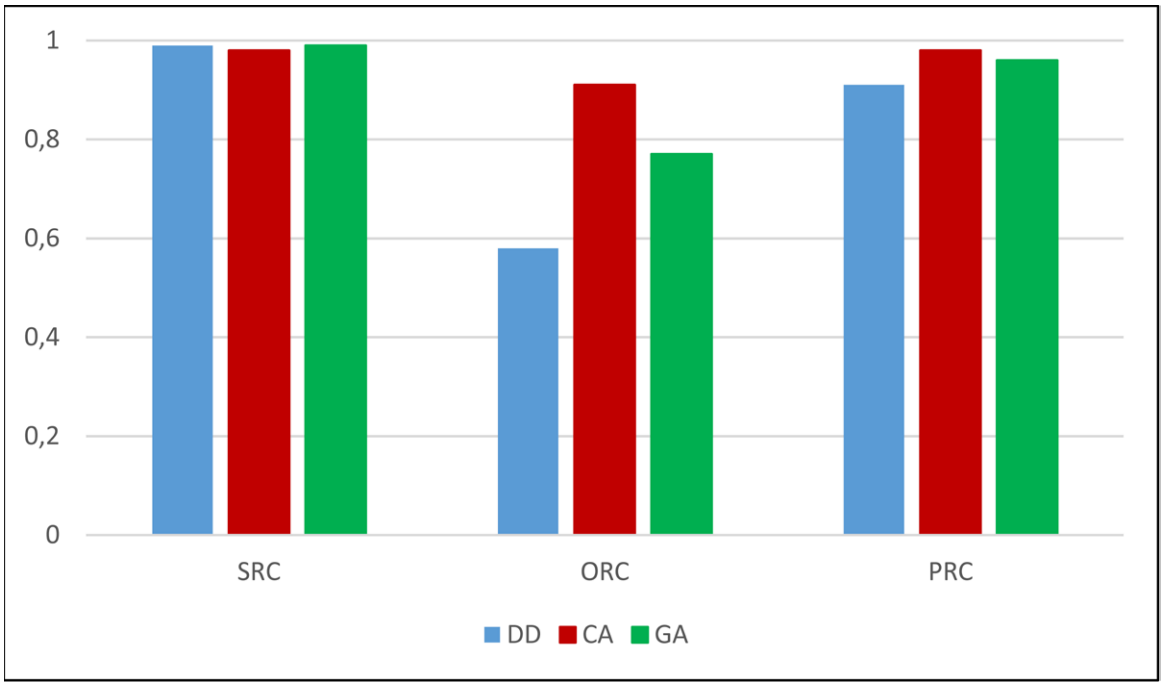

Figure 2: Response accuracy at RC comprehension in children with DD and their controls.

	SRCs mean (SD)	ORCs mean (SD)	PRCs mean (SD)
DD	0.99 (0.09)	0.58 (0.49)	0.91 (0.29)
CA	0.98 (0.12)	0.91 (0.29)	0.98 (0.15)
VA	0.99 (0.09)	0.77 (0.42)	0.96 (0.19)

Table 7: Proportions of raw scores (and SDs) of response accuracy at RC comprehension in children with DD and their controls.

RC_TYPE	Estimate	SE	Z	P
SRC – ORC	–3.8946	0.5679	–6.858	<0.001
SRC –PRC	–1.7450	0.6002	–2.907	0.004
ORC – PRC	2.1496	0.3044	7.063	<0.001
GROUP				
DD – CA	1.9686	0.5650	3.484	<0.001
DD – VA	1.0338	0.5259	1.966	0.049
INTERACTIONS				
DD-CA : SRC-ORC	3.0254	1.3765	2.198	0.028
DD-VA : SRC-ORC	0.9658	1.5586	0.620	0.535 ns
DD-CA : SRC-PRC	2.2551	1.4945	1.509	0.131 ns
DD-VA : SRC-PRC	0.9878	1.6301	0.606	0.544 ns
DD-CA : ORC-PRC	–0.7702	0.7995	–0.963	0.335 ns
DD-VA : ORC-PRC	0.0220	0.6702	0.033	0.974 ns

Table 8: Estimated coefficients for GROUP, RC_TYPE and their interaction in children with DD and TD controls.

2 SDs below the CA mean, 7 of which scored below 3 SDs. Focusing on PRC comprehension, we also examined the Z points of children with DD: one child scored 1 SD below the CA mean, one child 3 SDs; these are two of the children who had the lowest scores on ORC comprehension. No other child with DD scored equal to or more than 1 SD below the CA mean in PRC comprehension.

