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Semantic and Pragmatic Abilities Can Be Spared in Italian Children with SLI

Fabrizio Arosio[a], Francesca Foppolo[a], Elena Pagliarini[b], Maria Perugini[c], and Maria Teresa Guasti[a]

[a]Dipartimento di Psicologia, Università degli Studi di Milano-Bicocca; [b]Center for Brain and Cognition, Departament de Tecnologies de la Informació i les Comunicacions, Universitat Pompeu Fabra; [c]Unità di Neuropsichiatria Infantile, Azienda Ospedaliera della Provincia di Pavia

ABSTRACT

Specific language impairment (SLI) is a heterogeneous disorder affecting various aspects of language. While most studies have investigated impairments in the domain of syntax and morphosyntax, little is known about compositional semantics and the process of deriving pragmatic meanings in SLI. We selected a group of sixteen monolingual Italian-speaking children with SLI (mean-age 7;4) with a severe morphosyntactic deficit at the receptive and expressive level. We tested their comprehension of quantified sentences including *all* and *some* in order to establish whether they were competent with the logical and pragmatic meanings of these quantifiers. Children performed as well as their typically developing controls in understanding logical meanings. In comprehending pragmatic meanings, they obtained lower scores than age-matched controls but they were not different from language-matched children. However, differences in this ability correlated positively with age and with the ability to understand simple sentences in the SLI group. This suggests that aspects of the syntactic component might be involved in the development of this ability and that, despite their severe morphosyntactic deficits, children with SLI might catch up with their peers in deriving pragmatic meanings.

Introduction

Specific language impairment (SLI) is a broad term that refers to a heterogeneous population with deficits in many linguistic domains. In recent decades, different SLI sub-groups have been identified on the basis of dissociations emerging in the different domains (Conti-Ramsden & Botting, 1999; Conti-Ramsden, Crutchlet, & Botting, 1997; Dockrell, Messer, & Murphy, 2005; Friedmann & Novogrodsky, 2008; Rapin & Allen, 1983; Schaeffer, 2003a, 2003b; Van Daal, Verhoeven, & Van Balkom, 2004; Van Der Lely, 1996, 2005). In particular, a number of studies have found SLI subgroups with pragmatic deficits despite preserved language abilities, such as syntax (Friedemann & Novogrodzky, 2008). Failures in logical inferencing and unconventional conversational responses, impaired development of theory of mind and inappropriate communicative skills are some of the problems found in children with pragmatic deficits (Bishop, 1998, 2000; Bishop, Chan, Hartley, Adams, & Weir, 2000; Botting & Adams, 2005).

In this article, we investigate the ability of children with SLI with syntactic and morphosyntactic deficits in both production and comprehension to understand quantified sentences that are based on set-theoretic relations. Crucially, these sentences involve (a) one aspect of pragmatics related to Gricean conversational maxims and (b) one aspect of logical syntax and compositional semantics that is related to the comprehension of sentential structures and operators of quantification. Although competence in these areas is relevant for logical reasoning and inferencing,

CONTACT Fabrizio Arosio fabrizio.arosio@unimib.it Dipartimento di Psicologia, Università degli Studi di Milano-Bicocca, Piazza dell'Ateneo Nuovo, 1 - 20126, Milano, Italia.

and it is important for the acquisition of school competence and everyday communication, little research has been carried out with SLI children. In this study we aim at testing the status of the compositional semantic component in a population of children with SLI with impaired syntax and morphosyntax. Specifically, we investigate whether these children have maintained competence on set-theoretic relations on which the meaning of quantifiers is based, despite their impairment in other language domains. In addition, we also test their competence with quantifiers that involve pragmatic inferencing in order to gather new data about the development of the pragmatic component in this population. It is relevant to document the extent of the deficit in the areas of semantics and pragmatics in SLI from a theoretical perspective to understand the organization of the language faculty itself. This would also provide new insights for setting up rehabilitation programs, which may exploit areas of strength in children with SLI, with consequent benefits in other domains.

This article is organized as follows. First, we introduce some concepts relevant to understanding the semantics and pragmatics of quantification. Then, we review some of the literature on this topic in typically developing (TD) children and in those with SLI. Finally, we present our study and discuss the implications of our results.

Quantified sentences and the generation of pragmatic inferences

To understand the meaning of simple sentences like (1) and (2), we first need to know the meaning of the quantifiers *some* and *all*, namely the set relation denoted by these quantifiers, which is required to hold for the sentence to be true.

