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Abstract

This dissertation explores Specific Language Impairment (SLI) through a single case and a group study aimed to define language profiles in children with SLI compared to typically developing children having the same chronological age or the same mean length of utterance (MLU).

The single case study compared the morpho-syntactic characteristics of elicited and spontaneous production of a child with SLI to information provided by the literature about children with equivalent MLU. Results were scrutinised in the light of hypotheses which conceive SLI as an originally grammatical deficit. Delay was found in production of inflected verbs, in line with MLU, and was consistent with linguistic accounts. Delay found in production of direct and indirect object clitic pronouns as well as articles was unexpected based on the MLU and could only partially be explained by the linguistic hypotheses considered.

The group study examined lexical, morpho-syntactic and textual skills in comprehension and production as well as phonological memory in 50 children with SLI (SLI group). In order to identify profiles, their performance was compared to age- and MLU-matched typically developing children (TD group); and subgroups of children with SLI were identified and compared. Moreover, relationships among language abilities and phonological memory were scrutinised in the overall group of children (SLI and TD groups).

Statistical comparisons between the SLI group and the TD group revealed a complex pattern of impaired lexical and morpho-syntactic abilities as well as phonological memory; and partially preserved textual skills. Subgroups (in the SLI group) with the following characteristics were compared: both lexical and morpho-syntactic production mildly impaired; both lexical and morpho-syntactic production severely impaired; mildly impaired lexical production and severely impaired morpho-syntactic production. Results evinced different profiles in these subgroups regarding phonological memory, depending on the severity of the impairment in morpho-syntactic production exhibited by subgroups. This suggests a strong relationship between phonological memory and morpho-syntax in production.

The specific relationships among language and phonological memory abilities were examined through regression analyses. Results showed phonological memory as the best predictor for language comprehension and production in the overall group of children, while belonging to the SLI or the TD group did not account for any extra variability. This suggested a strong relationship between phonological memory and language, independently of belonging to one group or the other. The second predictor was lexical comprehension, which predicted both morpho-syntactic and text comprehension in the overall group, while belonging to the SLI or the TD group did not explain any extra variability. These results suggested that language abilities in comprehension are hierarchically structured in SLI as in typical development, regardless belonging to one group or the other.

Abstract

La seguente ricerca esplora i profili del Disturbo Specifico del Linguaggio (DSL) attraverso lo studio di un caso singolo e uno studio di gruppo, confrontandoli con quelli di bambini aventi la stessa età cronologica o la stessa lunghezza media dell'enunciato (LME).

Nello studio di caso singolo sono state comparate le caratteristiche morfosintattiche della produzione spontanea ed elicitata di un bambino con DSL con i dati in letteratura sulla produzione di bambini con LME equivalente. I risultati sono stati esaminati alla luce di ipotesi che concepiscono il DSL come un deficit di origine grammaticale. È stato trovato un ritardo nella produzione di verbi flessi, come atteso in base al livello di LME e in accordo con le spiegazioni linguistiche. Un ritardo inatteso per livello di LME è stato trovato nella produzione di pronomi clitici di oggetto diretto e indiretto e articoli, i quali hanno potuto essere spiegati solo parzialmente alla luce delle ipotesi considerate.

Nello studio di gruppo, sono state esaminate la comprensione e produzione lessicale morfosintattica e testuale insieme alla memoria fonologica in 50 bambini con DSL (gruppo DSL). Allo scopo di identificare profili, le prestazioni del gruppo DSL sono state comparate con la performance di bambini con sviluppo tipico (gruppo ST) appaiati per età e per LME e sono stati identificati e confrontati sottogruppi di bambini con DSL. Inoltre, i rapporti fra le abilità linguistiche e la memoria fonologica sono stati esaminati nel gruppo totale di bambini (gruppi DSL e ST).

Il confronto tra il gruppo DSL e TD ha mostrato, per il primo, un pattern complesso in cui le abilità lessicali, morfosintattiche e di memoria fonologica sono compromesse mentre le capacità testuali sono parzialmente preservate.

Sono stati comparati sottogruppi (del gruppo DSL) con le seguenti caratteristiche: produzione lessicale e morfosintattica lievemente compromessa, produzione lessicale e morfosintattica severamente compromessa, e produzione lessicale lievemente compromessa e produzione morfosintattica severamente compromessa. I risultati per i sottogruppi hanno evidenziato diversi profili in relazione alla memoria fonologica, imputabili alla severità del deficit in produzione morfosintattica dei sottogruppi. Ciò suggerisce una forte relazione fra memoria fonologica e morfosintassi.

I rapporti specifici fra abilità linguistiche e di memoria sono stati esaminati con analisi di regressione. I risultati hanno indicato che la memoria fonologica è il miglior predittore della comprensione e produzione linguistica nel gruppo totale di bambini, mentre l'appartenenza al gruppo DSL o al gruppo TD non ha spiegato ulteriore variabilità. Ciò suggerisce una forte relazione fra memoria fonologica e linguaggio, indipendentemente dalla appartenenza a un gruppo o all'altro. Il secondo migliore predittore è stato la comprensione lessicale, che ha predetto la comprensione morfosintattica e testuale nel gruppo totale, mentre l'appartenenza al gruppo DSL o TD non ha spiegato ulteriore variabilità. Questi risultati suggeriscono abilità linguistiche gerarchicamente strutturate in comprensione a prescindere del gruppo di appartenenza.

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Introduction

The current dissertation is focused on Specific Language Impairment (SLI). It explores the characteristics of this deficit through detailed as well as extensive analysis and attempts to provide profiles emerging from the examination of such characteristics.

The dissertation is divided in three chapters, addressing the theoretical framework, a single case study on morpho-syntactic production in SLI and the main study on the performance of a group of children with SLI and typically developing children in language and phonological memory tasks.

In the first chapter, the theoretical framework is introduced, within which the single case and the group studies were developed. SLI is described, providing definitions traditionally employed in research as well as most common criteria for diagnosing and classifying the impairment. Moreover, language and cognitive abilities that are impaired in children with SLI are presented, centring the attention on lexical, morpho-syntactic, textual and phonological memory skills. A description is also offered of the main hypotheses about the deficit underlying SLI. The first group of accounts presented proposes a deficit in non-linguistic processing and includes explanations based on impaired specific abilities and impaired general processing capacity. The second group comprehends linguistic hypotheses which conceive SLI as a deficit specific to the domain of grammar.

In the second chapter, a single case study on the morpho-syntactic production of a seven year-old child with SLI is presented. Elicited and spontaneous language production in different communicative contexts was examined and its morpho-syntactic characteristics were compared to information about younger children with equivalent MLU. Attention was focused on constructions related to verbal inflexion, since for the

linguistic hypotheses considered; the deficit underlying SLI affects this grammatical aspect. Account was taken of Gopnik and colleagues' (e.g., Gopnik and Goad, 1997), Clahsen and collaborators' (e.g. Clahsen, Bartket & Göllner, 1997) hypotheses and the Agreement Tense Omission Model (ATOM; e.g., Wexler, Schütze & Rice, 1998). For the first, children with SLI cannot build implicit morphological rules because they cannot abstract them from the input. For the second, SLI is due to a selective impairment in setting the structural relationship of grammatical agreement. For the third, SLI involves a syntactic feature deficit generating the optional specification of tense and agreement features in obligatory contexts. Moreover, the most affected elements in Italian SLI were examined; namely, direct and indirect object clitic pronouns as well as articles.

For the analysis, a comparison was made of the participant's production of simple and complex phrases with verbal inflexion as well as object clitics and articles with data from younger children with equivalent MLU. We expected similarities between the production of the participant and MLU-matched children, due to a deficit in verbal inflexion, as predicted by the linguistic hypotheses presented. In fact, results showed an important yet expected delay in production of inflected verbs, consistent with the linguistic accounts. Concerning clitics and articles, results showed production delayed to an unexpected degree that could only partially be explained by linguistic hypotheses. The ATOM model, which partially fitted the data, predicted clitic omission found in the participant's production with unexpectedly high frequency but could not completely account for article omission.

The strength of this single case study was the deep linguistic analysis of morpho-syntactic production, conducted taking into account the main linguistic hypotheses about the deficit underlying SLI. The limits were the restricted focus of this analysis, related to the grammatical deficit proposed by the linguistic hypotheses. Even though morpho-syntax is generally considered the main impairment in SLI (Leonard, 1998) and for many hypotheses about the underlying deficit it is the core deficit (for a review, Guasti, 2002), it is not the only ability affected. Other language capacities closely related to grammar appear to be impaired in SLI. These important abilities allow children to emit and recognise language sounds, understand and produce words as well

as interpret and create sequences of sentences forming a coherent text. Among such abilities, the focus here was centred on lexical and text comprehension and production. In addition, other cognitive abilities have been described as impaired in children with SLI (for a review, Leonard, 1998), such as phonological memory, essential for language processing. In order to get over the limits in the single case study, the main study was designed with the goal of providing a complete picture of the language of children with SLI. Moreover, the range of potentially impaired skills and the different combinations that can be found in the language of children with SLI demanded an investigation of a group, instead of a single case. Thus, the assessment of a large group of children with SLI was conducted that elicited detection of the skills and identification of different profiles within the group.

The group study presented in the third chapter examined lexical, morpho-syntactic and textual abilities in comprehension and production as well as phonological memory in 50 preschoolers with SLI and compared their performance to age- and MLU-matched typically developing peers.

The first aim of the study was to provide a profile of children with SLI, through mean comparisons between the SLI and the typically developing group. Results showed a complex pattern of partially preserved skills as well as abilities impaired to different degrees. In particular, lexical and morpho-syntactic comprehension and production were the most affected abilities, while textual skills were partially preserved, in line with data in literature (presented in the first chapter). These results confirm core language skills as an important weakness. They also suggest that cognitive abilities relevant for comprehending and producing texts represent an important strength for these children. Moreover, phonological memory showed strong impairment, standing out as an important weak point. The relationship among impaired and relatively preserved skills comprised the next goal of the study.

The second aim was to refine the profile of children with SLI by evincing the relationships among language abilities and phonological memory. A conceptual hierarchical model of potential relationships among these skills was adopted. According to this model, when performing a task which measures specific language ability, other

related capacities are also needed. Phonological memory is required for performing all language tasks. Lexical abilities are required for performing morpho-syntactic tasks; lexical and morpho-syntactic skills are necessary for accomplishing textual tasks. Moreover, comprehension capacities are needed for production. Based on this model, a series of fixed-order hierarchical multiple regressions with language measures as dependent variables were conducted on the group composed of children with SLI and typical development. The reason for carrying out this analysis without separating children with SLI from typically developing children was to initially try to explain the performance in language tasks without recourse to the difference between groups, but only to language and phonological memory abilities. In order to do so, potential predictors were introduced at different steps. In the first step, “age” was introduced for controlling its effect. In the second step, those skills that according to the conceptual hierarchical model were necessary for performing the specific task were incorporated. In the third step, the factor group (SLI or typical development) was introduced. Results showed, in the first place, phonological memory as predictor for language comprehension and production. This outcome depicts SLI as a condition where phonological memory is impaired and the degree of such impairment predicts the level of performance in linguistic tasks, as in a continuum with typical development. Lexical comprehension was the second predictor of morpho-syntactic and text comprehension. This pattern of relationships between language abilities was expected, based on the conceptual hierarchical model. An analogous pattern in production was not found. Moreover, a pattern of relationships between comprehension and production predicted by the model was not found. The examination of these results suggested that while abilities in comprehension are structured in SLI as in typical development, abilities in production are not. Concerning the group to which children belonged, results showed that for almost all measures of language ability being in the SLI or the development group did not explain any extra variance. This suggests that performance in most language tasks is predicted in a similar way in children with SLI and typically developing children, reinforcing the idea of a continuum between impaired and typical language development.

The third aim of the study was to recognise potential different profiles among children with SLI. The overall SLI group was divided by combining two criteria based on the severity of lexical and morpho-syntactic comprehension. One group was identified with mild lexical and morpho-syntactic impairment, one group with severe lexical and morpho-syntactic impairment and two groups with mixed impairment. The performance of the three largest groups was examined and compared: Mild Language Impairment (10 participants), Severe Language Impairment (16) and the group with mild lexical impairment and severe morpho-syntactic impairment (Severe Morpho-syntactic Impairment 23). Differences among groups in language measures, apart from those used as criteria for creating groups, did not emerge. This suggests that there were not specific language profiles characterising each group. The only aspect that distinguished groups was phonological memory. The results showed that the groups with mildly impaired morpho-syntax had the best phonological memory. These results evinced different profiles regarding phonological memory in groups separated by the severity of morpho-syntactic impairment. This reinforces the idea of a strong relationship between phonological memory and morpho-syntax emerged from previous analyses.

The fourth aim was the attempt to give a practical contribution with regard to tasks useful for identifying children with SLI. The intention was not to find clinical markers, but to select which tasks – among the wide variety of tasks employed – discriminated between SLI and typical development. A logistic regression analysis was performed and the simplest measures for each task were entered as independent variables and the group (SLI) as dependent variable. Those tasks related to the abilities proposed as clinical markers – namely, phonological memory measured by Sentence and Non Word Repetition as well as syntactic tense marking – were expected to predict the probability of belonging to the group of children with SLI. From the analysis, Sentence Repetition emerged as the best predictor. The version of this test used in the current study was related to phonological memory, but mainly measured grammatical competence. This result partially confirms the prediction about markers. The suggestion for clinical practice, based on these results, was that Sentence Repetition is the most useful task in this assessment for diagnosing SLI.

Chapter 1

Theoretical Framework

1. Specific Language Impairment (SLI)

1.1. Definition of SLI.

Specific Language Impairment is a “disorder in which language acquisition is impaired in an otherwise normally developing child” (Van der Lely, Rosen & McClelland, 1988). Depending on its specific definition, SLI occurs in approximately 3 to 15% of children ranging in age from three to 21 years (American Psychiatric Association 2000; Leonard, 1988; Riccio & Hynd, 1993; Tomblin, Smith, & Zhang, 1997). A common definition of SLI is a clinical presentation characterised by a delay or a disorder in linguistic development, together with absence of cognitive, sensorial, motor, affective or socio-environmental deficits (Chilosi, Cipriani, & Fapore, 2002). Linguistic development can be affected in one or more domains, mainly phonology, morpho-syntax and lexicon and in different degrees in production or in comprehension as well. SLI is amenable to treatment (Leonard, 1988), even though it is often a long-standing condition, with problems that can remain into adolescence and adulthood (Weiner, 1985).

1.2. Diagnosis of SLI.

Many criteria have been proposed for diagnosing SLI. They all respect the general definition of SLI. Children diagnosed with SLI may exhibit significant deficits in language abilities, yet show normal hearing, age-appropriate scores on non-verbal intelligence tests and no evidence of neurological dysfunction (Bishop, 2006).

In research fields, criteria provided by Leonard (1998) are often used for determining precise selection of children with SLI. Following these, language test scores may be 1.25 standard deviations under the age-appropriate mean or lower. Scores on tests measuring IQ may be 85 or higher. Hearing screening may be passed at conventional levels. There may be no recent episodes of otitis media with effusion and no evidence of seizure disorders, cerebral palsy or brain lesions. Children to be diagnosed may not be under medication for control of seizures. Regarding oral structure and function, there may be no anomalies. Concerning physical and social interactions, there should be no symptoms of impaired reciprocal social interaction or restriction of activities.

In clinical fields, the most followed criteria for diagnosis of language impairment are those proposed by the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Statistical Classification of Diseases and Related Health Problems (ICD-10) in its different versions. SLI is often defined by the combination of assessed language impairment (following DSM or ICD-10 criteria) and exclusion of factors as those presented by Leonard (1998) as the cause of such impairment. The *Diagnostic and Statistical Manual of Mental Disorders-IV-TR (DSM-IV-TR, 2000)* categorises communication disorders in expressive language disorder (315.31), expressive-receptive language disorder (315.32), phonological disorder (315.39), stuttering (307.0) and communication disorder not otherwise specified (307.9). Expressive and expressive-receptive language disorders are defined as language impairment in SLI. Exclusive phonological disorder may be comprised as well, depending on definition of SLI. In this dissertation, only included are those cases of SLI in which impairment affected morpho-syntax and not only phonology. That is, those cases in which there is no controversy concerning language impairment. The International Classification of Diseases-10 (2007) classifies specific developmental disorders of speech and language (F80) into four types and two categories defined by exclusion: specific speech articulation disorder (F80.0), expressive language disorder (F80.1), receptive language disorder (F80.2), acquired aphasia with epilepsy (F80.3), other developmental disorders of speech and language (F80.8) and developmental

disorder of speech and language unspecified, (F80.9). Expressive and receptive language disorders are defined as language impairment in SLI.

1.3. Types of SLI.

SLI is a heterogeneous impairment. Since it is mostly defined by exclusion – that is, by attesting language impairment while excluding primary factors for it – internal classifications are based exclusively on language characteristics. For this dissertation, the only classification used is that proposed by Chilosi et al., (2002), based on linguistic and clinical-statistical criteria. For these authors, there are three types of SLI: phonological, expressive and expressive-receptive SLI. Phonological SLI affects only phonology while expressive SLI affects phonology as well as lexical and morpho-syntactic production. Expressive-receptive SLI affects lexical and morpho-syntactic production as well as comprehension. This classification has the advantage of distinguishing exclusively phonological from more complex language impairment, as the DSM-IV-TR . It reflects the traditional linguistic division between phonology and grammar (composed of morphology and syntax; Radford, 2003). Moreover, in Chilosi et al.'s (2002) classification is also featured the important distinction between purely expressive and expressive-receptive impairment. Such distinction, based on frequency of clinical characteristics of children with SLI, was earlier presented by Rapin and Allen's (1983) taxonomy for English and frequently used in anglo-saxon studies. It is also considered in the DSM-IV-TR.

In sum, the groups in the classification of Chilosi et al. (2002) which are referred to in this dissertation are defined as follows: Phonological SLI is characterised by the child's inability to make age appropriate speech sounds, and it is the most prevalent language disorder among young children (Chilosi et al., 2002); Expressive SLI is characterised by a child's limited ability to learn new vocabulary (lexical deficit), construct word and phrases (morpho-syntactic deficit) and restricted speech production (phonological deficit); Receptive-Expressive SLI involves lexical, morpho-syntactic and phonological deficit in production as well as in comprehension.

1.4. Impaired abilities in SLI

Children with SLI present with difficulties in a number of different language domains, including lexical, morphosyntactic and textual or discourse skills (Leonard, 1998; Schwartz, 2009). In the following sections, a review of language difficulties shown by children with SLI is presented.

1.4.1. Lexical abilities.

Research on lexical acquisition on children with SLI concerns two main topics: the first, the onset time for lexical acquisition; and the second, lexical abilities of children with SLI during development. Children with SLI acquire their first words later if compared to typically developing children, according to first case studies on lexicon in language impairment (Weeks, 1974; Morley, Court, Miller & Gardside, 1955) and later group studies (Trauner, Wulfeck, Tallal & Hesselink, 1995). Late onset time for lexical acquisition is so important that it is frequently considered the first sign of SLI (Watkins, Kelly, Harbers & Hollis, 1995). While there seems to be agreement regarding this, all authors do not share the same view concerning lexical abilities later on time. For Locke (1992, 1993, 1994), once words begin to be comprehended, lexical development by children with SLI proceeds at a near-normal rate. However, this means that if children with SLI have a lexical development at approximately normal rate, we cannot expect them to catch up with their peers during childhood, especially in those years when vocabulary continues to accumulate at a rapid rate for both typically developing and SLI populations (Clarke & Leonard, 1996). For other authors, children with SLI have a specific difficulty in word learning. Rice, Buhr & Oetting (1992) examined the ability in these children to establish overall mapping between new words and their meaning and found they had poorer performance than typically developing children. Regardless if children with SLI acquire new words at the same rate or slower than typically developing children once lexical acquisition has begun, it is expected that during the preschool period, they would still exhibit limited lexicons. In fact, recent studies have shown that children with SLI have smaller lexicons than their age-mates and, in particular, they make more errors in naming tasks (Mc Gregor, Newman, Reilly & Capone, 2002; Bishop, 1997; Watkins et al., 1995).

1.4.2. Morpho-syntactic abilities.

Morpho-syntax has become widely known as a main characteristic of SLI and the most important obstacle for children with such impairment (Leonard, 1998). Morpho-syntactic onset, in particular first word combinations, appears later in children with SLI than in typically developing children (Trauner et al., 1995). During language development, children with SLI exhibit weaknesses mainly in the morpho-syntactic domain, even though their linguistic profiles and overall severity of their disorder may widely vary (Bortolini, Leonard & Caselli, 1998). For many researchers, the disorder mainly affects grammar, while other domains of language are less severely impaired or mostly unimpaired (Schaeffer, 2007). Morpho-syntactic deficits are so important and notorious in SLI that many accounts of this disorder are centred on it, in particular those which propose a linguistic knowledge problem underlying SLI (for details, see section 2.2.). Grammatical difficulties are documented on rule learning as well as comprehension and production of language (Dromi, Leonard, Adam & Zadunaisky-Ehrlich, 1999). In comprehension, difficulties are found in acquiring both morphology (Connell, 1987; Connell & Stone, 1992; Anderson, 2001) and syntax (Stark & Montgomery, 1995). Analogously, in production, evidence of problems is provided for morphology (Polite & Leonard, 2006; Leonard et al, 2007) as well as syntax (Schuele & Tolbert, 2001; Marinellie, 2004).