6.5 Discussion for Study 2

Our data confirm that a number of children with DD have deficits in their comprehension of ORCs: they lag behind CA controls but are not different from VA controls. As we argued in Study 1, this is expected since the VA controls are about 2 years younger than the children with DD and their CA controls, and we know that young Italian TD children still have problems with ORCs at that age (Arosio et al. 2009; Contemori & Belletti 2014). On the contrary, their comprehension of PRCs is at ceiling, similar to that of SRCs; there are no differences in PRC comprehension between children with DD and TD controls as a group. This suggests that children with DD do not have problems with the movement of the object per se, in RC comprehension, but, rather, they have problems moving an RC head across an embedded subject endowed with a feature subset of the head. As we argued in Study 1, this hypothesis needs further evidence by investigating ORC and PRC comprehension in children with DD with different types of intervening embedded subjects and with measures of subjects' computational resources. Finally, our results have further implications since they show that a significant group of children with DD has a consistent language deficit. In fact, a large number of children with DD scored drastically lower than 3 SDs below the CA mean.[14] This is particularly striking, if we consider that it is not usual practice (in Italy) to evaluate these children grammatical abilities, due in part to the unavailability of norm-referenced language tests for their age. Since DD and SLI often co-occur (McArthur et al. 2000; Bishop & Snowling 2004; Catts et al. 2005) and children with

[14] The fact that children with DD lag behind their CA controls more than children with SLI presumably depends on the different age of the two control groups. In fact the CA controls for SLI are much younger than the CA controls for DD.

DD are referred to clinical services during the school years, our results can help establish whether these children are also affected by a milder SLI. Of course, this conjecture needs further investigation, although it seems on the right track, since a number of recent studies have reported linguistic weaknesses in some DD children in areas that identify SLI. For instance, in a recent study, Arosio and colleagues (Arosio et al. 2016) report that a consistent number of children with DD fail to produce 3rd person singular direct object clitic pronouns. This phenomenon is identified as a persistent clinical marker of SLI in Italian (Arosio et al. 2014; Bortolini et al. 2006). At a clinical level, our study recommends that an evaluation of ORC comprehension should be included in testing materials for identifying language deficits. It also points out that the development of these materials should be motivated by properties of language representations explicitly modeled by linguistic theories of language architecture.

7 Conclusions

Our study confirms previous findings that RC comprehension is challenging for both children with SLI and those with DD, with problems mainly restricted to ORCs. In fact, while the comprehension of SRCs is unproblematic, the comprehension of PRCs is better than that of ORCs and is above chance in all groups. Our study shows that problems in RC comprehension are similar in young TD children and in children with SLI. In fact, if we compare our results with the results from Contemori and Belletti (2014), we observe that ORSs and PRCs are more problematic than SRCs for both younger typically developing children and those with SLI, with PRCs better understood than ORCs in both groups. Interestingly, while TD children persistently increase their comprehension of ORCs over time and promptly develop an adult comprehension of PRCs, children with SLI have consistent problems with ORC comprehension and their comprehension of PRCs seems not to develop fully. This is further suggested by the fact that problems with RCs in the participants with SLI are not modulated by age. On the contrary, the comprehension of PRCs is unproblematic for children with DD but their comprehension of ORCs is challenging, as it is for older TD children (Contemori & Belletti 2014; and CA controls in Study 2). Given the picture above, even though a direct comparison between SLI participants and DD participants is not allowed due to the heterogeneity of the two groups, our research suggests that interference effects, as modelized by a featural approach to Relativised Minimality are found to different degrees in TD children, those with SLI and those with DD. Moreover, our results suggest that a large number of children with a diagnosis of DD, who have no reported or certified language deficits, actually have oral language problems. As seen from the individual analysis, children who have problems in PRC comprehension are those who have severe deficits in ORC comprehension. Since this holds true for both the SLI and the DD group, our data suggest that the severity of the language impairment can be qualified by whether children have deficits in ORC comprehension only or in both ORC and PRC comprehension with respect to their TD peers. In our study we argued that this difference depends on whether children have problems in moving an object per se, in a position yielding uncanonical word order, or moving an object across a constituent endowed with similar features. Moreover, our results recommend that an evaluation of grammatical abilities should include RC comprehension and should become routine in DD diagnosis. This is important at a theoretical level and also at a clinical level, since identifying language deficits requires proper linguistic treatment, which in turn makes the use of compensatory instruments for coping with literacy in DD (i.e. audio books) effective. The study of language deficits in children with reading problems can foster our understanding of the relation between reading deficits and linguistic deficits, and leaves open

the question of whether DD and SLI are simply unrelated disorders, accidentally present in some children, or whether there is a multicomponent DD subtype with associated language deficits (Peterson & Pennington 2015).

Abbreviations

CA = typically developing age control, CP = complementizer phrase, DD = Developmental Dyslexia, DDE-2 = Devolopmental Dyslexia reading test (*Batteria per la Valutazione della Dislessia e della Disortografia Evolutiva-2*), DP = determiner phrase, GA = typically developing grammar control, ICD-10 = International Statistical Classification of Diseases and Related Health Problems 10th Revision, IQ = intelligence quotient, NP = noun phrase, ORC = object relative clause, PRC = passive relative clause, PPVT = Standardized Receptive Vocabulary Test, RC = relative clause, SD = standard deviation, SLI = Specific Language Impairment, SRC = subject relative clause, TCGB = Test di Comprensione Grammaticale per Bambini, TD = typically developing, TROG = Test for Reception of Grammar, TROG-2 = Test for Reception of Grammar – Version 2, VA = typically developing vocabulary control, VP = verbal phrase.

Competing Interests

The authors have no competing interests to declare.

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