(1)*Some of the apples are in the box.*
(2)*All the apples are in the box.*

For instance, the existential quantifier *some* requires the intersection between the set of things that are apples and the set of things that are in the box to be a nonempty set in order for sentence (1) to be true. Nonetheless, this might not be enough to use (1) appropriately in ordinary conversations. In fact, (1) is typically rejected as false by adult English speakers when it is uttered in a context where all the apples are in the box, despite the fact that, in this situation, the set relation denoted by the quantifier *some* is, logically speaking, satisfied. Saying that *some of the apples are in the box* when *all* of them are, satisfies the logical requirements for the sentence to be true, but provides less information than required in a cooperative exchange. In a word, (1) would be *under-informative* in a situation in which (2) is true. Starting from the assumption that the speaker is being cooperative and obeying conversational maxims (Grice, 1975), the hearer of (1) will typically infer (3), which is false in a context in which (2) is true, thus interpreting (1) as in (4):

(3)*Not all the apples are in the box*
(4)*Some but not all apples are in the box*

The inference in (4) is referred to as a Scalar Implicature (SI henceforth), i.e., a pragmatic enrichment that is typically conveyed by the use of a weak scalar term like *some*, which appears low in the entailment scale <some, all> (Horn, 1972). According to this scale, the higher element entails the weaker one, since, if it is true that all the apples are in the box, then it is true that all the subsets of apples within the relevant set are in the box. Due to this entailment relation among the quantifiers in the scale, the utterance in (1) is weaker than the utterance in (2), since (1) is true in a larger set of situations than (2). (2) is true in situations in which all the apples are in the box; (1) is true in situations in which all the apples are in the box and in situations in which subsets of apples within the relevant set are in the box. In terms of quantity of information conveyed, (1) turns out to be less informative than (2). On the basis of the Principle of Cooperation and the Maxims of Conversation that urge us to provide the most accurate and complete description of the facts, if a speaker utters (1), the hearer is entitled to infer that she

has no evidence for saying that all apples are in the box (i.e. (2)) or she knows that it is not the case that all apples are in the box (i.e., (3)); hence, the inference in (4).[1]

In the linguistic literature we find a long lasting debate on how this inference is conveyed (see Chemla & Singh, 2014a, 2014b and Sauerland, 2011; for a clear cut overview). According to a standard *Pragmatic* approach, based on the pioneering work of Horn (1972) and Grice (1975, 1989), the unsaid content is not directly part of the sentence compositional truth conditional meaning, but it is rather derived from conversational principles requiring the speaker to be conversationally cooperative and to use the most informative statement in a given context. According to this approach, an SI is thus derived at a second step in the derivation of the global sentence meaning by means of pragmatic reasoning about the speaker's intentions and on top of the derivation of the literal meaning of the sentence (e.g., Grice, 1975; Russell, 2006; Sauerland, 2004).

Recently, this view has been challenged. Chierchia (2006, 2013), Fox (2007) and Chierchia, Fox, and Spector (2012) developed a *Grammatical* view according to which SIs are computed "recursively and compositionally, on a par with ordinary meaning computation" (Chierchia, 2006, p. 544) and, therefore, are not part of a post-grammatical process. In this approach, scalar implicatures result from an exhaustification operation on alternatives that is carried out at the semantic level of computation by the semantic/pragmatic modules working in tandem. In our example, a sentence like (1) activates the alternative sentence (2), which is negated via the application of a silent exhaustification operator (*Only*) applied to *some* in (1) during the processing of the quantifier: this operation occurs during the first stage of sentence meaning computation and it rules out all the other (relevant and salient) alternatives (e.g., (2)), leading to the embedded inference "*some but not all apples are in the box*" reported in (4).