Research on grammatical deficits exhibited by children with SLI speaking Italian reveals primary difficulties in precise areas, regarding verbal inflection, the copula and function words. Concerning verbal inflection, difficulties are found in using the copula as well as the production of third-person plural forms of regular verbs Leonard et al. (1988). Regarding function words, the most affected areas are the determiner and the clitic systems. The most problematic elements in such areas are articles and object clitics (Bottari, Cipriani & Pfanner, 2001). Impairment regarding these elements has also been found in children with SLI speaking other languages, such as English (Rice et al., 1995). Children with SLI speaking Italian use these morphemes less than typically developing children with equivalent MLU (Sabbadini, Volterra, Leonard & Campagnoli, 1987; Cipriani, Chilosi, Bottari, Pfanner, Poli & Sarno, 1991; Leonard, Bortolini, Caselli, McGregor & Sabbadini, 1992; Bottari, Cipriani & Chilosi,

1994). Among clitics, object clitics, in particular direct-object clitics, seem to be a particular weak area in the spontaneous speech of Italian-speaking children with SLI (Bortolini & Leonard 1996, Leonard & Bortolini, 1998; Bortolini, Arfé, Caselli, Degasperi, Deevy & Leonard, 2006). As far as articles are concerned, Bottari, Cipriani, Chilosi and Pfanner (2001) found a significant dissociation between determiner production and the general level of morphosyntactic achievement. Verbal inflection, articles and object clitics are frequently omitted or substituted (Cipriani et al., 1991; Sabbadini, et al. 1987; Cipriani, Chilosi, Bottari, & Pfanner, 1993) .

1.4.3. Textual abilities.

Listening text comprehension (from now on, text comprehension) and verbal text production (from now on, text production) are the abilities to understand oral texts and to create them. Textual skills, also called narrative skills, involve the construction of a coherent mental representation, which arranges a set of textual contents and combines them with previous knowledge (Gernsbacher, 1994; Kintsch, 1994). Textual skills are classified as higher linguistic abilities, compared to basic language skills, such as those regarding comprehension and production of lexicon and morpho-syntax. Textual skills are strongly based on cognitive capacities which provide necessary information to be integrated with more pure language knowledge. In this dissertation, focus will not be on other capacities required for text comprehension and production, but mainly be on linguistic aspects.

For adequate text comprehension, a child needs to construct a coherent mental representation of the text. In the construction of such a representation, the interaction of cognitive and linguistic component skills and the processing of linguistic information are involved (Britton & Graesser, 1996; Gernsbacher, 1990; Hannon & Daneman, 2001; Johnson-Laird, 1983; Kintsch, 1994; Oakhill & Cain, 2007; van den Broek et al., 2005). He or she must identify and access the meaning of single words and decode the syntactic structure and meaning of each sentence. Moreover, he or she needs to integrate the information from all sentences to build local coherence and to incorporate background knowledge and ideas to make sense of the details that are not explicitly

mentioned in the text. Furthermore, the child needs to constantly check, reflect and repair on previously elaborated comprehension.

For adequate text production, a child has to be able to “hold in mind a complex model of relation among events while using language to express these relations” (Lahey & Bloom, 1994, p. 358). In order to accomplish this task, the child needs to integrate linguistic and cognitive abilities at many levels (Boudreau, 2007).

Research that has examined textual performance in children with SLI has yielded varied results. Some measures indicate differences in performance in narrative tasks between children with SLI and age-matched peers with typical development (Liles, 1993; Liles, Duffy, Merritt & Purcell, 1995). Studies on text comprehension revealed differences between children with SLI and typically developing children (Bishop & Adams, 1992; Crais & Chapman, 1987). Bishop and Adams (1992) observed that children with SLI exhibited an impaired performance in answering literal and inferential questions about a story presented either orally or pictorially. Crais and Chapman (1987) found analogous results: children with SLI had significantly poorer performances in identifying truth or falsity of literal and inferential statements about an orally presented narrative.

Regarding text production, results are more varied and they mainly depend on the measures used for testing skills. Differences between children with SLI and typically developing children are significant for some measures of constructing and retelling narratives (Boudreau & Hedberg, 1999; Crais & Chapman, 1987; Graybeal, 1981; Liles, 1985, 1987; Merritt & Liles, 1987; Paul, Hernandez, Taylor & Johnson, 1996; Purcell & Liles, 1992; Ripich & Griffith, 1988; Strong & Shaver, 1991), while they are not significant for other measures (Boudreau & Hedberg, 1999; Liles, 1985). In particular, regarding text cohesion, children with SLI and age-matched peers have equivalent performances (Strong & Shaver, 1991), but general organisational patterns appear to be consistent between groups and, therefore, difficulties in macro-level skills cannot be confirmed (Merritt & Liles, 1987; Boudreau, 2007).

1.4.4. Phonological memory.

Despite having average non verbal intelligence, children with SLI show a range of linguistic and non linguistic deficits. Here, we are interested on poor performance shown on short term and working memory tasks (e.g., Archibald & Gathercole, 2006).

Adequate language acquisition requires an intact memory system, in particular the so-called phonological short memory, a component of working memory (Riccio, Cash & Cohen, 2007). Working memory is conceptualised by many developmental researchers (Bayliss, Jarrold, Baddeley & Gunn, 2005; Bayliss, Jarrol, Baddeley, Gunn & Leigh, 2005; Conlin, Gathercole & Adams, 2005) as a multidimensional system comprising many components that are separable while being interactive. One of these components has the function of storing phonological information for a short period (Barrouillet & Camos, 2001; Conlin et al., 2005; Gavens & Barrouillet, 2004). It is a capacity-limited storage buffer which keeps speech input while another cognitive task is occurring (Baddeley, 1998, 2003). Speech enters phonological short term memory automatically and it is stored until it is processed. It serves as a mnemonic window in which sequences of incoming words are kept (Baddeley, 1998). Phonological short memory is usually measured through different tasks, in particular, digit spans and Non-word Repetition (Montgomery & Evans, 2009). Word repetition can also be considered a measure of phonological short term memory. In this task, the same processes are required as in Non-word Repetition, yet lexical knowledge plays an important role (Dispaldro et al, 2009).

Phonological working memory allows children to attend to phonological information, concentrate on it and manipulate it. Children with SLI have difficulties rehearsing such phonological information (Johnson & Myklebust, 1967). They have decreased phonological short term memory storage capacity and a reduced ability to process, organize and maintain information (Kirchner & Klatsky, 1985).

1.4.5. Relationships among language and phonological memory abilities.

Diminished language and phonological short term memory abilities found in children with SLI are interrelated. In particular, phonological short term memory, as

represented by capacity-limited storage buffer in Baddeley's models (Baddeley, 1998, 2003), has an essential role in language acquisition. In effect, children with phonological short term memory deficits fall behind their peers on general language measures (Gathercole & Baddeley, 1989, 1990). In particular it has been demonstrated that children with a reduced phonological short term memory have impaired lexical (Baddeley, Papagno & Vallar, 1988; Newbury, Bishop & Monaco, 2005; Trojano & Grossi, 1995) and morpho-syntactic abilities (Cohen et al., 2000; Montgomery, 1996). In typical development, it has been found that phonological short term memory contributes to individual differences in text comprehension (Florit, Roch, Altoè & Levorato, 2009; Cain, 2006; Seigneuric, Ehrlich, Oakhill & Yuill, 2000). To our knowledge, there are no studies relating text comprehension and production to phonological short term memory in children with SLI. Analogously to the relationships between phonological short term memory and language abilities, these are also correlated among each other. Lexical skills are required in order to compose and interpret phrases; phrase composition and interpretation are required for creating and understanding texts. Moreover, in language development, comprehension is chronologically and logically required for production in each domain.

2. Deficits underlying SLI

Research on the underlying deficit of SLI has not yet reached a unified theory, even though different hypotheses have attempted to explain the diverse profiles shown by children with SLI. Many accounts with the aim of explaining the origin of linguistic deficits of these children have appeared since the late 1980s. Although the details of these accounts vary in important ways, they can be placed in two main groups of theoretical perspectives. The first group posits that SLI is due to a non-linguistic processing deficit (for a review see Leonard, 1998). The second group conceives SLI as a deficit in linguistic knowledge, in particular in grammar (for a review, see Guasti, 2002).

2.1. SLI as a deficit in non-linguistic processing.

Among accounts assuming a deficit in non-linguistic processing, some propose that problems lie on specific abilities while others place the difficulty in general processing capacity.

2.1.1. *SLI as a deficit in specific abilities.*

SLI underlying deficit has been placed mainly on phonological short term memory (Gathercole & Baddeley, 1990 and later works). However, other accounts have also been provided; Tallal and Piercy's (1973a, b) proposal of a deficit in auditory perception deserves a specific mention here.

SLI as a deficit in phonological memory. For Gathercole and Baddeley (1990) underlying SLI there are deficits in the storage of phonological information in working memory, conceptualising this as a short term memory system specialised in the elaboration of verbal material. Conceptualisation of phonological short term memory and working memory and their relationship depend on different versions of memory models. For Gathercole and Baddeley (1990), who proposed a deficit in phonological memory underlying SLI based on their model, phonological working memory is a short term memory system specialising in the elaboration of verbal material. For Riccio et al. (2007), phonological short term memory is a component of working memory. They follow the position of developmental researchers (Bayliss Jarrold, Baddeley & Gunn, 2005; Bayliss et al, 2005, Conlin et al, 2005) for whom working memory is a multidimensional system comprising many components, among them phonological short term memory, that are separable while being interactive. However, for all these positions, phonological short term memory or phonological working memory have the function to maintain and process phonological information.

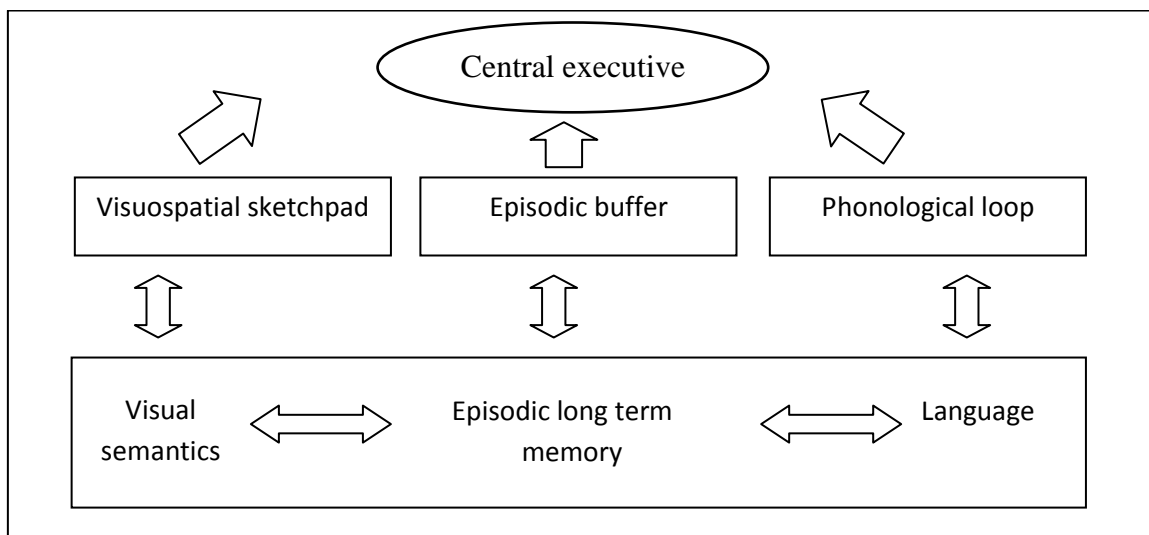
For this reason, the measures presented here no difference will be made between phonological short term and working memory, but will be called phonological short term memory. In the presentation of the account of SLI as a deficit in phonological memory, the preferred terminology here is that used by each author. For our analyses, phonological short term memory was considered as the ability to keep phonological

information for a brief period of time and it was measured it using tasks of Forward Digit Span, Word Repetition and Non-word Repetition.

The theoretical background use for phonological short term and working memory refers to that used by Baddeley (1998) and its latest version (Baddeley, 2000) shown in Figure 1 (see page 12). This model comprises an attentional control system, called the central executive assisted by three subsidiary slave systems, the phonological loop and the visuospatial sketchpad. The phonological loop holds verbal and acoustic information using a temporary store and an articulatory rehearsal system. The sketchpad holds visuospatial information, to be fractionable into different components: visual spatial and possibly kinesthetic. The episodic buffer (added to the model by Baddeley, 2000) stores information in a multi-dimensional code. It provides a temporary interface between the two slave systems and long term memory. It is controlled by the central executive, which is responsible for binding information from a number of sources into coherent episodes. Regarding language acquisition and, in particular, language processing, these components have different functions. The phonological loop plays an essential role in learning the phonological structures of new words during vocabulary acquisition. This assumption is based on evidence from typical and atypical vocabulary development as well as acquired language impairments in adulthood. For young typically developing children, at early stage of language development, poor performance in phonological loop tasks constrains vocabulary knowledge, implying a strong causal association between the phonological loop and the central executive (Gathercole et al., 1992). Phonological storage in working memory is also related to other aspects of language elaboration, including sentence comprehension and production. On the basis of the body of evidence in favour of a role of the phonological role in vocabulary acquisition, Baddeley et al. (1998) proposed that this component provides temporary storage of novel phonological forms of new words in order to permit the construction of more enduring long-term lexical phonological representations. The direct link between the phonological loop and long-term linguistic knowledge is reinforced in the latest version of the model (2000). The central executive, which is responsible for a range of high-level functions, has been associated with performance in phonological complex memory-span tasks, such as listening and reading

span. In these tasks, participants have to process the incoming information extracted from the input and store phonological material. For example, in some tasks the participants are required to make judgments regarding the semantic content of sentences (information processing) and remember the final word in a series of successive sentences (material storage). These kind of phonological-based complex memory-span task depends on both the central executive and the phonological loop (Baddeley and Logie, 1999). The processing and attentional elements are supported by the central executive while the phonological loop meets the phonological storage demands of the task.

Figure 1. Multi-component working memory model (Baddeley, 2000).



According to this model, a deficit in phonological memory will affect in a negative way mainly grammar processing and language acquisition (Gathercole and Baddeley, 1993). Coady and Evans (2008), in a review of recent works on SLI, found evidence that children with SLI have deficits in phonological working memory, among other impaired skills. They propose that these deficits are not just concomitants to linguistic impairment but they are the basis for it. This proposal is supported by documented deficient performance of children with SLI in the last 50 years. Studies have mainly focused on non-word repetition tasks (Dollaghan and Campbell, 1998; Weismer et al, 2000; Botting & Conti-Ramsden, 2001). Non-word repetition is assumed to measure phonological memory (phonological short term memory for Montgomery,

2003 and phonological working memory for Gathercole, 1995). During the performance of this task, listeners have to retain the novel sequence of sounds (non-words) after hearing it. Such coding requires a sufficiently long time to support its articulatory output and a sufficiently fine-grained form to allow a correct output (Gathercole, 1995). A phonological memory impairment, as the impairment underlying an inadequate Non-word Repetition, has been considered as the core deficit and the most probable heritable cause of SLI and difficulties in repeating non-word as the behavioural marker of SLI (Bishop et al, 1996; Conti-Rasmden, 2003). Other studies have related phonological memory and language impairment, alongside measurement through Non-word Repetition. Among the first to suggest a problem in rehearsing phonological information, were Johnson and Myklebust (1967), who report results from clinical observation. Other early research, conducted by Menyuk and Looney (1972), showed that children with SLI experience difficulty repeating sentences of increasing length. Moreover, it has been demonstrated that children with SLI have a poorer performance in the Token Test when the length of the command is increased (Tallal, 1975). Moreover, Cohen, Riccio and Hynd (1999) provided evidence of a deficit in phonological working memory in children with SLI contrasted by spared visual working memory, when the semantic demands of a task were improved. Many other studies of children with SLI show a poorer performance in complex span-tasks compared to age-matched typically developing children (Ellis Weismer, Evans & Hesketh, 1999; Montgomery, 2000a, 2000b; Marton & Schwartz, 2003; Archibald & Gathercole, 2006; Marton, Schwartz, Farkas & Katsnelson, 2006).

SLI as a deficit in other specific capacities. For other perspectives in this group, the source of the problem in SLI can be found in temporal processing mechanisms, such as auditory processing. For example, for Tallal and Piercy (1973a, 1973b), language disorders are caused by an impairment of auditory perception. They found that children with SLI had difficulty identifying tones that were brief or rapid, even though they had normal hearing and could perform the task when tones were presented at a slower rate. This and other studies (Tallal, 1976; Tallal and Piercy, 1974, 1975; and Tallal, Stark, Kallman and Mellits, 1980a, 1980b, 1981, 1985a, 1985b) set tasks that employed verbal as well as nonverbal stimuli. The authors interpreted their results as demonstrating that

nonverbal stimuli that must be processed quickly – either because the stimuli are brief or because they are presented rapidly in succession – are problematic for SLI children. Likewise, verbal stimuli that must be distinguished on the basis of relatively brief portions of the signal are also problematic. The hypothesis is that the relationship between performance in these processing tasks and language ability is due to the fact that the acquisition of many details of language relies on cues of relatively brief duration. More recent works (Heath, Hogben and Clark, 1999; Joanisse, Manis, Keating and Seidenberg, 2000) show that auditory deficits are more common in groups of children with language impairment than in typical development controls (for a review, see Rosen, 2003), but this is not regarded as the origin of the impairment for all authors.

2.1.2. SLI as a deficit in general processing capacity.

The assumption of an underlying general processing difficulty is based on non-linguistic deficits found in association with SLI. From this perspective, problems in other domains are not just concomitant weaknesses outside language, but are a sign that underlying both kinds of problem, there is a limitation in information-processing capacity (Leonard, 1998). Briefly presented below are the three main hypotheses of a general processing deficit underlying SLI.

The surface account, proposed by Leonard and collaborators (Leonard, 1989; 1992; Leonard, McGregor and Allen, 1992; Leonard, Eyer, Bedore and Grela, 1997; Leonard, 1998), assumes that limitations in processing are especially disadvantageous when children must perceive brief grammatical morphemes and hypothesize their grammatical function, and this generates problems in grammar acquisition.

Other accounts (Dromi, Leonard, & Shteiman, 1993 for Hebrew; Lindner and Johnston, 1992 for English and German), which can be referred to as Morphological Richness Accounts, sustain that children with SLI have a general processing capacity limitation that reduces their available cognitive resources. According to these accounts, when children with SLI devote their limited resources to the dominant grammatical cues in the input, few resources remain for the processing of information in other grammatical areas (Bortolini et al., 1998). Therefore, when children with SLI are

acquiring a morphologically rich language, for example, Italian, they will focus in morphology and expend in it many resources, causing a detrimental effect in syntax acquisition. Moreover, if the morphology itself is extremely complex in terms of its processing demands, this area of language would also be hard to acquire.

A different explanation for SLI is offered by Ullman and Pierpont (2005): the Procedural Deficit Hypothesis (PDH). For these authors, SLI is not specific to language and, more importantly, it does not affect all aspects of language. For them, the deficit affects motor and cognitive skills, and is located in a group of brain structures, called the procedural system. The procedural system is composed of a network of interconnected structures rooted in frontal/basal-ganglia circuits that subserves the learning and execution of motor and cognitive skills. Many individuals with SLI, then, may be afflicted with procedural system brain abnormalities, leading to impairments of the linguistic and non-linguistic functions that depend on it. In particular, a deficit in the procedural system will be the origin of grammatical impairments and of lexical retrieval deficits, very often associated with SLI. Many cases of SLI, which can be grouped under what the authors call the “Procedural language Disorder (PDL) umbrella”, can be accounted for by abnormalities of brain structures underlying the procedural memory system. The PHD claims that linguistic knowledge itself is directly affected, but that it extends also to non-linguistic functions.

2.2. SLI as a deficit in linguistic processing.

The second group of theoretical perspectives conceives SLI as a deficit specific to the domain of language, specifically to grammar. These accounts treat grammatical deficit as a knowledge problem.

2.2.1. *Inability to acquire implicit rules.*

Gopnik and her colleagues (Gopnik, 1990a, 1990b, 1994a,1994b; Gopnik and Crago,1991; Gopnik and Goad,1997; and Ullman and Gopnik,1994) propose that the deficit underlying language problems is a permanent inability to acquire implicit rules, such as those used to mark tense, number and person. In reviewed versions (Gopnik, 1994a, 1994b; Gopnik and Crago, 1991; Gopnik and Goad, 1997) the authors affirm

that SLI children cannot build implicit rules governing morphological and phonological processes in grammar. They cannot abstract rules from input. Thus, they are forced to find alternative strategies for acquiring language: using memory, learning explicit rules or drawing analogies. In particular, Gopnik and Goad's (1997) research, focused on morphology, suggests that children with SLI do not build inflectionally complex representations because they lack the sub-lexical features which encode inflectional information, such as number and tense marking. For example, a regular verb form as 'walked', instead of having the internal structure composed of a root ('walk') and a morpheme carrying the [+past] feature ('ed') is stored in the lexicon as a chunk, as the irregular form 'sung'. This hypothesis is supported by the evidence that even regular verbal forms exhibit frequency effects in the speech of persons with SLI, while in typically developing individuals, only irregular forms show such effect.

2.2.2. *The agreement deficit hypothesis.*

Clahsen and collaborators (Clahsen, 1986; 1989; 1991; Clahsen and Hansen, 1993; Clahsen et al. 1997) claim that SLI is due to a selective impairment in establishing the structural relationship of grammatical agreement. Such relationship put together I° -the head that carries the inflectional features associated with the verb- and the subject -in the specifier of I'. Following this account, only non-interpretable features would be affected. In generative grammar (Chomsky, 1995), grammatical features can be interpretable or non interpretable, depending if they are relevant for interpretation (the first ones) or not (the latter). Non-interpretable features must be checked and deleted before Logical Form (LF), while interpretable features do not need to enter checking relations. For example, ϕ -features of nouns, such as PERSON and NUMBER, contribute to the interpretation and are thus interpretable, whereas ϕ -features of verbs are non-interpretable and need to be checked off. According to this hypothesis, only non-interpretable ϕ -features of verbs, i.e. the verb's agreement features, would be affected. The prediction, then, is that agreement phenomena will cause major problems for SLI children, while tense marking will not appear to be particularly affected. This pattern was, in fact, found in German: children with SLI have problems with agreement morphology but not with tense morphology (Clahsen et al., 1997).

2.2.3. *The Extended Optional Infinitive Account (EOI) and the Agreement and Tense Omission Model (ATOM).*

The extended optional infinitive account is based on typical language development. Wexler (1994) claimed the existence of an early stage in language development in which children fail to obligatorily mark tense in main clauses. Based on this study, Rice, Wexler and Cleave (1995) propose that children with SLI have a grammar that reflects the characteristics of such stage. That is, the period when root infinitives (RI) are used instead of inflected forms is protracted on time. This account explains the fact that SLI children speaking English often omit inflectional morphology, in particular some sub-populations show deficit not in the whole inflectional system, but only in verbal inflections. The first version of this account explained the output produced by children with SLI speaking English, but gave no explanation for the output of children speaking pro-drop languages such as Italian. Root infinitives are not produced by young typically developing children speaking pro-drop languages. Production of these forms among children with SLI is very unusual. These are not possible forms of the vocabulary in languages such as Italian. Rizzi (1993, 1994) provided an explanation for different production during the RI stage of children with SLI speaking pro-drop and non pro-drop languages. In speech of young typically developing children in the RI period, some clauses are Complementizer Phrases (CP) and others can be less than CPs, that is, functional projections truncated below. English speaking children may produce clauses that are CPs (e.g. 'He plays') as well as clauses that are lower projections (e.g. Verbal Phrase, VP: 'He play'). Moreover, even young children's grammar requires an anaphoric tense to be identified sentence-internally. Then, when Tense Phrase (TP) projection is present, the inflected verb is required (e.g. 'He plays'). On the contrary, when TP is not present, as in lower projections, an infinitive is accepted (e.g. VP: 'He play'). In pro-drop languages such as Italian, where the subject is not obligatory, infinitives must necessarily rise to TP. Since the TP projection is present, an inflected verb is required and infinitives are not allowed in main clauses. This account predicts young children's productions in English and Italian: inflected verbs are produced as well as root infinitives in the first case, while in only inflected verbs are produced in the latter.

In addition to Rizzi's (1993, 1994) proposal, Wexler et al. (1998), revised their account and provided a different explanation for differences between production of Italian and English speaking children, called the Agreement and Tense Omission Model. They assume that SLI involves a syntactic feature deficit leading to the optional specification of tense [TNS] and agreement [AGR] features in obligatory contexts. The absence of RI in the production of Italian children with SLI and younger typically developing children is based on grammatical differences between English and Italian and a universal language constraint. Wexler et al.'s (1998) hypothesis develops within Chomsky's (1995) syntactic theory. In this framework, some functional categories have D-features (Determiner features, i.e. features that characterize noun phrases, NPs) that are uninterpretable. Therefore, to obtain a coherent meaning, they must be eliminated. In English, AGR as well as TNS have uninterpretable D-features that are eliminated by checking against the D-feature of the subject NP. In SLI, as in young children, a constraint called the Unique Checking Constraint (UCC) applies: children can only check once against the D-feature of their subjects, whereas adults can do this more than once. The UCC prevents a D-feature on DP from checking more than once on functional categories, thus children speaking English omit either AGR or TNS. The output is Optional Infinitives. Italian speaking children have the same difficulties due to UCC which applies in every language. However, in Italian, AGR does not have to be checked against, because it is itself interpretable as the subject of the sentence. Thus, the subject NP in Italian only has to check against TNS, not AGR, and this amount of checking can be managed and does not violate UCC. The Italian speaking child does not have to omit AGR or TNS in order to satisfy the UCC, showing an output where all features are specified. Only one movement is necessary (to check TNS) and, thus, the finite morpheme, which depends on both AGR and TNS, can be inserted producing an output with no Optional Infinitives. This can be synthesised in the Null-Subject / Optional Infinitive Generalization (NS/OI): a child learning a language goes through the OI stage only if the language is not an INFL-licensed null-subject language. UCC will still have an effect on children speaking languages like Italian, but they will not produce main clause infinitives, for the reasons just given. However, they are predicted to omit auxiliaries (Wexler, 1999) and they do, during the OI age range (Wexler, 2004).

2.2.4. *Other linguistic accounts.*

For some researchers (Eyer & Leonard, 1995; Guilfoyle, Allen & Moss, 1991; Leonard, 1995 and Loeb & Leonard, 1991), the deficit underlying SLI affects the acquisition of functional categories, in particular IP¹. These hypotheses are in accordance with the data obtained from young typically developing children. In the earliest stages of acquisition (before the end of the second year) grammars of young children contain lexical but not functional categories. Some researchers assume that IP is not present in such grammars. Children with SLI would have a linguistic knowledge that reflects that of younger children. The focus, then, is in impaired grammar and in imperfect acquisition, and not in language use.

For Ingram and colleagues (Ingram and Carr, 1994; Morehead & Ingram, 1973), underlying SLI there is a restriction in the range of contexts to which rules are applied. These children, for Ingram, show a late emergence of language and a slower evolution of it; however they develop similar linguistic systems as typically developing children but do not use them so creatively. When SLI children finally acquire rules, they apply such rules over a more limited range of possible exemplars than they should. Following this explanation, the problem does not lie in acquisition, nor completely in grammatical knowledge, but mainly in language use.

The Representational Deficit for Dependent Relations (RDDR) hypothesis proposed by van der Lely and colleagues (Van der Lely 1998, 2003, 2005b; van der Lely, Rosen and McClelland, 1988; van der Lely and Battell, 1998, 2001; van der Lely and Ullman, 1996a, 1996b) claims that the deficit underlying SLI can be found in the computational syntactic system (van der Lely 1994, 1998). They have carried out studies on a subgroup of language impaired children that exhibit an especially grammatical deficit (G-SLI) in order to identify these specific grammatical problems. The RDDR argues that the core deficit in this subgroup is “Movement” (Chomsky 1995). The operation/rule “Move” is implemented in the grammar of G-SLI, but it is optional, instead of being obligatory as in normal grammar. That is, in G-SLI grammar, movement can occur but it is not automatic and compulsory. Difficulties with head-to-

¹ IP stands for inflectional phrase, i.e. a phrase/clause which is a projection of INFL (a category whose members include finite auxiliaries and the infinitival form of verbs). (Radford, 1997)

head movement (e.g. V to I) can account for deficit with tense and agreement marking. Moreover, problems with A (Argument)-movement can account for difficulties in assigning thematic roles to noun phrases, particularly in passive sentences. Further, difficulties with Wh-movement explain problems with these kind of question.

Chapter 2

Study I: Language production in SLI, a single case study

Introduction

For this study, the morpho-syntactic skills of a seven year-old boy with SLI were examined in four different Communicative Contexts. Such skills were analysed through spontaneous and elicited production and compared to information about younger children with equivalent MLU. We focused on inflexional phrase and complex constructions, in areas related to hypotheses which state a linguistic deficit mainly affecting verbal inflexion underlying SLI. Moreover, we analysed the most affected elements in SLI in Italian.

We have considered the three main hypotheses that propose a linguistic deficit underlying SLI. For Gopnik and colleagues (Gopnik, 1994a, 1994b; Gopnik and Crago, 1991; Gopnik & Goad, 1997), children with SLI cannot build implicit rules governing morphological and phonological processes in grammar because they cannot abstract them from input. In particular, children with SLI do not build inflectionally complex representations because they lack the sub-lexical features which encode inflectional information, such as number and tense marking (Gopnik and Goad, 1997). Clahsen and collaborators (Clahsen, 1986; 1989; 1991; Clahsen and Hansen, 1993; Rothweiler and Clahsen, 1993; Clahsen, Bartket & Göllner , 1997) claim that SLI is due to a selective impairment in establishing the structural relationship of grammatical agreement. Such a relationship puts together I° -the head that carries the inflectional features associated with the verb- and the subject -in the specifier of I' . Wexler, Schuele and Rice (1998) proposed in their Agreement and Tense Omission Model (ATOM) that SLI involves a

syntactic feature deficit leading to the optional specification of tense [TNS] and agreement [AGR] features in obligatory contexts.

Research on Italian SLI, has shown that the most affected elements in this language are direct object clitics, indirect object clitics and articles. Object clitics and articles are used by children with SLI less than typically developing children with equivalent MLU (Sabbadini et al, 1987; Cipriani et al., 1991; Leonard et al., 1992; Bottari et al., 1994).

The aims of the current study were the following. First, we intended to provide a detailed description of the morpho-syntactic production of the participant, focusing on aspects of verbal inflexion related to the linguistic hypotheses presented and most affected elements in Italian, clitics and articles. Second, we aimed to give an explanation of the morpho-syntactic output based on such linguistic hypotheses.

PART I: DESIGN OF THE STUDY

1. Participant

The participant in the present study –from now on J– was 4 years old when he was first seen at the Developmental Neuropsychiatry Division of the Local Health Unit *Veneziana 12*. J. was born after a full-term normal pregnancy and uncomplicated delivery, with a twin sister. J.'s developmental motor milestones were considered normal. In contrast, language impairment was detected when he was first seen at the Developmental Neuropsychiatry Division, when he was 4 years old. J. received treatment from the arrival to the Division until the moment the tests used here were administered (when he was 7 years-old), with a frequency of 2 sessions of 45 minutes per week.

The diagnosis of SLI was made on the basis of the combination of normal intelligence and language impairment (Leonard, 1998). Intelligence was measured using the non verbal subtests in Scales, which gave scores within normal standards. Non verbal score in WPSSI was 92, when the child was 5;8. Normal intelligence was confirmed when the child was older: he obtained a non verbal score of 93 in the WISC-R when he was 6;6 and 96 in the WISC-III, when he was 7;4.

Language difficulties were identified by speech therapists. Primary causes for language difficulties were excluded. Moreover, language difficulties could not be accounted for by hearing loss since auditory threshold showed to be normal. Based on the information provided by the neuropsychiatrist and the otorhinolaryngologist physical abnormality of the speech apparatus, environmental deprivation and brain damage were excluded.

A diagnosis of dyspraxia was excluded since J's profile didn't meet all required criteria (Thoonen, Maassen, Gabreels, Screuder and Swart, 1997): there was not deviant, but just immature behaviour and no inconsistent error patterns within and between sessions were found.

2. Materials and Procedures

In order to build the language knowledge profile of J, his performance in comprehension and production tests was measured. This allowed us to determine an exclusive expressive language problem, since no difficulties were found in comprehension. Our examination focused on language production. Moreover, we administered auditory attention, phonological short term and phonological working memory tests for excluding deficits in these areas.

2.1. Language measures

2.1.1. Comprehension tests

Language impairment in J. affects only production, while comprehension is undamaged. This dissociation classifies J's Specific Language Impairment in the group of expressive SLI (Chilosi et al, 2002). Impaired comprehension was excluded using tests that measure text comprehension, lexicon and morpho-syntax. J's score stands in normal ranges: not lower than 2.0 standard deviation under the mean (as recommended by ICD-10). The following tests were used.

The Peabody Picture Vocabulary Test - Revised (PPVT-R; Dunn & Dunn, 2000) Italian version. This test, adapted and standardised for Italian children aged 3;6 to 17;0 years has 180 items and measures receptive lexical skills. Administration requires that the examiner orally presents a word describing one of four pictures. The individual is shown the four pictures and is instructed to point to the picture that the word describes. The test is discontinued once the individual makes six errors out of eight consecutive items. This test gives standard scores based on the age of the child, with a mean of 100 and a standard deviation of 15. J obtained a score of 85, showing a normal, albeit low, lexical knowledge.

Test for Reception of Grammar (TROG) (Bishop, 1982). This version of the test, originally in English, is adapted and standardised for Italian speakers from 4 years old. It has 80 items and measures morpho-syntactic comprehension. For each trial, the examiner presents a sentence and the individual has to identify the only picture representing it out of four. This test provides standard scores based on the age of the

child, with a mean of 100 and a standard deviation of 15. J obtained a score of 106, that is, in the normal range, over the mean.

Test di Comprensione del Testo Orale (TOR 3-8; Levorato & Roch, 2007).

This standardised test for Italian speakers aged 3;0 to 8;0 measures oral text comprehension. The child was asked to listen to a story appropriate for his age. Ten multiple-choice questions with four possible answers were asked in order to verify comprehension, during the narration. Questions were made verbally by the examiner. The possible answers were presented verbally together with four pictures representing them, to which the examiner pointed while presenting them. Five questions concerned information explicitly stated in the story (textual questions) and five required an inference to be made (inferential questions). This test provides standard scores based on the age of the child, with a mean of 10 and a standard deviation of 1.5. J. obtained 9 points, a score within the normal range.

The results J obtained in the tests measuring lexical, morpho-syntactic and text comprehension evinced no difficulties in comprehending language. Exclusion of a deficit in comprehension allowed us to classify the type of SLI as expressive SLI, following the classification of Chilosi et al. (2002).

2.1.2. Corpus of elicited spontaneous language production.

The data consist of videotaped speech samples that were obtained in three sessions in one month: when the child was 7;7.20, 7;7.27 and 7;8.17 years old. At the participant's home, the examiner and the child interacted in a quiet room, with mostly no interruptions. In the total time of recorded sessions J. produced 580 utterances, alternated with 604 produced by the examiner.

In order to obtain ecologically valid productions, the child was allowed to freely interact with the examiner, with whom he was already familiar. The child was free to propose topics and talk as he desired.

Interactions from the video-recorded sessions were transcribed and coded according to the set of conventions of the Child Language Data Exchange System (CHILDES; cf. MacWhinney and Snow 1985). Transcription followed standard Italian

orthography, with unintelligible utterances noted by 'xxx', and unintelligible words noted by 'xx', following CHILDES' instructions.

2.2. Cognitive measures

2.2.1. Auditory attention task (BVN 5-11, Bisiacchi et al., 2005).

This test measures the ability to focus attention as well as to activate and inhibit rapid and sustained attention responses in children from 4;7 to 11;0 years old. The child listens to a series of words and has to recognise among them a specific word, for example, "sole" ("sun"). J obtained a score of 96.98, that is in the normal range (mean = 100, standard deviation = 15).

2.2.2. Forward Digit Span (BVN 5-11, Bisiacchi et al., 2005).

This test was created for measuring phonological short term memory. It is standardised for children aged 4;7 to 11;0, with a mean of 100 and a standard deviation of 15. The set for span was composed of 21 sequences for seven level of difficulty: three, four, five, six, seven, eight and nine digits to repeat. Each sequence was presented only once. For each set, when two sequences of the same number of digits were incorrectly repeated, the test stopped. Practice trials were given before the administration. J obtained a score of 95.9, that is, within normal range.

2.2.3. Backwards Digit Span (BVN 5-11, Bisiacchi et al., 2005).

This test measures phonological working memory. Analogously to Forward Digit Span test, it is standardised for children between 4;7 and 11;00 years (mean = 100, standard deviation = 15). The set of span is formed by 21 sequences for seven level of difficulty: two, three, four, five, six, seven and eight digits to repeat. Administration was conducted as for the task of Forward Digit Span. J obtained a score of 108.7, in the normal range, over the mean.

These results exclude a deficit in auditory attention, phonological short term memory and phonological working memory.

3. Data analyses

We assessed language comprehension and production, auditory attention, phonological short term and working memory. As mentioned before, the reason for assessing language comprehension was to identify the type of SLI. J exhibited a deficit only in production, thus the type is expressive SLI. We measured auditory attention and phonological memories for excluding that a deficit in these abilities could be the primary deficit underlying this case of SLI. The performance of J in the tasks measuring these skills was normal. We examined language production for obtaining the profile of the morpho-syntactic deficit. The qualitative analysis of speech performed, focused on morpho-syntactic deficit, is explained in the following lines.

As presented before, the interactions between the examiner and the child were freely guided by the child. As a consequence of these free interactions, different Communicative Contexts occurred. We separately analysed the linguistic production of the Communicative Contexts and compared them in order to gather information about the consistency with which the morpho-syntactic characteristics occurred. Communicative Contexts were classified in two main types, Narrations and Conversations:

❖ **Narrations.** An episode was considered a narration when it consisted of telling a story or an anecdote:

In addition, Narrations were subdivided into:

- Narration-Procedure: They concern procedures, as for example, describing the way home.
- Narration-Autobiography: Narrations about autobiographic memories focus on personal stories, as for example, the trip to Argentina.
- Narration-Elicited: The Bus Story Test (Renfrew, 1987) presents a story on a cartoon strip that is first told by the examiner and then re-told by the child, following the strip.

❖ **Conversations:** Every other interaction, in which both the child and the examiner were freely involved and where the topic was decided by the child was classified as Conversation.

The classification of the speech samples gave as a result 16 Communicative Contexts composed of one Narration-Procedure, two Narration-Autobiography, two Narration-Elicited and eleven Conversations.

Speech samples, which occurred in different Communicative Contexts, were organised into episodes. A piece of speech sample was considered an episode when meeting the following conditions:

- A duration of at least 50 seconds of interactions between the child and the examiner.
- A recognisable topic.

Change of episode was recognised by change of the main topic. Each main topic was decided by the child, except for episodes in the Communicative Context Narration-Elicited.

Episodes beginning and topic were mostly decided by the child, even if elicited by the examiner through questions, with the exception of those included in the Communicative Context Narration-Elicited. Change of episode was based on change of the main recognisable topic.

Every episode was given a name on the basis of the topic. Their duration varies from 56 seconds to 518 seconds. The total number of the child's utterances varies from 0,31 times to 3,55 times of the total number of the examiner's utterances. Table 1 (see page 29) shows Communicative Contexts (Narration-Procedure, Narration-Autobiography, Narration-Elicited and Conversations), their duration, the number of utterances produced by the child, the number of utterances produced by the examiner and their ratio.

Table 1

Communicative Contexts, episodes, duration and ratio of utterances.

Communicative Contexts and Episodes	Duration in seconds	Utterances produced by the child, by the examiner and their ratio.
Narrations-Procedure		
<i>The way from the sports centre to home</i>	51	144/107 = 1.34
Total		
Narrations-Autobiography		
		144/107 = 1.34
<i>Turning the pages</i>	60	41/7 = 2.43
<i>Caps exchange</i>	173	39/29 = 1.34
Total		224/143 = 1.57
Narrations-Elicited		
		41/7 = 5.86
<i>Bus Story Test 1</i>	123	30/13 = 2.30
<i>Bus Story Test 2</i>	93	71/20 = 3.55
Total		
Conversations		
<i>Joking</i>	71	9/24 = 0.38
<i>Marco</i>	128	30/50 = 0.60
<i>I didn't understand a word</i>	56	5/16 = 0.31
<i>I drive the car</i>	126	31/25 = 1.19
<i>The camcorder</i>	72	21/29 = 0.72
<i>In the dark</i>	57	20/17 = 1.18
<i>Argentina</i>	133	22/47 = 0.47
<i>Animals</i>	57	29/25 = 1.16
<i>Do you have children?</i>	114	28/39 = 0.71
<i>What is a hook?</i>	216	77/73 = 1.05
<i>Achilles' weakness</i>	278	82/99 = 0.83
Total		349/428 = 0.82

Each context has a different number of episodes, which varies from one, for the Narrations-Procedure, to eleven, for the Conversations. The Narration-Procedure context was composed of the episode ‘The way from the sports centre to home’ where the child describes his way back home. The Narration-Autobiography context comprises two episodes, ‘Turning the pages’ and ‘Caps exchange’. In these episodes, the child tells a story of his personal life. For example, the second episode is an anecdote in which the participant was a baby and his father exchanged his and his twin sister’s caps in order to confuse friends. The Narration-Elicited context, based on the Bus Story Test is composed of two episodes. In the first one, the child spontaneously decided to tell the story of the Bus Story Test based on the strips, before listening to the narration by the examiner. This episode was called ‘Bus Story Test 1’. The second episode, ‘Bus Story Test 2’ consisted on the narration of the story after hearing the examiner telling it, following the instructions of the test.