Experimental research has shown that adults generally derive scalar implicatures and mixed evidence has been found in support of one or the other account of their derivation (cf. Chemla & Singh, 2014b for an overview), although evidence is not conclusive. In the case of acquisition, experimental work with different languages shows that children generally do not display adult-like performance with sentences that trigger an SI. Children fail to reject under-informative statements like (1) in which *some* is used to describe a situation in which *all* would be pragmatically more appropriate. This pattern has been documented cross-linguistically, with different tasks and different scalar items. For example, Noveck (2001) found that French 7-year-olds only derived the SI associated with *some* 11% of the time in a sentence evaluation task; similar performance was reported by Papafragou and Musolino (2003) for 5-year-old Greek-speaking children (12.5% of SI derivation). Katsos, Roqueta, Estevan, and Cummins (2011) documented the non-adult like performance of Spanish-speaking children, who computed the SI related to *some* only 36% of the time (mean age group: 4;6); a similar performance in the same task was found with 5-year-old English-speaking children by Katsos and Bishop, 2011 (26% of SI computation). Foppolo, Guasti, and Chierchia (2012) showed that Italian-speaking children at age 5 rejected under-informative statements with *some* 50% or 72% of the times depending on the task, and reached adult-like performance only at age 6, despite being adult-like in their comprehension of the quantifiers when an SI was not involved.

As noted by Guasti et al. (2005) and Foppolo et al. (2012), children's performance falls into a bimodal distribution, indicating that this ability depends on the individual stage of maturation. While most of the children tend to consistently accept under-informative SOME-statements, some children consistently reject them. Moreover, the experimental setting and the task demands modulate this difficulty (Foppolo et al., 2012).

The source of children's general difficulty with SI derivation is still under debate: some scholars consider this difficulty as pragmatic in nature, ensuing from children's yet immature pragmatic system (e.g., Noveck, 2001) or from their pragmatic tolerance (Katsos and Bishop, 2011). Others

[1]Informativity is a crucial notion in the process of SI derivation. Consider the sentence (1′), in which *some* appears in the antecedent of a conditional sentence; in this configuration, entailment relations are reversed: (1′) If some of the apples are in the box, then we have something to eat.In this case, no SI is derived, provided that (1′) does not certainly mean that "if some but not all the apples are in the box we have something to eat" (cf. Chierchia, 2013 for a discussion).

have provided a processing explanation, arguing that children fail to derive SIs because they lack the necessary processing resources required to generate alternatives (e.g., Reinhart 2004; Pouscoulous et al. 2007). A third line of explanation links children's difficulties with implicatures to a difficulty in accessing entailment scales, not because of mere processing limitations but specifically because they fail to represent relevant alternatives as members of the same scale (Barner Brook and Bale, 2011; Foppolo et al., 2012).

As mentioned in the introduction, since SLI might also affect the pragmatic component of language independently or beyond syntax and morphosyntax, an investigation of the ability to derive SIs in children with SLI might help clarify this issue. It may also offer new data about SLI children's pragmatic competence, a topic that is still under-investigated cross-linguistically. Before introducing our study, we will review the few studies that have investigated the comprehension of quantified sentences in children with SLI.

The comprehension of quantified sentences by children with SLI

Few studies have investigated SLI children's pragmatic competence. In one of these studies, Surian, Baron-Cohen and Van Der Lely (1996) tested a small group of children with SLI with impaired syntax and showed relatively well-preserved pragmatic abilities in complying with a task assessing the knowledge of Gricean conversational maxims. In their study, children were presented with short conversational exchanges in which one puppet asked a question to two other puppets (e.g., "Where do you live?") and one of them provided an answer that violated one of the conversational maxims (e.g., "I live on the moon"). Children's task was to identify the puppet that provided a silly answer. In line with Katsos et al. (2011), we express some concerns about the generalization of these conclusions. First, the group of children with SLI that was tested was very small (seven children). Second, although overall both the SLI and the TD group performed significantly above chance, a different pattern of response emerges depending on the type of maxim tested. While at ceiling performance was observed for the maxims of quality, relation and politeness, chance performance was observed for those items tapping the maxims of quantity, i.e. those maxims that are mostly involved in the generation of the kind of implicature that we are interested in here in which a comparison about informativeness is at stake. In addition, good performance on some items could be explained on the basis of world knowledge, and thus were beyond the pragmatic understanding of the conversational maxims involved. The items used to test violations of quality and relation were blatantly incongruous statements that could be rejected by children on the basis of plausibility, without considering the maxim under investigation. For example, children could have selected the answer "My favorite is sandwiches" to the question "What is your favorite program on T. V.?" as the silly one simply because they know that "sandwiches" are not a TV show, and not because they recognized that this statement is violating the maxim of relation in response to a question. Similarly, children might have spotted the answer "I live on the moon" as the silly answer to the question "Where do you live?" simply because they evaluated this statement as less plausible than the option "I live in London", and not because they recognized that this statement is violating the maxim of quality. For these reasons, we believe that Surian et al.'s study fails to provide conclusive evidence of well-preserved pragmatic understanding in children with other poor language abilities.

More recently, Katsos et al. (2011) reported that 4–9-year-old Spanish-speaking children with SLI performed worse than a group of TD age-matched controls (AM), but as well as a group of TD language-matched controls in a task specifically designed to tap into the derivation of Sis. This task had already been used in other works to test pragmatic competence in TD children. According to Katsos et al.'s results, children with SLI also had a problem with the logical meaning of quantifiers. However, we argue that in this case the results are not conclusive. First of all, the group of children with SLI tested by Katsos and colleagues was not homogeneous. The age range of children was so broad (from 4;0 to 9;0 years) that the SLI group included children who presumably had problems with SIs, but even TD children have problems with them up to at least age 6. On the other hand, the group may also have included children with SLI who had an adequate understanding of statements requiring the generation of SIs, since they

were older. Unfortunately, the study does not report an analysis of accuracy taking age into consideration, thus we do not know how age affected the children's performance. Second, language performance was clearly impaired with respect to control children, but to different degrees, since the percentile scores in the grammatical and lexical competence of some children with SLI varied considerably. For example, in grammar comprehension some children obtained a percentile score of 30, which is roughly just less than 1 SD below the mean of the normative age group (based on the means and SDs provided in Katsos et al.'s Table 2), while others got a percentile score of 4, which is more than 3 SDs below the mean of the normative age group. In a sentence recall task, some children obtained a percentile score of 25 while others scored 0. Finally, children with SLI performed worse than AM children not only in statements involving the generation of SI, but in all quantified statements, suggesting a primary problem comprehending quantified sentences, a factor that might explain their difficulties with the pragmatic inference as well.

The rationale of our study

To overcome the problems outlined above and to establish whether and how SLI children's linguistic deficits affect the semantic and/or pragmatic components of language, we tested a homogenous group of children with SLI over 6;0 years with the same task used by Katsos et al., using a subset of the items employed by them.

We examined whether children understand and evaluate the correct set relations associated with the Italian quantifiers *qualche* (*some*) and *tutti* (*all*); moreover, we investigated children's abilities to derive SIs by examining their comprehension of under-informative statements containing the quantifier *qualche* (*some*).

Participants

One group of 16 school-aged monolingual Italian children with SLI (mean age 7,4 years, range 73–118 months, 4 females) was tested for their comprehension of quantified sentences. Children were also tested in the standardised receptive grammar test TCGB (Chilosi & Cipriani, 1995), in the standardised receptive vocabulary test PPVT (Dunn & Dunn (Italian version by Stella, Pizzioli & Tressoldi, 2000)) and in a task assessing clitic pronoun production (Arosio, Branchini, Brabieri & Guasti, 2014), in order to evaluate their morphosyntactic abilities also in production. Additionally, children were tested in the standardized Raven's Coloured Progressive Matrices test (Belacchi, Scalisi, Cannoni, & Cornoldi, 2008; Raven, Court, & Raven, 1998) in order to have a homogeneous measure of their nonverbal cognitive abilities. Children with SLI were recruited from speech therapy centers in the Milan and Pavia metropolitan areas (Italy), they had been diagnosed as being specifically language impaired based on standard inclusion and exclusion criteria by expert clinicians (ICD-10; World Health Organization, 2004) and were receiving clinical services. All the children with SLI scored at least 2 SDs below the mean score for their age in the TCGB. The TCGB is a standardized test of grammatical comprehension that uses a picture selection task to evaluate the comprehension of simple sentences including transitive active constructions, locative prepositional phrases, negation, and complex sentences such as those containing relative clauses and passive constructions. The scores obtained on the TCGB indicate that the children had a severe deficit in grammar comprehension.[2] Severe

[2]Interestingly, although children scored at least 2 SDs below the mean score for their age on the TCGB, their raw scores on the test negatively correlated with their age ($r = -0.545$, $p = 0.029$), indicating that the number of errors in comprehension decreases with age (the raw score for the TCGB indicates the number of errors). An analysis of the types of errors showed that while errors occurred across different sentence types for younger subjects, older subjects mainly produced errors with relative clauses and passive constructions. This suggests that the comprehension of syntactically simple sentences not involving movements might still be under development and that the comprehension of syntactically complex sentences, requiring sophisticated morphosyntactic abilities, might not.