The Conversation context is composed of the highest number of episodes, due to the fact that they were spontaneously held by the examiner and the child, mostly initiated by him. For example, in the episode called ‘Achilles’ weakness’, the participant begins telling the legend of Achilles’ heel, and then pointing to his own and the examiner’s weak points. The duration of the episodes varied from 57 to 518 seconds. The wide range is due to one of the criteria for identifying episodes: having one main topic. The ratio of child’s utterances and examiner’s utterances was calculated dividing the number of utterances produced. Narrations show a ratio varying from 1,34 – for the Narration-Procedure episode and one of the Narration-Autobiography episodes– to 5,86 – for the first Narration-Elicited, in which the child spontaneously tells the story with little scaffolding of the examiner. The Narration-Elicited shows the highest ratio (3,55), since little encouragement was needed. The Conversation contexts present episodes in which the amount of interventions by the examiner is clearly higher than the number of utterances produced by the child – as in ‘I didn’t understand a word’ (ratio of 0,31) – and episodes in which the child guides the conversation, producing a higher number of utterance than the examiner, as in ‘I drive the car’ (ratio 1,19). We note that even the higher ratio in Conversations (1,18) is lower than the lower ratio of Narrations (1,34). This difference suggests that the distinction between Narration and

Conversation is tenable and therefore in the following analyses we distinguish between the two types of Communicative Context.

3.1. Analysis of indicators of the stage of morpho-syntactic level.

The first analysis focused on different indicators of syntactic level, in order to establish the stage of development of the child with reference to typical development. In particular, this analysis aimed to identify the specific stage of language development on the basis of morpho-syntactic indicators in production: the Mean Length of Utterance (MLU), the MLU of the five longest utterances, the complexity of long sentences.

3.1.1. MLU.

We have first used this indicator for evaluating the general grammatical level. It is a measure of grammatical productivity in children, calculated by dividing the number of words by the number of utterances produced, used within both clinical and research settings, in particular for language impairments (Miller and Chapman, 1981). The MLU was obtained using the CLAN program (CHILDES). From the total of 580 utterances produced by the child in the three sessions, those composed only by interjections were excluded. We excluded them since an MLU calculated from the whole corpus will not give a representative indicator of morpho-syntactic ability. First, because the length of utterances was artificially swelled by interposed interjections and, second, because almost 10% were single-words utterances formed by an interjection. This procedure reduced the total number to 527 utterances, from which the MLU was obtained.

3.1.2. MLU of the five longest utterances.

The second CLAN analysis we have performed computes the mean length in words of the five longest utterances. This indicator gives us information about the child's best performance regarding long phrases. We calculated the five longest utterances in the overall corpus and in each Communicative Context. Moreover, we computed the MLU of the five longest utterances per Communicative Context.

3.1.3. Degree of complexity of long sentences.

This qualitative indicator allowed us to complement the information given by the indicator about phrase length.

3.2. Analysis of Inflexional Phrase, direct object clitic, indirect object clitic and articles.

3.2.1. Inflexional Phrase (IP).

Many studies support differences in verb inflexion production by SLI children when compared with typically developing children, in particular regarding the present third person singular (Leonard, Sabbadini, Leonard and Volterra, 1987; Leonard et al., 1992; Leonard, Bortolini, Caselli and Sabbadini, 1993, Bortolini and Leonard 1996). For this reason, we were interested in examining IP production.

3.2.2. Direct Object (D.O.) clitics, Indirect Object (I.O.) clitics.

As shown by different studies (Sabbadini et al, 1987; Cipriani et al., 1991; Leonard et al., 1992; Bottari et al., 1994), children with SLI use these morphemes less than typically developing children with equivalent MLU (Bortolini and Leonard 1996, Leonard and Bortolini, 1998; Bortolini, Arfé, Caselli, Degaspero, Deevy & Leonard, 2006).

3.2.3. Articles.

A significant dissociation between determiner production and the general level of morpho-syntactic achievement in children with SLI has been found, suggesting a qualitatively deviant pattern (Bottari, Cipriani, Chilosi & Pfanner, 2001).

3.3. Criteria for testing element acquisition.

In order to establish the threshold over which an element (verbal inflexion, clitics and articles) is considered acquired, we have adopted the criterion used by Cipriani et al. (1993). We have defined productive acquisition of morpho-syntactic forms using the same threshold used by these authors for typically developing children,

since we compare our data with their sample. We assumed acquisition or productivity when a given element is correctly produced in at least 75% of the phrasal contexts in which it is clearly obligatory. An obligatory phrasal context is a phrase in which the element is required in order to be grammatical and to be in accordance with the pragmatic situation.

Moreover, to this criterion we have added the restriction proposed by Pizzuto and Caselli (1992), based on Cazden (1968) and de Villiers and de Villiers (1973), that is, that at least five obligatory contexts are needed in order to measure productivity.

PART II: RESULTS

A total of 527 utterances were considered for the analysis. MLU was calculated for the whole corpus and for the five longest sentences, and sentence complexity was analysed. Moreover, production of IP, clitics and articles was analysed.

1. MLU.

Total of utterances, excluding those composed only by intersections, gave an MLU of 2.8 words with a standard deviation of 2.2. MLU of utterances produced in each different context varied from 2.2 to 3.9. Table 2 reports the number of utterances per every communication contexts and the respective MLU. The lowest MLU, 2.2, was found in the Narration-Procedure context. In the Narration-Elicited and Narration-Autobiography contexts, instead, the highest MLUs were found: 3.6 and 3.9, respectively. The MLU in the Conversation context corresponds to the overall MLU, 2.8, as expected by the fact that such context presents the higher number of utterances, around 50% of the total number of utterances. The MLU from the Conversation is not higher or lower than every Narration context. These results suggest that there are no differences in the level of morpho-syntactic elaboration depending on the contexts.

Table 2

Number of utterances and MLU per each Communicative Contexts

Communicative Contexts	Utterances (interjections excluded)	MLU
Narration-Procedure	146	2.2
Narration-Autobiography	35	3.9
Narration-Elicited	61	3.6
Conversation	285	2.8
Total	527	2.8

2. Length in words of the five longest utterances.

The second CLAN analysis we performed computed the length of the five longest utterances.

The longest utterances were 16, 14, 13 and 11 (two utterances) words long.

Such utterances were:

- a) '[_{clause1}Poi con Lucia andato alla camera della nonna] e [_{clause2}c'era un divano grande di papà].'

Interpretation: 'Then, with Lucia, I went to grandma's bedroom and there was a big sofa of dad.'

- b) 'E poi la mamma [_{auxiliary omission}] fatto [_{article omission}] foto a [_{article substitution}] noi due e con la signora cicciona.'

Interpretation: 'And then, mom took a picture of the two of us with the fat lady.'

- c) 'Sì e la sua mamma ha un pancione grande [_{dependent clause perché} [_{auxiliary omission}] nato un'altra].'

Interpretation: 'Yes, and her mom has a big pot belly [_{dependent clause because} another girl was born].'

- d) 'Allora, dice, xx² e [_{article omission}] punto debole d'Achille è il tallone.'

Interpretation: 'Then, he/she says, xx (unintelligible word) and Achilles' weak point is the heel.'

- e) 'E l' angeli [_{wrong number inflexion}] ha un arco e le frecce per amare xxx ?'

Interpretation: 'And the angel has an arch and arrows for loving xxx (unintelligible piece of utterance).'

The longest utterances per each Communicative Context and their MLU are reported in Table 3 (see page 34). The length of the longest utterances ranged from six to 16 words. Their MLU varied from 7.6 to 13.4. The Narration-Autobiography context exhibited two of the longest utterances of the total corpus, and the highest MLU. Conversation and Narration-Elicited had very long utterances and high MLUs. The shortest utterances and the longest MLU were found in the Narration-Procedure.

² We followed the transcription rules in the CHILDES system: xx stands for a unintelligible word, xxx stands for an unintelligible sequence of words.

Table 3

Length in words and MLU of the five longest utterances in each Communicative Context.

Communicative Context	Length of the 5 longest utterances	MLU of the 5 longest utterances
Narration-Procedure	10,9,7,6,6	7.6
Narration-Autobiography	16,14,10,9,8	13.4
Narration-Elicited	11,9,8,8,8	8.8
Conversation	13,11,11,10,10	11

The Conversation context exhibited an MLU within the range of Narration contexts. This suggests that the level of complexity is equivalent in the Narration contexts and in the Conversation context. We found differences among Narration Contexts. Narration-Procedure context exhibits the lowest MLU and Narration-Autobiography, the highest. These differences can be explained by the fact that when describing procedures, shortest utterances are commonly used, as in the following example, in which the child describes the directions necessary to go from the sports centre to his home.

Example (1):

Examiner: *'Racconta, racconta tutto, racconta anche quella parte.'*
'Tell, tell everything, also that part.'

Child: *'Poi.'*
'Then.'

Examiner: *'Sì?'*
'Yes'

Child: *'Av- a- avanti.'*
'Ahead.'

Examiner: *'Sì?'*
'Yes?'

(CHI indicates with the hand.)

Child: *'A destra di di a di a destra?'*

Table 4

Correct productions and obligatory contexts in present, simple past, past perfect and imperative tenses.

Correct productions / Obligatory contexts				
	First Singular	Second Singular	Third Singular	Total
Present	43/45 ^{ACQUIRED}	12/12 ^{ACQUIRED}	84/85 ^{ACQUIRED}	139/142
Simple Past (<i>Imperfetto</i>)	0	0	7/7 ^{ACQUIRED}	7/7
Past Perfect	8/16 ^{NOT ACQUIRED}	1/2	13/33 ^{NOT ACQUIRED}	22/51
Imperative	-	18/18 ^{ACQUIRED}	-	18/18

Present was the most frequent form (139 correct productions), followed by past perfect (22 correct productions), imperative (18 correct productions) and simple past (7 correct productions). Present was acquired in the three singular forms, past perfect in none of them, simple past only in the third person and imperative in the second person, the only one for this tense. Obligatory contexts production reflected the same pattern: present obligatory contexts were mainly produced (142), followed by past perfect (51), imperative (18) and simple past (7).

Past perfect deserved an error analysis. The main problem with past perfect was auxiliary omission followed by use of infinitive instead of past perfect form and rarely by a wrong auxiliary or by the absence of infinitive. Table 5 (see page 39) presents the number of correct productions and obligatory contexts.

Table 5

Past perfect inflexion: correct and wrong productions.

Past Perfect	Productions / Obligatory contexts
Correct	21/51
Auxiliary omission	29/51
Wrong auxiliary	2/51
No inflexion (infinitive)	7/51

Single data from each Communicative Context confirmed overall results about singular persons except for the first person in the Narration-Procedure. In the Narration-Autobiography context, the production of first and third person in past perfect did not reach the productive acquisition threshold, only in 20 % and 40% of the times were these forms correctly produced in obligatory contexts

In the Narration-Elicited context, data gave us information about present and past perfect. In the present, the first and third persons reached the acquisition threshold. In the past perfect, the production of correct third person inflection was only 50%, under the productive acquisition threshold. In the Conversation context, we gathered information about present, past perfect and imperative. In the present tense, the three persons were always correctly produced. In the past perfect, neither the first nor the third person reached the acquisition threshold. In the imperative, forms were produced with no errors. In the Narration-Procedure, the first person in the past perfect tense was not produced in enough obligatory contexts to consider acquisition, consistently with overall results. On the contrary, data about the present tense did not correspond to overall results. The first person form in the present was not used in enough obligatory contexts to reach the acquisition threshold. We may consider, however, that the 67% percent of correct productions of present first singular came from a very small number of frequencies. In fact, this percentage was calculated from four correct productions out of six.

Regarding plural forms, it is noteworthy that despite the large number of utterances analysed, there were not enough obligatory contexts for testing acquisition. In particular, only two obligatory contexts were produced: for first and third person present.

The general profile of the participant, identified on the basis of the MLU, fits with the third stage of morpho-syntactic development proposed by Cipriani et al., (1993). The participant's MLU of 2.8 stands in the range between 1.9 and 3.0 shown by children in the third stage of typical development, being between 2;2 and 2;10 years old. Complex sentences and verbal inflexion production in the participant exhibit those characteristics expected for children in the third stage.

- Complex sentences formed by an independent clause and a dependent clause, introduced by a subordinating conjunction (as *because*) appear at this stage. J produced complex sentences such as the following, in which the dependent clause is presented by *perché* (*because*)
 - ‘*Sì e la sua mamma ha un pancione grande* [dependent clause *perché* [auxiliary omission] *nato un'altra*].’
Interpretation: ‘Yes, and her mom has a big pot belly [dependent clause because another girl was born].’
- The most frequent were singular forms. They were correctly produced 186 times in 218 obligatory contexts, while plural forms were correctly produced just one time in 5 obligatory contexts. It is noteworthy that plural forms were not only produced correctly just 20% of the times, but specially that small number of obligatory contexts produced, only five.
- Past perfect was frequently produced. Even if not productively acquired yet, it was produced 22 times out of 51 obligatory contexts. Even though past perfect was frequently produced, it was not always used in a correct form in particular due to the absence of auxiliary.

It is remarkable that although verbal inflexion was produced as expected for the third stage, plural forms were an exception. Typically developing children in this stage

begin to produce plural forms of simple past (*imperfetto*), despite the fact that production does not reach the acquisition threshold. The participant did not produce any plural forms at all in any context in the overall corpus.

In Table 6, we report the comparison between the morpho-syntactic characteristics exhibited by children in the third stage with those produced by J.

Table 6

Comparison between Stage III of morpho-syntactic development and the characteristics of the participant's speech, regarding MLU, complex sentences and verbal inflexion forms.

	Stage III: MLU 1.9 – 3.0, age 2;2 – 2;10	Participant: MLU 2.8, age 7,8
Complex sentences	Appearance of complex sentences formed by an independent clause and a dependent clause, introduced by a subordinating conjunction ('because'):	Appearance of complex sentences formed by an independent clause and a dependent clause, introduced by a subordinating conjunction ('because').
Verbal inflexion forms	<ul style="list-style-type: none"> - The most frequent forms are indicative singular. - Past perfect is frequently produced. - Some plural forms of indicative (third and first person) and simple past (<i>imperfetto</i>) are attested. 	<ul style="list-style-type: none"> - The most frequent forms are indicative singular (139 productions). - Past participle is frequent (22 productions), but it is not acquired yet and auxiliary production reaches only 36-39%. This corresponds to stage II, in which children omit auxiliaries. - Only one form of indicative produced (first singular). - No plural forms of simple past (<i>imperfetto</i>).

To this point, we have shown that the participant's morpho-syntactic development is in the III stage, as far as the MLU is concerned. Production of complex sentences (in particular, subordinates) corresponded to stage III of typical development. Regarding verbal inflexion, even though indicative production reflected the

characteristics of stage III, there is no overall correspondence with typical development, as auxiliaries were still missing, which is more representative of stage II of typical development. Moreover, while typically developing children in stage III produce plural forms of indicative (mainly third and first person) and simple past and no plural forms, these differences indicate that the participant's morpho-syntactic development did not perfectly match any of the stages considered for typical development. In particular, verbal inflexion was less developed.

Overall, the difficulties with verbal inflexion can be explained by the theories assuming a linguistic deficit underlying SLI which focus on IP at the basis of such deficit.

As mentioned before, we are interested on observing not only those morpho-syntactic characteristics on which these theories focus, but also on examining other aspects of the morpho-syntactic profile, especially those elements that are mostly impaired in Italian speaking children with SLI: Direct Object (D.O.) clitics, Indirect Object (I.O.) clitics and articles.

5. Object Clitics

Regarding object clitics, our results showed that D.O. and clusters were not acquired. As shown in Table 7, we found only two correct productions of D.O., out of ten obligatory contexts and no correctly produced clusters out of 5 obligatory contexts.

Table 7

D.O, I.O. and cluster productions.

	Correct production/Obligatory contexts
D.O.	2/10
I.O.	1/4
Cluster	0/5

6. Articles

Our results indicated that feminine singular definite and indefinites were already acquired, as well as masculine singular indefinites. Masculine singular, masculine plural and feminine plural definites were not yet acquired, as shown in Table 8. For other forms, data are not enough for testing acquisition. Considering overall results, we can say that definite articles were not acquired since they do not pass the 75% threshold. Indefinite articles, instead, were acquired if we consider only singular forms, for which we had enough data.

Table 8

Correct production, substitution by a Monosyllabic Place Holder (MPH) and omission definite and indefinite articles.

		Definite Articles	Indefinite Articles
Masculine Singular	Correct	NOT ACQUIRED 19/41	ACQUIRED 19/21
	Wrong	0/41	0/21
	Omission	22/41	2/21
Masculine Plural	Correct	NOT ACQUIRED 6/12	0/1
	Wrong	4/12	0/1
	Omission	2/12	1/1
Feminine Singular	Correct	ACQUIRED 36/41	ACQUIRED 24/26
	Wrong	0/41	0/26
	Omission	5/41	2/26
Feminine Plural	Correct	NOT ACQUIRED 4/6	0/0
	Wrong	1/6	0/0
	Omission	1/6	0/0
Total	Correct	NOT ACQUIRED 65/100	ACQUIRED 43/48
	Wrong	5/100	0/48
	Omission	30/100	5/48

For definite as well as for indefinite articles, omission is higher than substitution or replacement by a monosyllabic place holder, except for masculine plural definites. This evidence converges with results in Bottari et al. (2001) about types of error in determiner production by children with SLI. These authors highlighted a significant dissociation between determiner production and the general level of morpho-syntactic achievements in children with SLI if compared with typically developing children. The authors suggest that the omission rates of determiners form a qualitatively deviant pattern not only because they are in contrast with their normal and aphasic controls' production, but especially because they are not predicted by the level of overall morpho-syntactic development, as it happens in J's production.

In sum, for clitic pronouns and articles, production did not reflect stage III morpho-syntactic development. Production of clitic pronouns (D.O. and I.O.) reaches the productivity level (75%) in stage II, while the participant's production of D.O. object is much lower: only 20% of correct production, as shown in Table 9 (see page 45). Regarding articles, in this stage, typically developing children produce correct articles in at least 75% of obligatory contexts. The participant's production of articles is different for definite and indefinite articles. While indefinite articles are correctly produced in 90% of obligatory contexts, strongly exceeding the productivity threshold, definite articles only reach 65% of correct production, contrary to what was expected.

Table 9

III stage of morpho-syntactic development and participant's characteristics.

	Stage III: MLU 1.9 – 3.0, age 2;2 – 2;10	Participant: MLU 2.8, age 7,8
Clitic Pronouns	<p>Productivity (at least 75% in obligatory contexts) of D.O. and I.O. clitics.</p> <p>Cluster appearance (D.O. + I.O.).</p>	<p>D.O.: Only 20% correct production in obligatory contexts.</p> <p>No cluster in 5 obligatory contexts (in 527 utterances).</p>
Articles	<p>- In simple phrases, articles appear at least in 75% of obligatory contexts.</p>	<p>- Definite articles: 65% correct production in obligatory contexts.</p> <p>- Indefinite articles: 90% correct production in obligatory contexts.</p>

PART III: DISCUSSION

We compared the participant's production of complex constructions and inflexional phrases with data from typical development (Cipriani et al., 1993). Results indicated similarities in the production of complex constructions and inflected verbal forms between J and the younger MLU-matched children, aged between 2;2 and 2;10 years. These results suggest an important yet expected delay, consistent with the hypotheses about a linguistic deficit affecting verbal inflexion. However, the pattern found in J's object clitics and article production was different. We compared data about object clitics and articles with the same data from typically developing children, in order to find out if these areas are affected in the same way (expected delay) or in a strongest way (unexpected delay). The results show that object clitic and article production are delayed not only in relation to chronological age, but also to MLU, showing that acquisition is delayed in an unexpected degree. These results are found in the entire corpus of linguistic production, independently of the Communicative Context (Conversation, Narration-Autobiography, Narration-Procedure, Narration-Elicited). These results suggest an atypical profile, as complex construction and inflected verbs are delayed, but in line with MLU, while object clitic and article production are unexpectedly delayed, beyond what MLU would predict.

The gap between MLU, complex constructions and inflected verbs in one side, and object clitics and articles, in the other, outline an atypical profile.

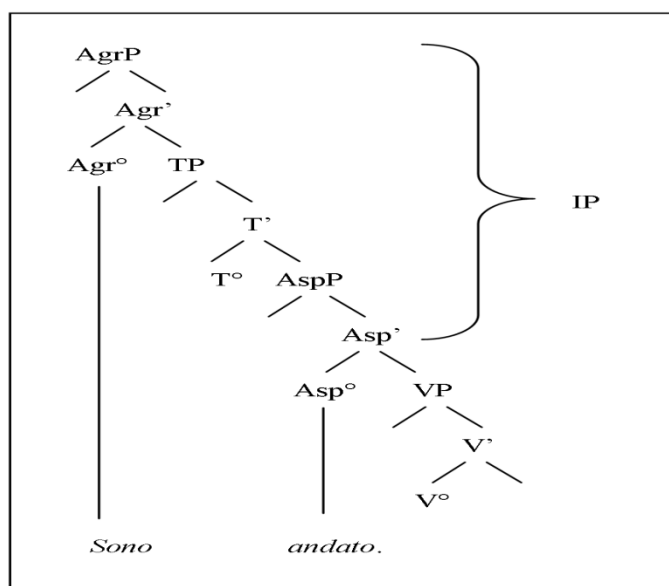
The question that arises is whether the linguistic characteristics of J are similar to those observed in younger children with typical development, or were there important differences. The data obtained from J's production showed errors characteristic of younger typically developing children. However his general grammar profile did not correspond to any stage of typical language acquisition. This suggests that J's grammar development did not just reflect typical development in a delayed form, but, instead, it appeared to have been acquired in a deviant way: congruent with MLU for verbal inflection and complex sentences, but incongruent for clitic pronouns and articles. From these data, we can conclude that the hypotheses about a linguistic deficit that affect

verbal inflexion can explain the expected delay but cannot fully account for the most impaired areas, namely articles and clitics.

The linguistic-based account for SLI, by Gopnik and Goad (1997) proposes that children do not build inflectionally complex representations because they lack the sub-lexical features which encode inflectional information, such as number and tense marking. To demonstrate this, they present a wide range of converging evidence from spontaneous speech and from data naturally and experimentally elicited, stimuli and oral or written responses being oral or written. This evidence supported that language-impaired children do not have access to the internal structure of words, in particular to tense features in verbs and number features in nouns.

Data obtained from our participant's speech can give us some information about internal structure of words in the participant's grammar. First, difficulties with verbs are those expected given his MLU. The main problem was found in past perfect production. Past perfect in Italian is formed by an auxiliary verb ('essere' or 'avere') which carries tense, person and number features, in I° position, and a participle form of the main verb in V° position (as shown in figure 1).

Figure 1: Structure of the sentence 'Sono andato' ('I went / was gone').



The participant's speech is characterised by a low percentage (36%) of correct past perfect production, as shown in Table 10). It is noteworthy that errors are mainly due to lack of auxiliary (29 out of a total of 38 errors) and substitution by infinitive forms (seven out of 38), representing 95% of incorrect productions. This type of error can be accounted for Gopnik and Goad's hypothesis which suggests that sub-lexical features which encode inflectional information are missing.

Table 10

Present and past perfect production.

Past Perfect	Frequency	Percentage
Correct	21	36%
Auxiliary omission	29	49%
Wrong auxiliary	2	3%
No inflexion (infinitive)	7	12%
Total	59	100%
Present	Frequency	
Correct	142	95.95%
Wrong inflexion	6	4.05%
Errors in person	2	
Errors in number	4	
Errors in tense	0	
Total	148	100%

Gopnik and Goad's hypothesis, however, does not explain the main problem: article and pronoun clitic production. If articles and nouns had no sub-lexical features and were stored as chunks, as this hypothesis claims, we would expect errors mostly in agreement, since problems wouldn't be found in the positions for articles or clitics, but with the information internal to the lexical element. Instead of that, we found that errors with article are mainly omission and not substitution. That is, problems are principally due to the position and not to agreement with the noun. Moreover, we found no incorrect noun-adjective agreement to suggest that nouns are underspecified for gender and number. Errors with clitic pronouns respect an analogous pattern: only omission but not substitution were found.

In this study, we did not focus on noun inflexion or verbal-noun compound. However we can mention that these constructions should also be relevant for testing Gopnik and Goad's hypothesis.

Gopnik and Goad (1997) affirm that nouns as well as verbs are not morphologically complex and that they are listed in the lexicon without morphemes that may modify them, such as diminutives. Our speech data did not give us enough information for testing complexity in nouns, since the only diminutives produced were '*piccolino*' (diminutive of 'little'), a very common one, that could be stored as a single unit, and '*calcetto*' which is not a real diminutive but a specific word for five-a-side football.

Regarding noun-verb compounds, we found evidence that may suggest that verb forms are not all stored as chunks, as predicted by this hypothesis. In some cases, they may have an internal structure as in typically developing children's grammar. The child produced the new compound '*mangiabanane*' ('banana-eater') which creation requires one to take the root of the verb '*mangiare*' ('to eat'), that is, '*mang-*', add the vowel '*a*' (due to phonological restrictions) and join them to the noun '*banane*' (bananas). An alternative explanation for these contradictory data, that fits with Gopnik and Goad's (1997) hypothesis, is that verb forms in our participant's grammar are not complex, and that the compound '*mangiabanane*' was created using the third person singular '*mangia*' (stored as a chunk) and the noun '*banane*'.

Deeper analyses are required for testing all consequences of assuming Gopnik and Goad's hypotheses.

The second account for SLI we have considered is the agreement deficit hypothesis, proposed by Clahsen and collaborators (Clahsen, 1986; 1989; 1991; Clahsen and Hansen, 1993 and Clahsen et al., 1997). These authors claim that SLI is due to a selective impairment in establishing grammatical agreement relationships. It predicts that non-interpretable ϕ -features of verbs –i.e. the verb's agreement features– would be affected in the speech of children with SLI, while interpretable features –that is, tense– would not. In order to verify if this prediction is confirmed by our data, we looked at the type of errors committed. First, we focused at the grammatical structure of

Inflexional Phrase (IP) in Italian. IP can be divided in two different projections: Agreement Phrase (AgrP) and Tense Phrase (TP), as shown in figures 2 and 3. Inflexion in Italian requires T° and Agr° position to be filled, in order to check tense and agreement (number and person)-features. Verbs in present raise to these positions, while verbs in past perfect need an auxiliary to fill them, as shown in Figures 2 and 3 (see page 54), respectively.

Figure 2: Structure of the sentence 'Mangio' ('I eat').

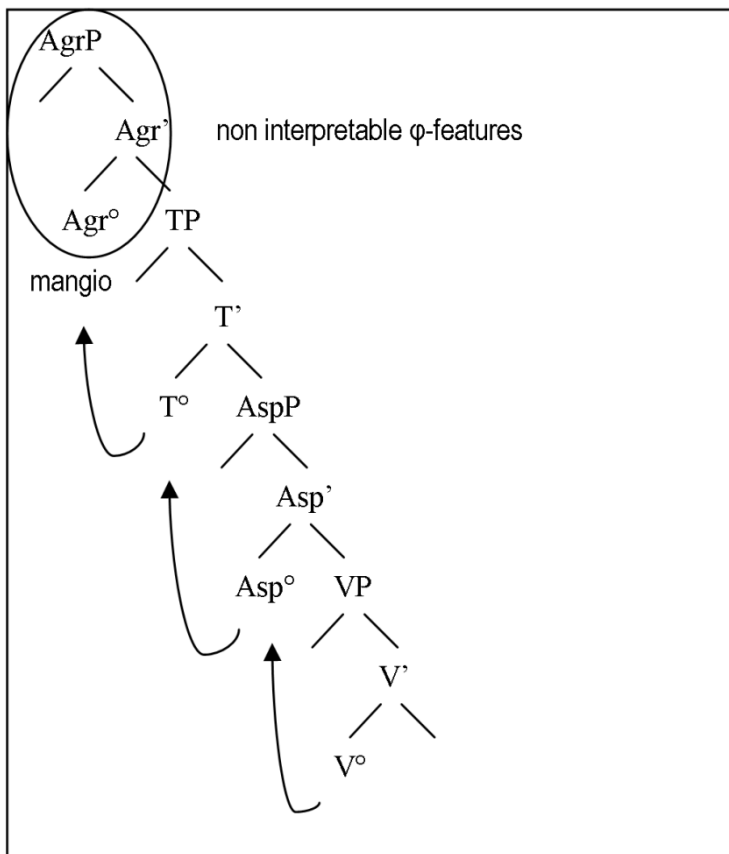
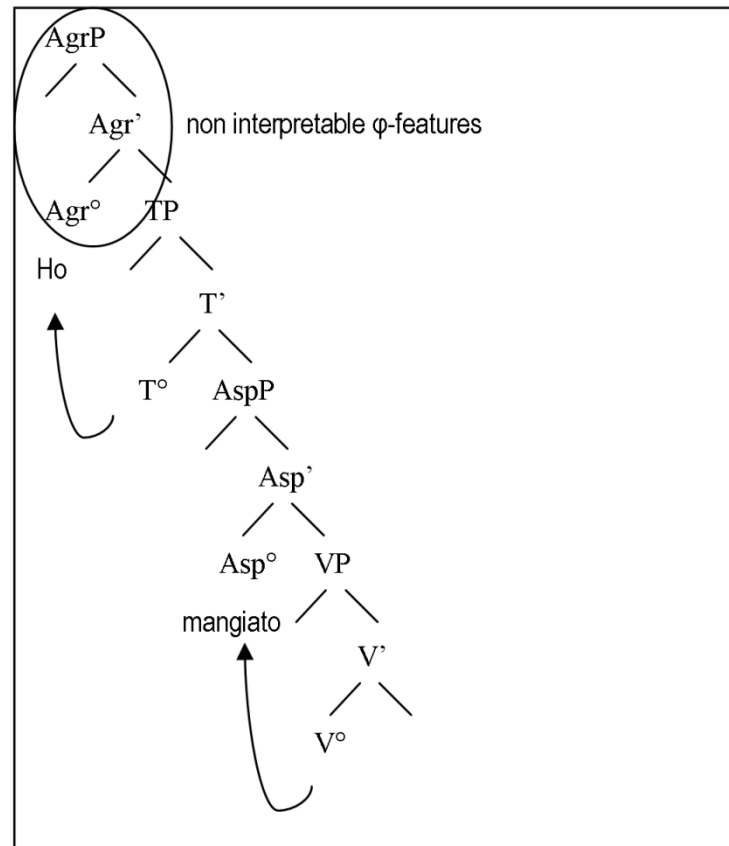


Figure 3: Structure of the sentence 'Ho mangiato' ('I ate / have eaten').



Difficulties in AgrP and not in TP would be reflected by errors in agreement but not in tense. For example, instead of a sentence like (a), a sentence like (b) would be produced, where tense (future) is correct, but agreement (person and number) is not.

a) *Le bambine correr*-_[3rd person+plural+future]*anno domani alla gara.*

The girls will run in the competition tomorrow.

b) *Le bambine correr*-_[1st person+plural+future]*à domani alla gara.*

The girls will run in the competition tomorrow.

Most errors in our data did not show this pattern and the errors were difficulties in AgrP and not in TP, that is, they were not substitution by forms correct for tense and wrong for person or/and number. Errors, instead, were mainly uninflected infinitive verb forms and past perfect without auxiliary, as shown in Table 10 (see page 55). In particular, when the context required past perfect production, most errors were auxiliary omission (29), followed by substitution by an infinitive (seven), both unspecified forms neither for tense nor for agreement. Only six cases of errors could be explained by Clahsen's hypothesis: when the context required a present verb, from a total of eight errors out of 15 obligatory contexts, six were due to difficulties in AgrP but not in TP (agreement errors), as predicted by Clahsen's hypothesis. The two remaining errors were substitutions by an infinitive, a non inflected form.

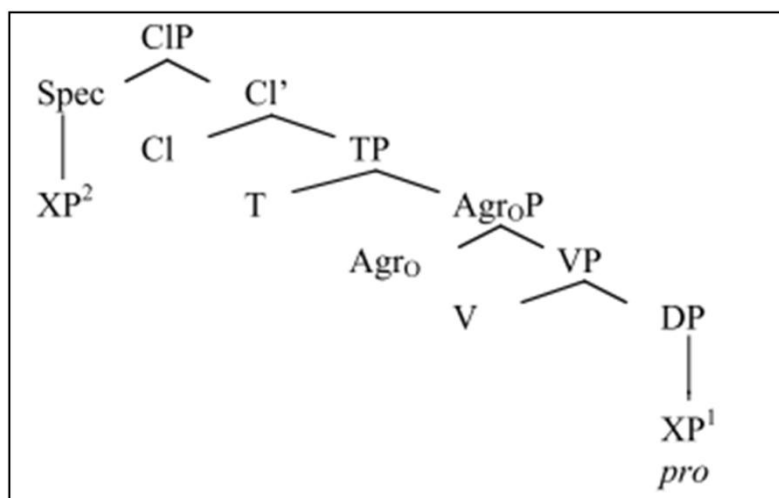
Apart from problems with verbs, our participant had problems mainly with articles and pronoun clitics. He produced them below the level expected for his MLU. This kind of difficulty cannot be explained by Clahsen's hypothesis.

The last account we considered, among those which propose a linguistic deficit underlying SLI was the Agreement Tense Omission Model (ATOM) (Rice et al., 1995). It predicts that in Italian, children will not produce root infinitives instead of finite forms due to the fact that AGR in Italian does not have to be checked, since it is interpretable as the subject of the sentence. Other verbal forms were predicted, to result in errors with other finite forms, as in the case of auxiliary omission in past perfect. The pattern found in the production of J can also be explained within the ATOM. The same

pattern of production has been explained by Torrens, Gavarrò and Wexler (2004) for clitic omission in Catalan and Spanish. Following the explanation by Wexler et al. 2002, we assume that clitics are verbal agreement morphemes (Uriagereka, 1995) that are base generated to the left of the verb and that they are heads of their own projections (Sportiche, 1996). We also assume that they are embedded in a clause structure like that in Figure 4 (see page 57) below (where CIP = Clitic Phrase, and AgrOP = Agreement Object Phrase).

The specifier of the clitic phrase is a landing site of the co-referent DP, which is XP^1 at the base-generated position, as shown in Figure 4. XP^1 is moved to the specifier of the clitic projection, XP^2 . The XP matches on features (person, number, gender, case) with the co-indexed clitic. As presented before, the UCC principle states: the D-feature of DP can only check against one functional feature. The UCC acts together with another restriction, Minimise Violations: given an LF, one should choose a numeration, the derivation of which violates as few grammatical properties as possible. If two numerations are both minimal violators, either one may be chosen. Together, these restrictions generate the possibility of object clitic omission in young typically developing children (Wexler et al., 2002), as in this case of SLI. In Italian, a *pro* object has two D-features to be checked: one in AgrO (a case feature), one in Cl (the definiteness feature). In a given derivation, if double checking occurs, the UCC is violated and the clitic then surfaces as in the adult grammar. If, on the contrary, the UCC is not violated and no double checking occurs, the derivation crashes due to the fact that two uninterpretable features in CIP and AgrOP are unchecked. The derivation can converge only if one of the functional categories is not projected. If CIP is eliminated, the derivation converges, but no clitic can be spelled out in CIP; *pro* moves to AgrO and checks against the case features there – and clitic omission results, with the only violation in the interface condition on the projection of CIP.

Figure 4: Clitics structure (from Torrens et al., 2004)



In sum, the three linguistic based hypotheses we have considered account for part of the participant's atypical production. In particular, they explain auxiliary omission in past perfect production as a result of problems in the verbal inflexion, expected given J's MLU. Gopnik and Goad's (1997) hypothesis, which considers TP as a possible impaired area, can explain an output where auxiliaries are not correctly produced. However, we would expect auxiliaries to be substituted by forms with a wrong tense instead of being omitted, which is the pattern found occurring in J's production. In an analogous way, Clahsen's (Clahsen et al., 1997) proposal of an impaired AgrP area better explains substitution, in this case, by an auxiliary with a wrong agreement instead of an omission. Only the ATOM model (Rice et al., 1995) clearly predicts auxiliary omission as a possible non finite form.

Even though J's verbal inflexion production, explained by these hypotheses, is delayed for his age, it is expected for his MLU. We are mainly interested in finding an explanation for article and object clitic pronoun omission since these were unexpected errors, but have been found in previous research on children with SLI speaking Italian (Sabbadini et al., 1987; Cipriani et al., 1991; Leonard et al. 1992; Bottari et al. 1994). Gopnik and Goad's (1997) and Clahsen et al.'s (1997) hypotheses cannot, to our knowledge, explain clitic and article omission, while Rice et al.'s (1995) account

predicts clitic but not article omission. The ATOM model affirms that clitics may be omitted in order to avoid violating the UCC principle. This principle is assumed to be the main difference between (atypical as well as younger typical) children's and adult's grammars. Further work will focus on proposing an additional explanation for article omission, using the ATOM model.

Chapter 3

Study II: Language comprehension and production in SLI, a group study

Introduction

Albeit SLI is, by definition, an impairment affecting language abilities, there is not complete agreement in literature regarding which abilities are impaired and the degree of such impairment. The pattern of the results of the different investigations is quite complex and sometimes not consistent. Most studies have considered specific aspects of language acquisition; some have taken into account non linguistic performance, such as phonological memory (for a review, Leonard, 1998). To our knowledge, no study has considered core and high level language abilities, with respect to comprehension and production, neither the relationship between language and memory has been deeply analysed in the same group of children. The current investigation represents the first attempt to scrutinise the performance of preschoolers with SLI in language and phonological memory tasks, looking for profiles designed by the correspondent abilities and patterns of relationships among them.

The performance of a group of 50 children with SLI aged 3;6 to 6;4 was examined in tasks assessing phonological memory as well as lexical, morpho-syntactic and textual abilities in both comprehension and production. Their performance was compared to a group of age-matched peers and a group of MLU-matched peers. Moreover, the relationships among language abilities and between these skills and phonological memory were examined. Tasks in our assessment that discriminated between children with SLI and typically developing children were also identified. These aims are described in the following lines.

1. Profiles of children with SLI in language abilities and phonological memory.

The first aim was to identify the profile that emerges from comparing the performance of children with SLI and age- as well as MLU-matched typically developing children in language and phonological memory tasks. First, we compared the means of the group of 50 children with SLI and a group of 52 age-matched typically developing children. We identified impairment or normal performance in each language and phonological memory ability assessed. Impairment was attested by a significantly lower mean score in the SLI group than in the typically developing group, while normal performance was assumed when scores were equivalent. Second, we selected MLU-matching children from the SLI and the typical development groups, obtaining two subgroups of 29 children. The selection procedure was the following. For each child in the SLI group, a child with an equivalent MLU was searched in the TD group. MLUs from two children were considered equivalent when they differed up to a maximum of 0.20. For example, for a child in the SLI group with an MLU of 2.35, a matching typically developing peer had to have an MLU between 2.15 and 2.55. All children in the SLI and the TD group that could be matched by MLU formed matching couples. Analogous to the analyses conducted on the SLI and TD groups, mean scores of SLI and TD subgroups matched by MLU were compared.

This comparison was done in order to detect potential asynchronies and identify strongly impaired abilities. Language of children with SLI is characterised by not being simply delayed but also showing atypical trends, with some language abilities more developed than others (for discussion on the issue, Leonard, 1998). In general, it was expected that some skills would be strongly impaired – that is, so undeveloped that they did not reach the level of younger MLU-matched children – while others would be slightly impaired or partially preserved. Strong impairment was recognised when the performance of the group of children with SLI was significantly poorer than the group of MLU-matched typically developing children and slight impairment when their performances were equivalent. The double comparison was done for two reasons. First, we wanted to identify impairment and the degree of it. Second, we aimed to detecting not only weakness but also strength, that is, impaired as well as completely or partially preserved abilities. We intended to provide a profile of weaknesses as well as strengths

in children with SLI that could give a contribution to investigations on the subject and helpful information for clinical practice.

A complex pattern of impaired and preserved abilities was expected for the group of children with SLI. In particular, impairment was expected in core language areas – namely, lexicon and morpho-syntax – since several studies report important deficits in these areas in children with SLI (for a review, Leonard, 1998). Regarding lexical abilities, many investigations have revealed late onset time for lexical acquisition (e.g. Trauner et al., 1995) and even specific difficulties in word learning once it has begun (Rice et al., 1992). Concerning morpho-syntax, late onset for acquisition (e.g. Trauner et al., 1995) and important impairment during development (Bortolini, Leonard & Caselli, 1998) have been described. Moreover, morpho-syntax has been considered the key characteristic of SLI and the principal obstacle for children with such impairment (Leonard, 1998).

The pattern of impaired and preserved abilities in children with SLI was expected to be complex especially due to performance in high level language abilities (text comprehension and production). In literature, studies on textual abilities in children with SLI have yielded to different results. Comprehension has been reported as normal by almost all studies (e.g., Bishop and Adams, 1992 and Liles, Duffy, Merritt & Purcell, 1995), while production appears to be normal according to some studies (as Paul, 1996 and Ripich & Griffith, 1988) and impaired according to others (as Merritt & Liles, 1989 and Boudreau, 2007). Textual abilities in the group of children with SLI were expected to be partially preserved or slightly impaired in some aspects.

Apart from the analysis of language performance in each area, comprehension was compared to production. Disparity between comprehension and production is an issue frequently discussed in literature. Studies have reported that in SLI, in particular the expressive type, production is impaired while comprehension is preserved (Chilosi et al, 2002). Our group of SLI is mainly composed of children showing the characteristics of expressive SLI. The performances of 43 out of 47 children in standardised comprehension tests were situated at a very low level, yet within the normal range, suggesting a diagnosis of expressive SLI. Despite these characteristics,

all children were treated as a single group since the diagnosis was not done previously or independently to our assessment. Children in the SLI group were tested when they were already diagnosed with SLI in the Health Service Units where we recruited them, but before such diagnosis was specified for any particular type. In order to avoid a circularity problem and albeit having enough information for classifying the children with expressive or expressive-receptive SLI, the overall group was not divided. When examining the performance of the single group, however, the potential effect of the characteristics of SLI found in most children was considered.