morphosyntactic deficits in these children are further confirmed by data of the clitic production test (Arosio et al., 2014) in which all the children scored more than 2 SDs below the mean for their age, with no correlations between raw scores on clitic production and age. Failure to produce clitic pronouns is a clinical marker of SLI in Italian at age 5 and 7;5 (Arosio et al., 2014; Bortolini et al., 2006). This additional feature indicates that all the children had a severe morphosyntactic problem in production. Thus, our group of children with SLI is homogeneous in displaying a grammatical receptive and expressive deficit affecting syntax and morphosyntax. All the children's non-verbal IQs were within normal limits (IQ>85 at Raven). Their individual scores are reported in Table 1.

Each child with SLI was individually matched to two typically developing children: one child with the same chronological age (± 3 months) (age control child—CA) and one with the same grammatical age as measured in terms of scores on the TCGB test (± 3 points) (grammar control child—GA). Control children were recruited from schools and kindergartens in the same residential areas as those in the SLI group. All the children scored within 1 SD from the mean score for their age on the TCGB and the PVVT tests. None of the children was receiving clinical services and all of them had non-verbal IQ within normal limits (IQ>85 on Raven). Children with SLI were individually matched to typically developing controls; gender matching was also observed. Group data are reported in Table 2.

No differences between the SLI group and the TD groups were found according to a number of one-way ANOVAs: no age difference between children with SLI and CA children [$F(1, 15) = 0.00$, $p = 1$]; no difference in raw scores on the TCGB test and the PPVT test between children with SLI and GA children (respectively [$F(1, 15) = 0.08$, $p = 0.78$] and [$F(1, 15) = 0.22$, $p = 0.65$]); no difference in Raven's raw scores between children with SLI and CA children [$F(1, 15) = 3.3$, $p = 0.09$].

TD children were tested in a quiet room at their schools, children with SLI in a quiet room at their speech therapy centers. Informed consent prior to testing was collected from children's parents. Parents, educators, and speech therapists were informed of the study's results at dedicated meetings. The study was approved by the Ethics committee of the University of Milano-Bicocca according to the standards of the Helsinki Declaration (1964).

Materials and procedures

We made use of a shortened version of Katsos' et al. (2011) *Cavegirl and Boxes* design testing the comprehension of sentences containing a quantified subject. In this task, the children were told that the Cavegirl, a fictional character, was learning Italian and they were asked to help her when she made errors.

Table 1. Individual data of children with SLI (np = no clitic produced, < −8.50 DS).

Child	Age	Sex	PPVT Z points	TCGB Z points	Clitic production Z points	Non verbal IQ Raven's centiles
1	7;5	M	−1.00	−6.94	−3.81	75°
2	6;4	M	−0.73	−2.00	−3.81	25°<x < 50°
3	6;1	M	−1.13	−2.51	−5.37	75°
4	7;8	M	0.66	−4.05	−3.81	50°<x < 75°
5	7;6	M	< −2.33	−2.56	np	50°
6	9;10	F	−1.87	< −2.29	−5.37	75°
7	7;4	M	< −2.33	−2.21	−8.50	75°<x < 95°
8	75	F	−0.53	−4.18	−7.72	50°<x < 75°
9	8;4	M	−0.80	−4.30	−2.25	25°<x < 50°
10	7;5	M	0.47	−2.21	−2.25	75°
11	7;6	M	−1.87	−7.96	np	75°
12	7;7	F	< −2.33	−2.56	−7.72	25°<x < 50°
13	6;10	M	−1.87	−4.81	−1.47	50°<x < 75°
14	8;3	F	−0.73	−5.76	−3.03	25°
15	6;8	M	−2.07	−2.65	np	50°<x < 75°
16	6;1	M	< −2.33	−2.93	np	25°<x < 50°

Table 2. Information about participants.

	Age Mean (SD)	PPVT raw score Mean (SD)	PPVT Z score Mean (SD)	TCGB raw score Mean (SD)	TCGB Z score Mean (SD)	RAVEN raw score Mean (SD)
SLI	87.75	76.44	−1.30	14.50	−3.84	22.94
	(11.66)	(23.73)	(0.89)	(7.61)	(1.84)	(3.78)
CA	87.75	108.40	0.04	3.69	−0.20	25.00
	(11.62)	(21.27)	(0.80)	(2.63)	(0.72)	(6.19)
CA	64.19	72.75	−0.57	14.31	−0.06	19.44
	(12.08)	(21.85)	(0.60)	(8.19)	(0.57)	(5.64)

The children saw the picture of the Cavegirl and the picture of the boxes containing toys on the screen of a PC administering the experiment; meanwhile, they heard the Cavegirl saying how many toys were in the boxes; after that, they were invited to answer a comprehension question asking whether the Cavegirl had said it right or wrong (*Did she say it right or wrong*?). Sentences uttered by the Cavegirl were digitally recorded by a female native speaker of Italian and played through loudspeakers connected to the PC. We tested the comprehension of the universal quantifier *tutti* (all) and the existential quantifier *qualche* (*some*) in locative sentences (*Some/all x are in the boxes*). The set of objects used in the task was a subset of those used by Katsos and colleagues (2011) randomly distributed across conditions (toy-cars, clocks, pens, apples, strawberries, bananas, pears, oranges, skirts, t-shirts). Sentences containing the quantifier *tutti* were logically true or false with respect to a given situation, as represented in Table 3. Sentences containing the quantifier *qualche* were logically true or false with respect to a given situation and also logically true but pragmatically under-informative with respect to a given situation (i.e., the sentence "*some cars are in the boxes*" was uttered in a situation where all cars were in the boxes). We tested 3 items for each condition as represented in the table below for a total of 15 items. Items were randomly ordered and preceded by five familiarization items including sentences with numerals (*three cars are in the boxes*). The experimenter collected the children's answers to the comprehension question: acceptance of true informative sentences, rejection of false sentences and rejection of pragmatically under-informative sentences were considered correct answers.

Results

Raw proportions of SLI and TD children's response accuracy for the two quantifiers in each condition are represented in Table 4 reporting acceptance rates for ALL-true and SOME-true conditions and rejection rates for ALL-false, SOME-false, and SOME-Under-informative conditions.

As shown in the table, TD children and those with SLI were at ceiling in their comprehension of the logical meaning of *all* and *some* statements. Contrary to CA children, children with SLI had problems rejecting under informative uses of *some* sentences. In our analyses, group differences in comprehending quantified sentences were analysed by means of different pairwise comparisons

Table 3. Experimental conditions for the quantifier comprehension task.

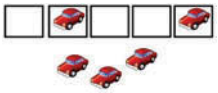
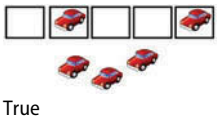
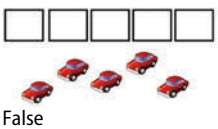
	Situation 1	Situation 2	Situation 3
ALL	 True	 False	/
SOME	 True	 False	 Under-informative

Table 4. Raw proportions of accuracy in quantifier comprehension.

	OVERALL mean (SD)	SOME TRUE mean (SD)	SOME FALSE mean (SD)	SOME UNDER-INF. mean (SD)	ALL TRUE mean (SD)	ALL FALSE mean (SD)
SLI	0.87 (0.33)	0.89 (0.31)	0.94 (0.24)	0.60 (0.49)	0.98 (0.14)	0.96 (0.20)
CA	0.92 (0.57)	0.85 (0.36)	0.94 (0.24)	0.89 (0.31)	0.96 (0.20)	0.98 (0.14)
GA	0.90 (1.07)	0.81 (0.39)	0.98 (0.14)	0.75 (0.44)	1.00 (0.00)	0.98 (0.14)

Table 5. Estimated coefficients for *Group* and *Condition* in the CA comparison.

CA comparison	Estimate	SE	Z	P
GROUPS				
SLI-CA	2.9204	1.0098	2.892	0.0038
CONDITIONS				
SOMEunder-inform. vs SOMEtrue	2.2692	0.6397	3.547	0.0003
SOMEunder-inform. vs SOMEfalse	2.9005	0.7558	3.838	0.0001
SOMEunder-inform. vs ALLtrue	4.1155	1.1704	3.516	0.0004
SOMEunder-inform. vs ALLfalse	3.3647	0.8784	3.830	0.0001
INTERACTIONS				
SLI-CA : SOMEunder-inform. vs SOMEtrue	−2.8129	0.9946	−2.828	0.0046
SLI-CA : SOMEunder-inform. vs SOMEfalse	−2.1847	1.1601	−1.883	0.0596
SLI-CA : SOMEunder-inform. vs ALLtrue	−2.8939	1.5280	−1.894	0.0582
SLI-CA : SOMEunder-inform. vs ALLfalse	−1.3520	1.5223	−0.888	0.3744