In addition to language assessment, the performance of children in the study was tested by tasks measuring phonological memory, in particular short term and working memory. The reason for evaluating phonological memory was that several studies describing cognitive deficits apart from language has focused on this ability (e.g., Archibald & Gathercole, 2006). Furthermore, phonological memory not only has been reported as impaired in children with SLI, but has also been considered as the deficit underlying language problems (Gathercole and Baddeley, 1990). In the performance of children in our SLI group, slight or strong impairment in phonological short term or working memory was expected.

2. Relationships between language and phonological memory

The second aim of our study was to refine the profile of children with SLI by evincing the relationships among language abilities and between such skills and phonological memory.

During development, language and phonological memory capacities are interrelated forming a complex structure of relationships. We were interested in discovering the connections among core and high language skills as well as links between phonological memory and language abilities. In order to represent potential relationships between such capacities, we adopted a **conceptual hierarchical model**. The potential relationships in this model are one-way connections between abilities required for performing tasks measuring other abilities. The aim of the model was to represent which abilities may be required for performing language tasks. For example,

for performing a task measuring a high level language ability, such as text production, other abilities apart from textual skills are required. First, phonological memory is necessary for all language tasks, as for generating a text. Second, lexical and morpho-syntactic knowledge – that is, more basic language abilities – is required in order to be able to perform a text production task. Third, text production implies capability in text comprehension. As illustrated by the example, according to this model, relationships among required and tested abilities are based on three criteria. The first, phonological memory may be required for performing all language tasks. The second, to execute every language task, apart from the specific language ability measured, knowledge in more basic language areas is needed, as assumed in theories of language acquisition (Van der Lely, 2005). That is to say, lexical knowledge is necessary for performing morpho-syntactic tasks; lexical and morpho-syntactic knowledge is required for performing textual tasks. The third, based on the acquisition process, it is assumed that comprehension in the same area is needed for production. That is, lexical comprehension is required for lexical production. Analogously, morpho-syntactic and text comprehension is needed for morpho-syntactic and text production, respectively.

Table 11 (see page 61) presents language tasks and abilities required for performing it, according to the model.

Table 11

Language tasks and language abilities required to perform them, according to the conceptual hierarchical model

Language Task	Language abilities required						
Lexical comprehension	Phonological memory	Lexical comprehension*					
Lexical production	Phonological memory	Lexical comprehension	Lexical production*				
Morpho-syntactic comprehension	Phonological memory	Lexical comprehension		Morpho-syntactic comprehension*			
Morpho-syntactic production	Phonological memory	Lexical comprehension	Lexical production	Morpho-syntactic comprehension	Morpho-syntactic production*		
Text comprehension	Phonological memory	Lexical comprehension		Morpho-syntactic comprehension		Text comprehension*	
Text production	Phonological memory	Lexical comprehension	Lexical production	Morpho-syntactic comprehension	Morpho-syntactic production	Text comprehension	Text production*

*Language ability measured by the task.

Based on the conceptual hierarchical model, the potential relationships between abilities were examined conducting fixed-order hierarchical multiple regression analyses on the overall group of children. The reason for carrying out the analysis on the overall group instead of dividing children with SLI from typically developing children was trying to initially explain the performance in language tasks without recourse to the difference between groups but only to phonological and language abilities. The pattern of relationships emerged would show whether these abilities were related in children with SLI similarly than in typically developing children, suggesting a continuum between typical and impaired language development. The effect of belonging to one group or the other was also examined, after considering relationships between abilities. A series of regressions in three steps were performed, having as dependent variable measures of lexical, morpho-syntactic and text comprehension as well as production. In the first step, age was entered in order to control its effect. In the second step, those abilities that according to the conceptual hierarchical model are required for the performance in the relevant task were entered. In the third step, the factor belonging to the SLI group or the TD group was entered for detecting if belonging to one group or the other accounted for the performance in language tasks beyond the effect of phonological memory and language abilities.

A complex pattern of relationships among phonological memory and language abilities was expected. Since to our knowledge, previous studies have not examined relationships measuring effects of required abilities on performing specific language tasks in children with SLI and typically developing children, our goals were mainly exploratory.

3. Different profiles within the group children with SLI

The third aim of this study was to recognise if children with SLI presented all the same pattern of performance in language and memory tasks or if different profiles emerged. The interested was focused on describing different sub-groups within the overall SLI group and to compare their profiles.

The overall group was divided in four sub-groups by combining two criteria of selection. These criteria regarded the severity of lexical and morpho-syntactic production. The reasons for this choice were the following. On the one hand, since most children in the group with SLI showed the characteristics of expressive SLI, we used criteria based on impaired production. On the other hand, since lexicon and morpho-syntax are the most affected areas in SLI, criteria of impairment regarded lexical and morpho-syntactic production. The first criteria of selection regarded the degree of the lexical impairment. That is, it divided the group in children with severe or mild impairment in lexical production. Analogously, the second criteria regarded severe and mild impairment in morpho-syntactic production. The four groups obtained had both areas severely impaired (Severe Language Impairment group), both areas mildly impaired (Mild Language Impairment group), or a combination of mild impairment in one area and severe impairment in the other (Severe Lexical Impairment and Severe Morpho-syntactic Impairment).

The mean scores of the groups in language and phonological memory tasks were compared, in order to identify different profiles. Children with mild impairments were expected to perform significantly better than children with severe impairments in lexical and morpho-syntactic comprehension tasks. Regarding textual abilities and phonological memory our goals were exploratory.

4. Language and phonological memory tasks which better discriminate between performance of children with SLI and typically developing children

The fourth aim of our study was the attempt to give a practical contribution with regard to tasks useful for identifying children with SLI. Previous studies have already proposed various clinical markers for SLI. In particular, the tasks mostly proposed in literature as related to markers are Non-word Repetition, Sentence Repetition and syntactic tense marking (e.g. Bishop, North & Donlan, 1996; Campbell, Dollaghan, Needleman & Janosky, 1997; Rice, Wexler & Hershberger, 1998; Conti-Ramsden, Botting & Faragher, 2001). In the current investigation, the goal was not to find clinical markers. Neither the design of the study, nor the analyses performed would fulfil the requirements of sensitivity, specificity and accuracy needed for correctly recognise

children with SLI within a group of children. Our aim was limited to identifying discriminating measures among the tasks we employed. The goal was to detect which measures in our assessment could predict if a child belongs to the group of SLI. We evaluated if these predictors were language or phonological measures and whether they have been proposed as clinical markers. The practical contribution aimed to achieve was to provide a selection of tasks to be administered during assessment. The tasks we employed were chosen at the beginning of the study for two reasons. First, they covered main aspects of language comprehension and production as well as phonological memory. Second, they are frequently used in Health Service Units and/or they are easy to administer. We think that selecting the best tasks among these for identifying children with SLI could be useful for assessment in clinical settings.

In order to find the tasks that would stand out as predictors for SLI, a logistic regression analysis was performed. This analysis took into account a set of potential predictors, that is, measures from the tasks used for assessment. Those tasks proposed as markers in literature, namely non word and Sentence Repetition, were expected to stand out as predictors.

PART I: DESIGN OF THE STUDY

1. Participants

A total of 121 children aged 3;6 years (42 months) to 6;4 years (76 months) participated in the study. There were two groups: fifty children with SLI (SLI) and 52 age-matched children with typical development (TD). The SLI group was composed of 33 males and 17 females, their age varied from 42 to 76 months, with a mean of 60.22 and a standard deviation of 8.50. The TD group was constituted by 23 males and 29 females, with an age range of 42 to 76 months, a mean of 58.62 and a standard deviation of 9.14. This information is presented in Table 12.

Table 12

Description of SLI and TD groups: total number of children, number of males and females, mean age, standard deviation for age and age range.

	Number of children			Age		
	total	males	females	mean	standard deviation	range
SLI	50	33	17	60.22	8.50	42-76
TD	52	29	23	58.62	9.14	42-76

1.1. Recruitment and Screening Procedure

1.1.1. Children with SLI

All children with SLI were recruited from nine National Health Service Units (*Unità Locali Socio-Sanitarie* and *Aziende Socio-Sanitarie*; ULSS and ASL) in the provinces of Udine, Padua, Venice and Rovigo. They were diagnosed with SLI by psychologists and speech therapists working in the aforementioned units. The diagnosis was made via language assessments using standardised tests which identified language impairment as a primary problem, i.e., SLI (excluding other causes, such as hearing loss

or physical impairment, global developmental delay, neurological dysfunctions, emotional problems or environmental deprivation). Moreover, to be identified with SLI, children should be evaluated as having typical cognitive skills. In addition to the identification of SLI, psychologists and speech therapists in the units make a further diagnosis of language impairment type. They classified the children as having one of the three forms of SLI: phonological, expressive or expressive-receptive (Chilosi, Cipriani & Fapone, 2002). Phonological SLI affects only phonology while expressive SLI affects phonology as well as lexical and morpho-syntactic production. Expressive-receptive SLI affects also lexical and morpho-syntactic production as well as comprehension. The diagnosis was made in two steps. First, during the assessment of linguistic production in addition to diagnosing phonological delay, lexical and morpho-syntactic production was evaluated. If morpho-syntactic production was within normal range, then a diagnosis of pure phonological SLI was made. If lexical and morpho-syntactic production showed delay, then a further evaluation was conducted. In the second step, lexical and morpho-syntactic comprehension was assessed in order to identify expressive or expressive-receptive SLI.

We evaluated children during their assessment process for the diagnosis of SLI and/or the early stages of their therapy when they were being seen by psychologists and speech therapists in the National Health Service Units (Unità Locale Socio-Sanitaria, ULSS and Azienda Sanitaria Locale, ASL). We excluded cases already diagnosed as pure phonological SLI in the first step of SLI classification done by the experts in ULSS and ASL. The reason for evaluating children before or at the beginning of therapy and the exclusion of pure phonological SLI cases was based on the aim of investigating lexical, morpho-syntactic and textual abilities in children with SLI prior to any potential effects of therapy. Eight children had received some therapy sessions by speech therapists in the units. They had received one (one child), two (one child), three (four children) or four (two children) therapy sessions of 45 minutes.

1.1.2. Typically developing (TD) children

The TD children were recruited from four schools in the province of Padua. We contacted the schools and asked teachers to refer children who satisfied the following criteria:

- Age between 42 - 76 months.
- No history of language, hearing loss or oral physical impairment, global development delay, neurological dysfunctions, emotional problems or environmental deprivation according to their parents.

2. Materials

In order to achieve the aims of the study, a comprehensive assessment of language and phonological memory skills was projected. Examined skills covered different linguistic processing units: single words (lexical skills), sentences (morpho-syntactic skills) and sequences of sentences (textual skills) in comprehension as well as production. In addition, underpinning memory abilities were measured: phonological short term memory and phonological working memory.

2.1. Lexical comprehension

The Peabody Picture Vocabulary Test - Revised (PPVT-R; Dunn & Dunn, 2000) Italian version. This test, adapted and standardised for Italian speakers aged 3;6 to 17;0 years has 180 items and measures receptive lexical skills. Administration requires that the examiner orally presents a word describing one of four pictures. The individual is shown the four pictures and is instructed to point to the picture that the word describes. The test is discontinued once the individual makes six errors out of eight consecutive items. This test gives both raw and standard scores (M=100, SD=15) based on the age of the child. Raw and standard scores were used for analyses.

2.2. Lexical production

The Fono-Lessicale Test – production sub-test (TFL; Vicari, Marotta & Luci, 2007). This standardised Italian sub-test of vocabulary production consists of 45 items appropriate for speakers aged 3;0 to 11;0 years. Items are rank ordered in terms of their ability to be named, which is thought to be correlated with their frequency. The examiner presents a picture representing an object or an action which the child has to name. For items incorrectly named, a semantic cue was given. When the child was not able to give the correct answer with the semantic cue, he/she received a phonological cue. For example, item 14 was the name “martello” (“hammer), which pronunciation is [mar.'tel.lo]. The semantic cue, given first, was “it is used for hitting nails” The phonological cue, giving after the first one, was the two phonemes: [ma]. Responses with and without cues were counted to obtain the scores. The total number of correct responses without any cue, the total number of correct responses after a semantic cue and the total number of correct responses after a phonological cue are summed to provide the three different raw scores. Moreover, the total number of correct responses without any cue raw scores was used for analyses.

2.3. Morpho-syntactic comprehension

The Prove di valutazione della comprensione linguistica (Rustioni; Rustioni 1994). This Italian test is standardised to provide levels of functioning instead of standard or percentile scores on children between 3;0 to 7;0 year-old. For each trial, the examiner orally presents a sentence and the child has to choose the correct picture out of four possibilities. The total number of items varied from eight to twelve, depending on the protocol required. We used all six protocols specified for the following age ranges (in months): 36 to 47 (protocol 3), 48 to 53 (protocol 4A), 54 to 59 (protocol 4B), 60 to 65 (protocol 5A), 66 to 71 (protocol 5B), 72 to 84 (protocol 6/7). The test instructions require that the examiner stops the test after a certain number of errors, depending on the protocol. The test provided raw scores and levels, based on the age of each child and the raw score obtained. The levels were as follows: insufficient, very low, medium low, medium, medium high, good and very good. Levels were used for describing the

characteristics of the group with SLI in the presentation of subgroups (Section Data Analysis). Raw scores were used for analyses.

2.4. Morpho-syntactic production

Two tests were administered to assess morpho-syntactic production: the Sentence Repetition task and the Narration Task. The Narration was also used for examining text comprehension.

Sentence Repetition task (Devescovi & Caselli, 2007). This test includes 27 sentences of different lengths and complexity. Each sentence is accompanied by a picture reproducing its meaning. Pictures are expected to reduce the load for phonological memory. This test was not designed for measuring any kind of memory, but for evaluating morpho-syntactic aspects of the sentences produced during repetition. We employed this test as a measure of grammar development as proposed by its authors. Coding of the test requires counting the number of correctly repeated sentences and calculating the total MLU, regardless of correctness. We considered as correct any word that could be identified as the target, despite incorrect pronunciation. Only those words identified by both independent coders were considered correct. The reason for using this criterion was to obtain a measure that did not penalise children with phonological immaturities when testing for morpho-syntax.

In addition, we calculated the percentage of Morpho-syntactic Information repeated. Morpho-syntactic information included gender and number morphemes for nouns, tense and number morphemes for verbs, articles and prepositions. For example, the sentence “*Le bambine dormono*” (“The girls sleep”) carries lexical and morpho-syntactic information. The first word, an article, conveys only morpho-syntactic information, gender (feminine) and number (plural) in one single morpheme. The second word, a noun, conveys lexical (the meaning of “girl”) and morpho-syntactic information, gender (feminine) and number (plural) in one single morpheme. The third word, a verb, conveys lexical (the meaning of “to sleep”) and morpho-syntactic information, tense (present indicative) and number (plural) in a single morpheme.

Perfect repetition comprises three units (morphemes) carrying morpho-syntactic information.

In sum, three measures were obtained: the number of correct items (correct items raw score), MLU (raw score) and Morpho-syntactic Information (percentage). From these measures, we selected Items and Morpho-syntactic Information for comparing SLI and TD groups on morpho-syntactic abilities tested by Sentence Repetition. MLU was excluded because a ceiling effect (and little variation) was found in the performance of the TD group, we present the results when describing the data.

Narration Task (Marini and Carlomagno, 2004). This test involves a picture-story elicited description. The stimuli included two single-pictures as well as two stories illustrated with a series of six coloured pictures. One single-picture stimulus illustrated a home scene where a boy is getting some biscuits and giving them to his sister, while their mother is washing the dishes (Goodglass & Kaplan, 1972). The other single picture stimulus showed a picnic on a lake and was taken from the Western Aphasia Battery (WAB; Kertesz, 1982) for Marini and Carlomagno's (2004) test. The two multi-picture sequences were taken from Huber and Gleber (1982) and Paradis (1987), respectively. The first sequence is about a man who is walking with his dog and is hit on the head by a flower pot. The second story is about a man who falls from a tree when he is trying to get a bird nest. The child had to produce a narration for the single-picture stimuli and the multi-picture stimuli. Each story telling was tape-recorded on a professional, high-definition recorder with a high-sensitivity stereo condenser microphone built in (R-09HR by Roland). Subsequently, the recording was independently transcribed by the author and a trainee in Psychology. Reliability between transcribers was adequate at 90%.

The method of transcription was computerised, using WORD format and followed Italian orthography. Transcriptions were then prepared for coding by the author. Transcriptions of each story told were prepared separately, but only when all four stories were produced by participants. Transcriptions from seven children were not coded since those children did not narrate all four stories. Utterances were identified based on the guidelines of the test's author. They gave priority to the acoustic criterion,

followed by the phonological, semantic and grammatical criteria. Unintelligible and immediately repeated words or sounds (stutter), neologisms and phonological fillers (as “eh”, “mm”) were excluded. These new versions of transcription were used for a quantitative analysis of morpho-syntactic as well as textual abilities. Morphosyntactic production was measured by MLU, Incorrect Morpheme Rate and Grammatical Complete Sentences. The Incorrect Morpheme rate was obtained by counting how many times bound (noun and verbal morphemes) and free (prepositions, pronouns and articles) morphemes were omitted or wrongly produced and dividing this by the total number of words. Grammatical complete sentences were identified when an inflected verb and its arguments were produced in a sequence of words with no grammatical errors. This analysis was based on the work by Marini and Carlomagno (2004).

2.5. Text comprehension

The Test di Comprensione del Testo Orale (TOR 3-8; Levorato & Roch, 2007).

This standardised test for Italian speakers aged 3;0 to 8;0 measures oral text comprehension. Each individual is asked to listen to a story appropriate for his/her age. In order to minimise the cognitive and memory load of the task, the experimenter asks the questions during two predetermined points, one in mid reading (interrupts the reading) and the other at the end of the story. A total of ten multiple-choice questions with four possible answers were asked in order to verify paragraph comprehension. Five questions concerned information explicitly stated in the story (Explicit Questions) and five required an inference to be made (Implicit Questions). Each possible answer was presented verbally by the experimenter whilst pointing to pictures representing each alternative. The individuals were then asked to point to the correct picture. One of the two stories provided by the test was used and the following measures obtained: total raw score, total standard score ($M=10$, $SD=1.5$), as well as raw scores for Explicit and Implicit Questions. We used all scores for our analyses.

2.6. Text production

Narration Task (Marini, 2007). This test, previously presented for examining morpho-syntactic production, was used for text production as well. The same stories, transcribed and prepared for coding were used for a quantitative textual analysis. The analysis focused on cohesion as well as local and global coherence. Cohesion is the textual relationship within a sentence. The number of cohesion errors was calculated by counting aposiopesis (broken off and unfinished sentences) and errors in using conjunctions. The Cohesion Error Rate was obtained by dividing the number of cohesion errors by the total number of words. Coherence, as a measurement of the semantic meaningfulness of the text, was determined at a local level (among adjacent utterances) and at a global level (among all utterances). The number of local coherence errors was obtained by counting the omission of referents when using referential nouns (preceded by a definite article), pronouns and demonstratives. The Local Coherence Error Rate was obtained by dividing the number of local coherence errors by the total number of utterances. The number of global coherence errors was obtained by counting the number of repeated phrases as well as semantically incorrect and irrelevant phrases. The Global Coherence Error Rate was obtained by dividing the number of global coherence errors by the total number of utterances. This analysis was based on the work of Marini and Carlomagno (2004).

2.7. Phonological short term and working memory

These abilities were measured by four tasks. Forward Digit Span (in BVN 5-11, Bisiacchi et al., 2005), Word and Non-word Repetition (Dispaldro, Benelli, Marcolini & Stella, 2009) were used for testing phonological short term memory. Backwards digit span (in BVN 5-11, Bisiacchi et al., 2005) was used for measuring phonological working memory.

Forward and Backwards Digit Span (BVN 5-11, Bisiacchi et al., 2005). This test measures phonological short term memory (Forward Digit Span) as well as phonological working memory (Backwards Digit Span). It is standardised for children aged 4;7 years to 11;0. The sets for span were comprised of three sequences for each

level of difficulty. The set for forward span was composed of 21 sequences for seven level of difficulty: three, four, five, six, seven, eight and nine digits to repeat. The set for backwards span was formed by 21 sequences for seven level of difficulty: two, three, four, five, six, seven and eight digits to repeat. Each sequence was presented only once. For each set, when two sequences of the same number of digits were incorrectly repeated, the test stopped. Practice trials were given before the administration. This test offers raw scores and standard scores ($M=100$, $SD=15$) for Forward and Backwards Digit Spans. We used raw scores provided by the test for our analyses.

Word and Non-word Repetition task (Dispaldro et al., 2009). This task measures pure phonological memory (Non-word Repetition) and phonological memory in conjunction with lexical knowledge (word repetition). These measures were created for testing Italian speakers between 3;0 to 4;0 years. The original task consisted of two sets of 16 real words each and one set of 16 non words, making a total of 48 stimuli. This task was adapted by the first author of the test for the present study. This new version included a set of 24 words and a set of 24 non words. Each set included eight bisyllable, eight trisyllable and eight quadrisyllable elements. Only words with high familiarity levels were selected. Familiarity was defined as the “estimated frequency of occurrence of a word in the daily lives” (Dispaldro et al., 2009, p. 946). Given the articulatory and phonotactic characteristics of Italian, the words had simple and complex syllabic structure (CV and CVC or CCV). They had the primary stress on the penultimate syllable, the most frequent stress pattern in Italian. Words were chosen to be easy for young children to repeat, as the syllabic and phonemic characteristics of the words are usually mastered by age three.