between children with SLI and the two control groups. For each comparison we carried out repeated measure logistic regression analyses in a mixed model, with Group (SLI vs. TD) and Condition (SOMEtrue vs. SOMEfalse vs. SOMEunder-informative vs. ALLtrue vs ALLfalse) as independent fixed factors and Response Accuracy as the dependent variable; subject and items were modeled as random effects. In these analyses, we also used a backwards elimination procedure to compare the goodness-of-fit of the models. All analyses were conducted using R (version 2.13.1); for mixed modeling we used the LanguageR package (version 1.4; Baayen, 2011).

In the CA comparison, we found a Group effect, an effect of Condition and an interaction between Group and Condition. The interaction was due to the fact that the two groups differed only in their comprehension of SOME under-informative sentences; children with SLI performed less well than aged-matched peers in this condition. Estimated coefficients, their standard errors, Z-values, and associated p-values for the Group and Condition fixed factors and their interactions are reported in Table 5.

No effect of Group or any interaction between Group and Conditions were found in the GA comparison. By investigating the impact of age on the SLI group's ability to derive pragmatic implicatures we found a positive correlation between age and accuracy in their comprehension of SOME under-informative sentences ($r = 0.7561$, $p < 0.001$). At the same time, we did not find a significant correlation between accuracy in the comprehension of SOME under-informative sentences and IQ ($r = 0.266$, $p = 0.3193$, we considered the raw scores obtained in the Raven test). As shown in Table 5, accuracy in the pragmatic condition increases with age in the SLI group, as reported for TD children in the literature, but there seems not to be a positive correlation with non-verbal intelligence. No significant correlations were found between accuracy in the pragmatic condition and scores on the PPVT and the clitic production task. On the other hand, we found a significant correlation between scores on the TCGB and accuracy in the pragmatic condition in the SLI group ($r = —0.585$, $p = 0.0172$).[3] This suggests that, in the SLI group, accuracy in the pragmatic condition increases when errors in sentence comprehension on the TCGB decrease.

[3]Correlations are calculated on raw scores and not on Z-scores (or SDs, standardized scores, percentiles). Z-scores express deviations from mean scores of children of the same age. In children with different ages a Z-score might be associated with different raw scores and might express different levels of grammar proficiency.

Discussion

Previous research reported poor performance in the derivation of SIs and problems with the logical meaning of quantifiers in a group of Spanish-speaking children with SLI (Katsos et al., 2011). As we argued above, the influence of age on performance was not properly controlled for in that study since the age range of the group included children at an age in which TD peers do not (typically) derive SIs and children at an age in which TDs are (typically) adult-like. Moreover, although the grammatical (and lexical) competence of the SLI group varied considerably, i.e., some of the children were at the 30th percentile for grammar comprehension while others were at the 4th, the relation between grammar proficiency and derivation of SIs within the SLI group was not considered in this study.

Using the same paradigm as Katsos and colleagues, in our study: (i) we tested school-aged Italian-speaking children with SLI matched separately for age and linguistic abilities with two groups of Italian-speaking TD children; and (ii) we considered the impact of age and grammar proficiency on the ability to understand the logical meaning of quantifiers and to derive associated SIs.

Our results show that the ability to generate the SI triggered by the quantifier *some* is weaker in Italian-speaking children with SLI than in age-matched controls, but comparable to that of language-matched controls, i.e., children who are two years younger. Interestingly, our results show that the ability to generate SIs increases with age in the SLI group, although no correlation is found with non-verbal intelligence. Our data also indicate that the ability to generate SIs increases with the ability to understand simple active sentences that do not involve subordination or movement, as emerges from SLI individual performance on the TCGB. On the contrary, our data reveal that the ability to understand and produce complex syntactic relations remains impaired in children with SLI, showing no improvement with age. These results suggest that the ability to generate SIs is still under development in children with SLI as is their ability to understand simple active sentences. Their morphosyntactic abilities in the production and comprehension of complex syntactic relations involving movement are dramatically impaired; they are not under development and they do not correlate with the ability to derive SIs. These results have the following two implications: (i) that the ability to compute SIs is not impaired in children with SLI, but might develop more slowly than in TD children, allowing them to catch up with their TD peers between age 7 and 8; and (ii) that the ability to compute SIs is in strict relation with the development of the ability to achieve syntactic operations.

As discussed in the Introduction, according to a pragmatic view, SIs are analyzed as part of a post-semantic/pragmatic component invited by a reasoning process about speakers' intentions (Grice, 1975; Horn, 1972; Levinson, 1983; Sauerland, 2004; Spector, 2007). From this view, they occur at the level of the whole utterance or after the compositional meaning of the utterance has been computed and they constitute a pragmatic enrichment of the statement. From the grammatical view, instead, SIs are computed compositionally by making use of the principles of logical syntax (Chierchia, 2006, 2013; Chierchia et al., 2012; Fox, 2007), like other aspects of sentence meaning (including the meaning of quantifiers investigated in this study). With respect to this debate, our data *per se* cannot directly speak in favor of one or the other approach but they suggest that the achievement of grammatical operations that are relevant for the compositional derivation of the meaning of simple sentences (not involving long distance argument movement) impacts on SI computations.

Regarding the area of the deficits involved in SLI, our data show that some aspects of both pragmatics and semantics are (relatively) preserved in children with SLI (e.g., the lexicalization of entailment scales, the computation of logical relations among scalars and the computation of the informational strength of a certain utterance). This opens up the question of whether other aspects of both components are also preserved. If SIs are compositionally derived via a semantic-pragmatic module, then our data show that some aspects of this module are spared in the SLI group we studied.

This may open up the question of whether the semantic component as a whole is preserved and if this is an area of strength which can be exploited to foster general language ability in children with SLI. Most importantly, showing that some semantic relations are preserved at the semantic level is relevant for syntax as well, since some of these relations (e.g., scope or c-command) are shared with the syntactic component. This would mean that these relations are available to children with SLI *tout court* and these children's weakness in syntax cannot be attributed to a lack of competence with such relations but might be attributed to a pure morphosyntactic deficit.

We also showed that, as a group, school-age children with SLI did not differ from their age-matched peers and performed almost at ceiling in understanding quantified sentences that did not involve a scalar inference. This result shows that children with SLI seem not to have problems with the semantic component associated to the meaning of the quantifiers *all* and *some*. Despite their severe impairment in both the receptive and expressive core aspects of grammar, their comprehension of quantified sentences was preserved and their ability to generate SIs was only mildly affected. To our knowledge, this finding is the first piece of evidence showing that features of the compositional semantic component can be preserved, while other components (morphosyntax) are impaired. We show that children with SLI have a firm grasp of set-theoretic relations on which the meaning of quantifiers is based. In other words, they know that the statement *some As are B* is true if the intersection between the set A and the set B is not empty. They also know that *all As are B* is true if the set denoted by A is a subset of the set B. In addition, our results show that the ability to generate SIs is still under development. In this respect, our data are partially compatible with Katsos et al. (2011), but offer a more accurate and convincing picture, especially in light of the fact that age was more controlled for in our study and children's poor performance in understanding pragmatic *some* was independent on poor understanding of the quantifiers involved in the inference.

Given these facts, we believe that our data have two main implications. On the one hand they contribute to shedding new light on the development of the pragmatic component in SLI and to better understanding the dissociation among syntax, semantics, and pragmatics in this disorder, and in the language faculty in general. On the other hand, they indicate an area of strength which can be exploited to foster general language ability in SLI.

In summary, our data show that Italian children with SLI aged 7;5 years have a firm grasp of the logical meaning of quantifiers and that they can gain a better understanding of under-informative SOME statements with age, in spite of severely impaired performance in morphosyntax. This is evidence that some components of language are affected by the disorder, while others are relatively or even completely spared. Our data suggest that the derivation of SIs depends on grammatical operations that are relevant for the compositional derivation of the meaning of simple sentences, which are still under development in SLI. Of course this hypothesis opens up a question concerning whether we find a dissociation between the ability to derive SIs and other non-scalar quantity-based implicatures in children with SLI. Moreover, our results raise additional questions that call for further investigation and open up new perspectives in the study of SLI, and in the definition of rehabilitation protocols. Finally, since our data show that the derivation of SIs is still under development in children with SLI at age 7;5, future investigation with older children will be helpful to establish whether, and when, this ability can reach full adult-like performance.

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