The non words were assembled by using the phonemic structure of the real words available. Each non-word was created keeping the same initial phoneme of a word and, wherever possible, the other phonemes were replaced with phonemes, in the same position, similar in sonority and/or manner of articulation. The two sets of stimuli were matched for length in syllables and in phonemes. They were also matched in initial phoneme, syllabic structure, phonological neighbourhood size and phonotactic probability. Phonological neighbourhood size is “the number of words that differ from the target word by only a single phoneme” (Dispaldro et al., 2009, p. 946).

Neighbourhood size has a different effect in word and Non-word Repetition. Words with high levels in neighbourhood size are especially difficult to process; while non-words with high levels are especially easier to process (Garlock, Walley & Metsala, 2001; Edwards, Beckman & Munson, 2004, Munson, Swenson & Manthei, 2005). To exclude such effect of neighbourhood size in words and non words, both sets were matched on low level of neighbourhood size. The structure of all lexical items had high phonotactic probability. This information was obtained from the frequency provided by the Istituto di Linguistica Computazionale, CNR (1989). The two sets of stimuli are reported in Appendix 1.

In performing the task, the children were asked to repeat each item that the examiner produced as accurately as possible. Each target of each list was read out by the examiner who waited for the child to respond. Neither correction nor reinforcement was provided. The order of presentation of items and sets was fixed. The examiner gave practice trials to the children before each set. The two sets were administered in the same session. The children's responses were recorded on a professional, high-definition recorder with a high-sensitivity stereo condenser microphone built in (R-09HR by Roland) and transcribed using the International Phonetic Alphabet (IPA) by the author or a trainee in Psychology. Subsequently, the transcriptions were swapped in order that a different transcriber listened to the recordings and confirmed the errors present. Inter-transcriber reliability rate was 99%. For the analyses, we used the number of errors produced in each list (words and non words) as measures.

2.8. Composite measures

The creation of composite measures was based on conceptual factors. We used original as well as composite measures, depending of the analyses conducted (see Part II: Design of the study, Data analyses). Regarding morpho-syntactic production, we obtained three measures from the Narration Task: MLU, Incorrect Morphology Rate and Complete Sentences. In order to calculate a composite representing a measure of morpho-syntactic production in this task, we combined Incorrect Morphology Rate and Complete Sentences since each of these measures provides information about morphology and syntax, respectively. It was necessary to obtain an error measure at the

statistical level. This was obtained with the following procedures. The Complete Sentences measure was divided by the total number of utterances, obtaining a complete sentences rate. We calculated an additional measure, that is, the rate of utterances which did not have the characteristics of a well-formed sentence. That is, there was no inflected verb or at least one of its arguments was missing, or there were other grammatical errors. We called this new measure Incomplete Sentences Rate. We created a composite by averaging Incorrect Morphology and Incomplete Sentences Rates. This composite was called Incorrect Morpho-syntactic Rate.

Moreover, in order to have a measurement of morpho-syntactic production that would include information from both Sentence Repetition and Narration Task, we created a new composite, combining the Morpho-syntactic Missing Information measure in Sentence Repetition and the Incorrect Morpho-syntactic Rate. It was necessary to calculate an error measure. This was calculated with the following procedure. The Morpho-syntactic Information measure in Sentence Repetition expressed the percentage of correctly repeated information. From this measure, we calculated the percentage of morpho-syntactic information not included during repetition (missing information). For example, if 95% of the information was correctly repeated, 5% of it was missing. This new percentage was transformed to a decimal. In the example, 5% was transformed to 0.05. This new measure, expressed in decimals was called Morpho-syntactic Missing Information Rate. Then, we calculated the mean of Morpho-syntactic Missing Information Rate and Incorrect Morpho-syntactic Rate from Narration Task (expressed also as decimals) and obtained the Productive Morpho-syntactic Incorrect Rate, a general measure of morpho-syntactic production.

Regarding text production, we obtained three measures from the Narration Task: Cohesion, Local Coherence and Global Coherence Error Rates. To represent the information about text production in a single measure, we calculated a composite error measure. The composite Productive Text Error Rate was calculated averaging the three measures.

Regarding Word and Non Word Repetition, despite conceptual differences between repetition of real words and unreal words, we created a composite. This

decision was, first, based on the assumption that both tasks mainly measured phonological short term memory, even though other skills as phonological ability and lexical knowledge (for Word Repetition) may also have an effect on performance. Second, this decision is based on the high correlation found between Word and Non-word Repetition in the overall group (SLI and TD), $r = 0.93, p < .001$. The correlations between these measures for the SLI and the TD group, separately, are also very high: $r = 0.89, p < .001$ and $r = 0.79, p < .001$, respectively. Using a composite precluded the single measures to be taken as two different predictors for linguistic performance. Potential differences between Word and Non-word Repetition were considered due to the possibility that Word Repetition, but not Non-word Repetition, may be related to lexical knowledge. Correlations between PPVT-R and Word Repetition, in the one hand, and PPVT-R and Non-word Repetition, in the other, were examined. For the overall group the correlation between PPVT-R and Word Repetition was $r = 0.31, p = .005$ and the correlation between PPVT-R and Non-word Repetition was $r = 0.34, p = .005$ (see Table 13, in page 77). Correlations for the SLI and the TD groups separately were not significant at the $p < .05$ level (see Table 13). The results from the overall group showed that Word Repetition is not more related to performance in lexical comprehension than Non-word Repetition. This suggests that Word Repetition is not more dependent to receptive vocabulary than Non Word Repetition.

Table 13

Correlations between PPVT-R, Word Repetition and Non-word Repetition in the overall group, as well as in SLI and TD group

	PPVT-R and Word Repetition	PPVT-R and Non-word Repetition
Overall group	-0.31*	-0.34*
SLI	-0.01	0.03
TD	-0.01	-0.13

* $p < .005$

All measures used for analysis are summarised in Tables 14 and 15 (see page 78).

Table 14

Linguistic abilities and measures for comprehension and production in raw (RS) and standard (SS) scores.

	Comprehension	Production
Lexical Abilities	PPVT-R: RS and SS	TFL: RS
Morpho-syntactic Abilities	Rustioni: RS	Sentence Repetition: Correct Items RS, Morpho-syntactic Information. composite Morpho-syntactic Missing Information Rate. Narration Task: MLU, Incorrect Morphology Rate and Complete Sentences. composite Incorrect Morpho-syntactic Rate. composite Productive Morphosyntactic Incorrect Rate.
Textual Abilities	TOR: SS	Narration Task: Cohesion Error Rate, Local Coherence Error Rate and Global Coherence Error Rate. composite Productive Text Error Rate.

Table 15

Phonological short term and working memory measures in raw (RS) and standard (SS) scores.

Phonological short term memory	Forward Digit Span: SS and RS Non-word Repetition: Errors Word Repetition: Errors
Phonological working memory	Backwards Digit Span: SS and RS

3. Procedure

The tasks were administered to the children individually in a quiet room with only the examiner and the child present. When children with SLI were tested, the speech therapist was also present. The tasks were administered in the following order: Sentence Repetition, PPVT-R, Forward and Backward Digit Span, TFL, TOR 3-8, Rustioni and/or TCGB, Word and Non-word Repetition and Narration Task. This order was fixed and aimed at balancing task difficulty and time engagement so as not to overload the individual children. All children required approximately three sessions to complete the tasks with five sessions being the maximum number of sessions needed.

The objective was to administer all tests to every child. However, that was not always possible due to different reasons: they or their parents stopped participation; they refused or were not able to do the task. Hence, data were missing from the following tests: PPVT-R (3), Rustioni (5), Sentence Repetition (2), Word and Non-word Repetition (1), Forward and Backwards Digit Spans (2), Narration Task (7). Moreover, data was totally or partially missing due to other reasons for the narration task. Data from nine children were excluded because their story telling was at a level of unintelligibility which did not allow separation of the narration into utterances or because they did not produce the four stories. For the PPVT-R, raw scores from three children could not be transformed in standard scores because too low. We kept data for the analysis using raw scores but lost it for the analyses that employed standard scores.

4. Data analyses

In this section we present subgroups selected from the SLI and the statistical analyses performed on the overall group of children as well as separate groups (SLI and TD) and subgroups.

4.1. Subgroups

In order to identify profiles within the SLI group (third aim of the study), we needed to create subgroups. We considered different aspects of language production. The reason for choosing production was that most children displayed the characteristics

of expressive SLI. Expressive SLI is a subtype distinguished by preserved comprehension (Chilosi et al., 2002). Among the tasks administered, we employed standardised tests for measuring lexical and morpho-syntactic comprehension (Rustioni test and PPVT-R). The performance of 43 out of 47 children with SLI in these tests was very low, but within the normal range. These tests were selected because they measure core language areas widely recognised to be affected in SLI (Leonard, 1998) and taken into account in descriptions of expressive SLI (Chilosi et al., 2002). For attesting preserved comprehension, traditionally used criteria were applied. For the PPVT-R, performances below or equal two standard deviations under the mean were classified as impaired. Performances over that threshold were considered typical. For the Rustioni test, a criterion frequently used in the Health Services Units was adopted. Impairment was recognised when scores were at the “insufficient” and “very low” levels. Scores from levels “low” to “very good” were classified as typical. Despite most children in the SLI group exhibited characteristics of expressive SLI, they were all treated as a single group. The reason was that the diagnosis of expressive SLI was not done previously nor independently to our assessment. Children were tested when they were already diagnosed with SLI in the Health Service Units where they were recruited, but before such diagnosis was specified for any particular type. In order to avoid circularity problem and albeit having enough information for of expressive or expressive-receptive SLI, the overall group was not divided. Instead, subgroups were created based on the severity of the deficit in language lexical and morphosyntactic production, shared by all children. We applied the combination of two criteria for dividing the overall group in four subgroups. These criteria regarded the severity of the impairment in lexical and morpho-syntactic production. We chose these abilities because they are the most affected in SLI, as mentioned before. For determining if impairment was severe or mild, a limit was set based on standardised mean scores of the TD group. Performance was classified severely impaired when the pertinent score was equal or below two standard deviations under the standardised mean score of the TD group, and preserved when it was over such threshold. One criteria regarded lexical production and was based on the TFL test. The other concerned morpho-syntactic production and was based on the Morpho-Syntactic Information measure (from the Sentence Repetition task). We chose this measure of morpho-syntax for two reasons. First, it was necessary to select a

measure from Sentence Repetition, since a morpho-syntactic measure related to the Narration Task would exclude the possibility of using this task for comparing textual performance of subgroups. Second, the Morpho-syntactic Information was the most sensitive measure from Sentence Repetition, since it took into account accuracy in repetition related to morpho-syntactic information, regardless lexical information correctly recalled. Combining these two criteria the following four groups were obtained, composed of different number of participants.

- Severe Language Impairment (Severe LI): Sixteen children with both lexical and morpho-syntactic production severely impaired.
- Mild Language Impairment (Mild LI): Ten children with both lexical and morpho-syntactic production mildly impaired.
- Severe Lexical Impairment (Severe Lexical I): One child with lexical production severely impaired and morpho-syntactic production mildly impaired.
- Severe Morpho-syntactic Impairment (Severe Morpho-syntactic I): 23 children with lexical production mildly impaired and morpho-syntactic production severely impaired.

4.2. Descriptive statistics

In order to present the data before displaying analysis, in the results section, results of all tests are provided for the group with SLI and the TD group. Standard scores were reported when available, and raw scores, in other cases, as used for mean comparisons. Results for composite measures, used for regression analyses were also presented. In this section, the following information is provided for each measure, for each group (SLI and TD): mean, standard deviation, range of scores (minimum and maximum) and number of children to which the task was administered and who had a performance that could be examined.

4.3. Mean comparisons

In order to identify the profile of children with SLI (first aim of the study) regarding language and phonological memory, two type of comparisons with typically developing children were made. First, the overall group of children with SLI was compared with the entire TD group, composed of age-matched peers. Second, subgroups from the SLI and the TD groups formed by children matched by MLU were compared. Moreover, for identifying different profiles among the group of children with SLI (third aim of the study), it was subdivided in subgroups according to the severity of the impairment. The groups were compared for language and phonological measures.

4.3.1. Comparisons between children with SLI and age-matched typically developing children (SLI and TD groups)

The aim of comparing the SLI group to the TD group was to identify the profile of children with SLI by distinguishing between impaired and preserved abilities. When the mean score of children with SLI was significantly lower than the mean score of the group of age-matched peers, impairment in the relevant ability was assumed. In all other cases, equivalent performances were attested and preserved skills assumed.

4.3.2. Comparison between children with SLI and MLU-matched typically developing children (SLI and TD subgroups)

The aim of this comparison was to refine the profile of children with SLI by discriminating between strong and slight impairment. After the comparison between the overall group of children with SLI and age-matched peers, mean scores in the SLI and the TD subgroups matched by MLU were compared.

Regarding those abilities considered impaired by the previous analysis, when the mean score of the SLI subgroup was significantly lower than the mean score of the TD subgroup, strong impairment was assumed. Instead, when the mean scores of the subgroups were equivalent, slight impairment was assumed. That is, when performance of children with SLI was significantly poorer than age-matched typically developing children, the relevant ability was considered impaired. When it was also significantly

poorer than younger MLU-matched typically developing children, such ability was considered to be strongly impaired. Otherwise, it was considered slightly impaired.

A combination of significantly poorer performance of the SLI subgroup than the TD subgroup regarding a measure and equivalent performances of SLI and TD groups concerning the same measure was not expected and was not found.

For mean comparison between children with SLI and age-matched typically developing children (SLI and TD groups) as well as between children with SLI and their MLU-matched peers (SLI and TD subgroups), the same procedure was followed, described below.

4.3.3. Procedure for comparisons between SLI and TD groups (age matching) as well as SLI and TD subgroups (MLU-matching)

For mean comparisons original measures were employed as dependent variables. Original measures and the linguistic abilities they tested are reported in Table 16 and 17 (see page 84).

Table 16

Linguistic abilities and measures for comprehension and production in raw (RS) and standard (SS) scores.

	Comprehension	Production
Lexical Abilities	PPVT-R: RS and SS	TFL: RS
Morpho-syntactic Abilities	Rustioni: RS	Sentence Repetition: Correct Items RS, Morpho-syntactic Information. Narration Task: MLU, Incorrect Morphology Rate and Complete Sentences.
Textual Abilities	TOR: SS	Narration Task: Cohesion Error Rate, Local Coherence Error Rate and Global Coherence Error Rate.

Table 17

Phonological short term and working memory measures in raw (RS) and standard (SS) scores.

Phonological short term memory	Forward Digit Span: RS Non-word Repetition: Errors Word Repetition: Errors
Phonological working memory	Backwards Digit Span: RS

Means of standardised scores were compared when available (PPVT-R, TOR 3-8 and digit spans), using independent-samples t-tests. Means of raw scores for the other measures were compared by conducting one way, between groups, analyses of covariance (ANCOVA), which allowed to control for age. The aim was to control for the increases in raw scores throughout development. When raw scores did not satisfy the assumption of homogeneity of variance (as measured by the Levene's test), transformations were applied to the data. Logarithmic transformations were applied to

frequencies and arcsine transformations to error rates. Analyses were carried out on the transformed data; though, for clarity, descriptive statistics are presented using untransformed variables. Analyses on transformed data are identifiable by the sign “+” within the results. For all analyses, the independent variable was belonging to one group or the other (SLI and TD groups) or one subgroup or the other (SLI and TD subgroups). For comparisons between children with SLI and age-matched typically developing children, the independent variable was group (SLI or TD groups). For comparisons between children with SLI and MLU-matched typically developing children, the independent variable was subgroup (SLI or TD subgroups). The dependent variable was the measure of linguistic or memory abilities in standard (t-tests) or raw (ANCOVA) scores. For describing effect sizes, the following index were used: Cohen’s d , for t-tests and η^2 , for analyses of variance. Following Cohen’s (1988) guidelines for psychological research, we interpreted $d = .2$ and $\eta^2 = .01$ as a small effect, $d = .5$ and $\eta^2 = .059$ as a medium effect and $d = .8$ and $\eta^2 = .138$, as large effect.

4.3.4. Comparisons among children within the SLI group (Severe, Mild Language Impairment, Severe Lexical Impairment and Severe Morpho-syntactic Impairment groups)

This analysis is situated not with previous mean comparisons, but after regressions in the structure of the dissertation because it was conducted for achieving the third aim of the study. It is described here because the procedure was similar to the other mean comparisons.

The SLI group was divided in four subgroups, as illustrated in the relevant section. For comparing, three of these groups were taking into account: Severe LI, Mild LI and Severe Morpho-syntactic I (severely impaired morpho-syntax and mildly impaired lexicon). The Severe Lexical I group (mildly impaired morpho-syntax and severely impaired lexicon) was excluded because it would not be statistically valid a comparison with a one-element group. Moreover, the groups chosen were selected due to their relationship with potential sub-populations of SLI: those with severe impairment, mild impairment or a combination of impairment already reported in literature. Differences between severe and mild impairment in production have been

frequently described (Chilosi et al, 1995). The association of severely impaired morpho-syntax and mildly impaired lexicon resembles the characteristics of the Grammatical-SLI (G-SLI) subgroup presented by Van der Lely and colleagues (van der Lely, 1999; van der Lely & Battell, 2003; van der Lely, 2005). These authors define the G-SLI group based on specific characteristics of morpho-syntax. Such information about children in our study was not available. The similarities regarded exclusively morpho-syntax as the main deficit.

The performance of children in all lexical, morpho-syntactic and textual abilities as well as phonological memory was compared. We excluded from comparisons those tasks that were used for establishing the criteria of impairment in morpho-syntactic and lexical production.

The procedure for mean comparisons was the following. Original measures in language and phonological tasks displayed in Table 16 and 17 (see page 90) were used as dependent variables. Measures from the tasks employed as criteria for selecting the groups were excluded. The independent variable was the subgroup (Severe LI, Mild LI and Severe Morpho-syntactic I). Means of raw scores were compared by conducting a multivariate analysis of covariance (MANCOVA), which permitted to control for age. When scores did not satisfy the assumption of homogeneity of variance, logarithmic (to frequencies) or arcsine (to error rates) transformations were applied, identifiable by the sign “+”. Analyses were conducted on the transformed data; however, for clarity, descriptive statistics are presented using untransformed variables.

4.4. Correlations

We present the table of correlations in order to provide exhaustive information to the reader, particularly for interpreting outcomes from regressions.

4.5. Hierarchical Regressions

In order to evince how language abilities are related among themselves and how they are connected to phonological memory skills (second aim of the study), the following procedure was adopted. First, potential relationships among abilities were represented in a **conceptual hierarchical model**. Such relationships are one-way links between skills required for performing tasks measuring other abilities. According to this model, relationships among required and tested abilities are based on three criteria. The first, phonological memory is required for performing all language tasks. The second, to execute every language task, apart from the specific language ability measured, knowledge in more basic language areas is needed, as assumed in theories of language acquisition (Van der Lely, 2005). That is to say, lexical knowledge is necessary for performing morpho-syntactic tasks; lexical and morpho-syntactic knowledge is required for performing textual tasks. The third, based on the acquisition process, it is assumed that comprehension in the same area is needed for production. That is, lexical comprehension is required for lexical production. Analogously, morpho-syntactic and text comprehension is needed for morpho-syntactic and text production, respectively.

Based on the conceptual hierarchical model, potential relationships between abilities were examined conducting fixed-order hierarchical multiple regression analyses on the overall group of children, as well as on the SLI and the TD groups separately. Hierarchical regressions were performed on the overall group for initially accounting for the performance in language tasks, considering only phonological memory and language abilities. Afterwards, the effect of belonging to one group or the other was measured. When such effect was significant, analogous regression were separately performed on the SLI and the TD groups. The objective of these new analyses was to discover the relationships among abilities on each group, when belonging to one or the other had an effect on language performance.

In sum, hierarchical regressions were conducted with dependent variables representing performances in lexical, morpho-syntactic and text comprehension as well as production tasks on the overall group of children. When the factor belonging to one group or the other explained an extra variance, subsequent regressions were performed.

4.5.1. Fixed order hierarchical regressions on the overall group of children

For these analyses, original as well as composite measures were employed. For morpho-syntactic and text production, composite measures were used as dependent variables. For all other abilities, original measures were selected as dependent variables. The dependent variable for each analysis were PPVT-R raw score (lexical comprehension), TFL raw score (lexical production), Rustioni raw score (morphosyntactic comprehension), composite Productive Morphosyntactic Incorrect Rate from Sentence Repetition and the Narration Task (morphosyntactic production), MLU in the Narration Task (morphosyntactic production), TOR 3-8 raw score (text comprehension) and composite Productive Text Error Rate (text production). The effect of age was controlled by entering this variable in the first step. In the second step, potential predictors for each language measure (dependent variable), according to the conceptual hierarchical model, were entered as independent variables. In the third step, the variable “group” that represented the group to which belonged each child, SLI or TD, was entered. In the fourth step, interactions between the independent variables in the second step and the independent variable “group” were entered. A list of independent and dependent variables used for regressions is displayed in Tables 18 and 19 (in pages 89 and 90, respectively).

Table 18

Independent variables entered in the first and second steps and dependent variables for regression analyses.

Independent variables	Dependent variables						
	lexical comprehension (PPVT-R)	lexical production (TFL)	morpho- syntactic comprehension (Rustioni)	morpho-syntactic production (MLU in Narration)	morpho-syntactic production (comp. Productive M-s. Incorrect Rate)	text comprehension (TOR 3-8)	text production (comp. Productive Text Error Rate)
Step 1							
Age	X	X	X	X	X	X	X
Step 2							
phonological Short Term M. (Forward Digit Span)	X	X	X	X	X	X	X
phonological Short Term M. (composite Word and Non-word Repetition)	X	X	X	X	X	X	X
phonological Working M. (Backwards Digit Span)	X	X	X	X	X	X	X
Lexical comprehension (PPVT-R)		X	X	X	X	X	X
Lexical production (TFL)			X	X	X	X	X
Morpho-syntactic comprehension (Rustioni)				X	X	X	X
Morpho-syntactic production (comp. Incorrect Morpho-syntactic Rate in Sentence Repetition)						X	X
Text comprehension (TOR 3-8)							X

Table 19

Independent variables entered in the third and fourth steps and dependent variables for regression analyses.

Independent variables		Dependent variables						
		lexical comprehension (PPVT-R)	lexical production (TFL)	morpho-syntactic comprehension (Rustioni)	morpho-syntactic production (MLU in Narration)	morpho-syntactic production (comp. Productive M-s. Incorrect Rate)	text comprehension (TOR 3-8)	text production (comp. Productive Text Error Rate)
	Step3							
Group		X	X	X	X	X	X	X
	Step4							
	Interaction group and:							
phonological Short Term M. (Forward Digit Span)		X	X	X	X	X	X	X
phonological Short Term M. (composite Word and Non-word Repetition)		X	X	X	X	X	X	X
phonological Working M. (Backwards Digit Span)		X	X	X	X	X	X	X
Lexical comprehension (PPVT-R)			X	X	X	X	X	X
Lexical production (TFL)				X	X	X	X	X
Morpho-syntactic comprehension (Rustioni)					X	X	X	X
Morpho-syntactic production (comp. Incorrect Morpho-syntactic Rate in Sentence Repetition)							X	X
Text comprehension (TOR 3-8)								X

4.5.2. Fixed order hierarchical regressions on the SLI and the TD groups

When the variable belonging to the SLI or the TD group, entered in the third step, appeared as a significant predictor, subsequent regressions were separately conducted for each group. For these new analyses, independent and dependent variables were the same as in previous regressions, excluding variables in the third and fourth steps (factor “group” and interactions with factor “group”).

4.6. Logistic regressions

The logistic regression was performed in order to identify which tasks in our assessment on language and phonological memory abilities were the best for discriminating between children with SLI and typically developing children. In particular, the aim was to detect which tasks were useful in predicting the probability for a child to belong to the group with SLI. The simplest measures obtained from the tasks were taken into account. The reason for doing this was trying to identify the easiest and fastest way to discriminate between children with SLI and their typically developing peers. Composite measures and refined measures (e.g., the rate of morpho-syntactic information conveyed in Sentence Repetition) were more informative of the competence of participants but required high investment of time and complex coding. We preferred original measures, before composition and selection, since they would be easier to use for clinical purposes.

A hierarchical logistic regression was conducted on the dependent variable belonging to the group with SLI “SLI group” (0 = TD group, 1 = group with SLI). In the first block, “age” was forced in a single step, for controlling its effect. In the second block, language measures taken into account were entered with the forward stepwise method. The specific statistics used in the test for removing variables from the model was the likelihood ratio.

The measures employed and the abilities they test are displayed in Table 20 (see page 92).

Table 20

Abilities tested, tasks used for measuring them and simple measures calculated

Abilities	Tasks	Measures
Lexical comprehension	PPVT-R	Raw score
Lexical production	TFL	Raw score
Morpho-syntactic comprehension	Rustioni	Raw score
Morpho-syntactic production	Sentence Repetition	Raw score (number of correct items)
	Narration Task	Grammatical complete sentences, Incorrect Morphology Rate
Text comprehension	TOR 3-8	Global raw score (number of correct answers)
Text production	Narration Task	Cohesion Error Rate, local and global error rate
Short Term Memory	Forward Digit Span	Raw score (number of digits)
	Word Repetition	Errors
	Non-word Repetition	Errors
Working Memory	Backwards Digit Span	Raw score (number of digits)

PART II: RESULTS

1. Descriptive Statistics

In this section, the results obtained in the language and memory tests by children in the SLI and TD groups are described. The number of children tested is reported for each measure, mean scores, standard deviations and range of scores for each group. Standard scores were used when available (indicated in tables). In all other cases, raw scores were employed. Scores of original as well as composite measures are reported. Information about all language and phonological memory measures are summarised in Tables 20 (in page 94) and 21 (in page 95), respectively.

1.1. Lexical abilities

PPVT-R. Lexical comprehension was examined in 48 children of the SLI group. Their minimum and maximum standard scores were 66 and 102, respectively. The mean standard score was 81.44 and the standard deviation was 10.03. In the TD group, 51 children were examined. Their minimum standard score was 69 and the maximum score was 120. The mean standard score and standard deviation were 96.09 and 14.16, respectively.

TFL. Lexical production was measured by this test. From the SLI group, 50 children were tested. The scores ranged from 0 to 37. The mean was 24.78 and the standard deviation was 6.89. From the TD group, 52 children were tested. The scores varied from 19 to 42. The mean was 33.33 and the standard deviation was 5.34.

Table 20

Descriptive statistics for language abilities (SLI and TD)

Language abilities and measures	SLI			TD		
	n	M (SD)	Range	n	M (SD)	Range
Lexical Abilities						
<i>Comprehension: PPVT-R*</i>	48	81.44 (10.03)	66-102	44	96.09 (14.16)	69-120
<i>Production: TFL¹</i>	50	24.78 (6.89)	0-37	52	33.33 (5.34)	19-42
Morpho-syntactic abilities						
<i>Comprehension: Rustioni²</i>	47	48.17 (15.40)	17.80- 85.90	52	71.41 (15.53)	40.60- 100
<i>Production: Sentence Repetition</i>						
Items ³	49	11.18 (8.43)	0-27	52	24.63 (4.81)	8-27
Morpho-syntactic Information ⁴	49	80.57 (18.80)	19-100	52	99.29 (2.25)	90- 100
MLU	49	4.18 (0.77)	1.4-4.7	52	4.70 (0)	4.7- 4.7
<i>Production: Narration Task</i>						
Incorrect Morphology Rate ⁵	39	0.08 (0.08)	0-0.39	47	0.02 (0.02)	0-0.07
Complete Sentences	39	15.31 (12.02)	3-68	47	23.04 (9.88)	9-52
MLU	39	4.13 (1.23)	1.78- 6.52	47	5.10 (1.67)	2.44- 13.57
composite Incorrect Morpho-syntactic Rate ⁵	39	0.33 (0.15)	0-0.64	47	0.18 (0.09)	0.05- 0.41
<i>Production: Sentence Repetition & Narration Task</i>						
composite Productive Morpho-syntactic Incorrect Rate ⁵	39	0.24 (0.11)	0.06- 0.60	47	0.10 (0.05)	0.02- 0.20
Textual abilities						
<i>Comprehension: TOR 3-8</i>						
Global Score*	50	9.52 (1.72)	6-13	52	11.02 (1.78)	8-15
Explicit Questions Score ⁶	50	2.64 (1.32)	0-5	52	3.48 (1.21)	1-5
Implicit Questions Score ⁶	50	2.28 (1.09)	0-5	52	3.02 (1.16)	1-5
<i>Production: Narration Task</i>						
Cohesion Error Rate ⁵	39	0.9 (0.9)	0-0.42	47	0.5 (0.5)	0-0.27
Local Coherence Error Rate ⁵	39	0.32 (0.22)	0-0.97	47	0.34 (0.26)	0-1.00
Global Coherence Error Rate ⁵	39	0.14 (0.10)	0-0.34	47	0.09 (0.09)	0-0.43
composite Productive Text Error Rate ⁵	39	0.18 (0.10)	0.40- 0.54	47	0.16 (0.10)	0-0.41

*Standard scores; 1 Maximum score possible: 45; 2 Maximum score possible: 100; 3 Maximum score possible: 27; 4 Maximum score possible: 100; 5 Maximum score possible: 0; 6 Maximum score possible: 5.

1.2. Morpho-syntactic abilities

Rustioni. Morpho-syntactic comprehension was measured by the Rustioni test. The test was administered to 47 children from the SLI group. Their scores ranged from 17.80 to 85.90. The mean score and standard deviation were, respectively, 48.17 and 15.40. From the TD group, 52 children were examined. Their minimum score was 40.60 and maximum, 100, the highest possible score for the Rustioni test.

Sentence Repetition. Morpho-syntactic production was measured by this and the following task. The Sentence Repetition task was administered to 49 children from the SLI group and 52 children from the TD group. Four measures were obtained: correctly repeated Items, percentage of correctly repeated Morpho-syntactic Information and MLU. In the SLI group, the number of correctly repeated items ranged from 0 to 27, out of 27 items (sentences) to be repeated. The mean score was 11.18 and the standard deviation, 8.43. In the TD group, the minimum number of repeated items was 8 and the maximum, 27. The mean score was 24.63 and the standard deviation, 4.81. Regarding percentage of correctly repeated Morpho-syntactic Information, in the SLI group, the lowest percentage was 19 and the highest, 100. The mean percentage was 80.57 and the standard deviation, 18.80. For the TD group, percentages were very high and vary from 90 to 100. The mean percentage was 99.29 and the standard deviation, 2.25. With regard to MLU, performance of children in the SLI group varied from 1.4 to 4.7, the maximum MLU for all sentences correctly repeated. The mean was 4.18 and the standard deviation of 0.77. The TD group had an homogeneous performance. MLU obtained was the 4.70, with almost no variation (standard deviation rounded down to 0), showing a strong ceiling effect. For this reason, we excluded this measure of Sentence Repetition from analysis.

The Narration Task. Apart from Sentence Repetition, morpho-syntactic production was examined through the Narration Task. The number of children to which this test was administered and whose production could be analysed were 39 from the SLI group and 47 from the TD group. Measures obtained were the Incorrect Morphology Rate, the number of Complete Sentences, MLU and the composite Incorrect Morpho-syntactic Rate, obtained from the first two measures. In the measure

Incorrect Morphology Rate, children from the SLI group obtained scores from 0 to 0.39, with a mean of 0.08 and a standard deviation of 0.08. Children in the TD group obtained scores from 0 to 0.07, with a mean of 0.02 and a standard deviation of 0.02. Regarding the Complete Sentences, children in the SLI group produced a number of sentences between 3 and 68. The mean score and standard deviation were respectively, 15.31 and 12.03. Children in the TD group generated 9 to 52 complete sentences, with a mean of 23.04 and a standard deviation of 9.88. The MLU of children in the SLI group ranged from 1.78 to 6.52, with a mean of 4.13 and a standard deviation of 1.23. The MLU of children in the TD group, varied from 2.44 to 13.57, with a mean of 5.10 and a standard deviation of 1.67. Concerning the composite Incorrect Morpho-syntactic Rate, the SLI group obtained scores which varied from 0 to 0.64, with a mean score of 0.33 and a standard deviation of 0.15. The TD group had performances which varied from a rate of 0.05 to 0.41, with a mean score and a standard deviation of 0.18 and 0.09, respectively.

Regarding the composite which combined performance in Sentence Repetition and in the Narration Task, we have data from 39 children in the SLI group and 47, in the TD group. Scores in the SLI group ranged from 0.06 to 0.60, with a mean of 0.24 and a standard deviation of 0.11. Scores in the TD group varied from 0.02 to 0.20 with a mean and a standard deviation of 0.10 and 0.05, respectively.

1.3. Textual abilities

TOR 3-8. Text comprehension was measured by this test and was administered to 50 children from the SLI and to 52 children from the TD group. The measures obtained were standard Global Score and raw scores for Explicit and Implicit Questions. For the SLI group, scores varied from 6 to 13 with a mean of 9.52 and a standard deviation of 1.72. For the TD group, scores ranged from 8 to 15, with a mean of 11.02 and a standard deviation of 1.78. Concerning scores of Explicit Questions, children in the SLI group obtained scores between 0 and 5 (the minimum and maximum raw scores in this test). The mean was 2.64 and the standard deviation, 1.32. For the TD group, results varied between 1 and 5. The mean score and standard deviation were 3.48 and 1.21, respectively. Regarding scores on Implicit Questions, children in the SLI group obtained between 0 and 5 points (as for Explicit Questions, these are the minimum and

maximum raw scores in the test). The mean was 2.28 and the standard deviation, 1.09. Children in the TD group obtained scores between 1 and 5, with a mean of 3.02 and a standard deviation of 1.16.

The Narration Task. Text production was measured by this test, administered to 39 children from the SLI group and 47 children from the TD group. Three textual measures were obtained: error rates of cohesion, local coherence and global coherence. Children in the SLI group obtained Cohesion Error Rates between 0 and 0.42, with a mean and a standard deviation of 0.09. Children in the TD group obtained rates between 0 and 0.27, with a mean and a standard deviation of 0.5. Regarding the Local Coherence Error Rate, the SLI group showed scores between 0 and 0.97, with a mean of 0.32 and a standard deviation of 0.22. The TD group displayed rates between 0 and 1.0, with a mean of 0.34 and a standard deviation of 0.26. Global Coherence Error Rates in the SLI group varied from 0 to 0.34, with a mean of 0.14 and a standard deviation of 0.10. The TD group obtained scores between 0 and 0.43, with a mean and a standard deviation of 0.09. In the composite Productive Text Error Rate children with SLI obtained scores between 0.40 and 0.54 with a mean of 0.18 and a standard deviation of 0.10. Typically developing children had minimum and maximum scores of 0 and 0.41, respectively. The mean was 0.16 and the standard deviation, 0.10.

1.4. Phonological memory abilities

Forward Digit Span, Word and Non-Word Repetition and Backwards Digit Span. Phonological short term memory was measured by Forward Digit Span and Word and Non-Word Repetition. Phonological working memory was tested by Backwards Digit Span. For digit spans, the measure employed was number of digits correctly repeated. The measures of Word and Non-word Repetition were the total number of errors made. The Forward Digit Span test was administered to 49 children from the SLI group. Their score ranged from 0 to 4, with a mean of 1.80 and a standard deviation of 1.28. The children from the TD group who performed this task were 52. Their scores varied from 0 to 5, with a mean of 2.58 and a standard deviation of 1.67. Regarding Non-word Repetition, from the SLI group 48 children were tested was 48. The number of errors ranged from 0 to 96, with a mean of 30.48 and a standard deviation of 20.54.

From the TD group, 52 children performed this task. Their errors ranged from 0 to 12, with a mean of 1.58 and a standard deviation of 3.22. Concerning Backwards Digit Span, this task was performed by 49 children from the SLI group, with a minimum and maximum score of 0 and 2, respectively. The mean was 0.45 and the standard deviation was 0.84. The test was administered to 52 typically developing children, whose scores varied from 0 to 3, with a mean of 1.04 and a standard deviation of 1.17. All results are summarised in Table 21.

Table 21

Descriptive statistics for phonological short term and working memory abilities (SLI and TD)

Memory abilities and measures	SLI			TD		
	n	M (SD)	Range	n	M (SD)	Range
Short Term Memory						
Forward Digit Span	49	1.80 (1.28)	0-4	52	2.58 (1.67)	0-5
Word Repetition	48	25.17 (20.32)	1-87	52	1.25 (2.65)	
Non-word Repetition	48	30.48 (20.54)	0-96	52	1.58 (3.22)	0-12
Working Memory						
Backwards Digit Span	49	0.45 (0.84)	0-2	52	1.04 (1.17)	0-3

2. Comparisons between children with SLI and age-matched typically developing children

In this section, the performance on language and memory tasks of children with SLI and TD children was compared using original scores. When standard scores were available, independent samples t-tests were conducted. In all other cases, one-way between group analysis of variances were performed on raw scores, with “age” as covariate. The information about the scores in these tests is summarised in Table 22 (see page 100).

Table 22

Comparisons between means in language and phonological memory measures (SLI and age-matched TD)

Phonological memory and language abilities and measures	SLI group		TD group		Test
	n	M (SD)	n	M (SD)	
Lexical Abilities					
<i>Comprehension: PPVT-R*</i>	48	81.44 (10.03)	44	96.09 (14.16)	$p < .001$
<i>Production: TFL</i>	50	24.78 (6.89)	52	33.33 (5.34)	$p < .001$
Morpho-syntactic abilities					
<i>Comprehension: Rustioni</i>	47	48.17 (15.40)	52	71.41 (15.53)	$p < .001$
<i>Production: Sentence Repetition</i>					
Items	49	11.18 (8.43)	52	24.63 (4.81)	$p < .001$
Morpho-syntactic Information	49	80.57 (18.80)	52	99.29 (2.25)	$p < .001$
<i>Production: Narration Task</i>					
Incorrect Morphology Rate ⁺	39	0.08 (0.08)	47	0.02 (0.02)	$p < .001$
Complete Sentences	39	15.31 (12.02)	47	23.04 (9.88)	$p < .001$
MLU	39	4.13 (1.23)	47	5.10 (1.67)	$p < .001$
Textual abilities					
<i>Comprehension: TOR 3-8</i>					
Global Score*	50	9.52 (1.72)	52	11.02 (1.78)	$p < .001$
Explicit Questions Score	50	2.64 (1.32)	52	3.48 (1.21)	$p < .001$
Implicit Questions Score	50	2.28 (1.09)	52	3.02 (1.16)	$p < .001$
<i>Production: Narration Task</i>					
Cohesion Error Rate	39	0.9 (0.9)	47	0.5 (0.5)	$p < .005$
Local Coherence Error Rate	39	0.32 (0.22)	47	0.34 (0.26)	$p = .71$
Global Coherence Error Rate	39	0.14 (0.10)	47	0.09 (0.09)	$p = .28$
Short term memory					
Forward Digit Span	49	1.80 (1.28)	52	2.58 (1.68)	$p = .001$
Non-word Repetition (Errors) ⁺	48	30.48 (20.54)	52	1.58 (3.22)	$p = .001$
Word Repetition (Errors) ⁺	48	25.17 (20.32)	52	1.25 (2.66)	$p = .001$
Working memory					
Backwards Digit Span	49	0.45 (0.84)	52	1.04 (1.17)	$p < .001$

*Standard scores

2.1. Differences in lexical abilities

Lexical abilities were measured by PPVT-R (comprehension) and TFL (production). Regarding lexical comprehension, the performance of the SLI group (M=81.44, SD=10.03) was significantly poorer than the performance of the TD group (M=96.09, SD=14.16) in PPVT-R; $t(77.59) = -5.54, p < 0.001, d = 1.19$. Analogously, in production, the SLI group (M=24.78, SD=6.89) performed significantly more poorly than the TD group (M=33.33, SD=5.34) group in TFL, $F(2,115) = 35.38, p < .001, \eta^2 = .44$. These results suggest that children in the SLI group had smaller receptive and productive lexicon.

2.2. Differences in morpho-syntactic abilities

When looking at comprehension (as measured by the Rustioni Test) we found that the SLI group (M=48.17, SD=15.40) had significantly poorer scores than the TD group (M=71.41, SD=15.53); $F(2,115) = 32.63, p < .001, \eta^2 = .37$. This suggests that children in the SLI group have poorer morpho-syntactic comprehension.

Regarding morpho-syntactic production tested by Sentence Repetition, we conducted analyses evaluating differences between groups in terms of correct items and percentage of correct Morpho-syntactic Information repeated (Morpho-syntactic Information). The SLI group (M=11.18, SD=8.43) produced significantly fewer correct items than the TD group (M=24.63, SD=4.81); $F(1,98) = 111.31, p < .001, \eta^2 = .53$. Moreover, regarding Morpho-syntactic Information the SLI (M=80.57, SD=18.80) repeated a significantly lower percentage of correct information than the TD group (M=99.29, SD=2.25); $F(1,98) = 54.40, p < .001, \eta^2 = .30$. It is noteworthy that for both measures, standard deviation in the SLI group is very high, showing that performance of children present important differences within the group.

With regard to production tested by the Narration Task, we conducted analyses looking at morpheme errors and omissions rate (Incorrect Morphology Rate), grammatical complete sentences (Complete Sentences) and MLU. The SLI group (M=0.08, SD=0.08) had significantly higher Incorrect Morphology Rate than the TD group (M=0.02, SD=0.02), $F(1,71) = 38.75, p < .001, \eta^2 = .35^+$. For both groups,

standard deviation was extremely high, showing an important variability within each group. Concerning grammatically complete sentences, the SLI group (M=15.31, SD=12.02) produced significantly fewer complete sentences than the TD group (M=23.04, SD=9.80), $F(1,81) = 74.30, p < .001, \eta^2 = .48$. Furthermore, the SLI group (M=4.13, SD=1.23) had significantly lower MLU than the TD group (M=5.10, SD=1.67), $F(1,83) = 12.58, p = .001, \eta^2 = .13$. These results suggest that children in the SLI group have significantly lower morpho-syntactic abilities during Sentence Repetition and narration.

2.3. Differences in textual abilities

Textual abilities were measured by TOR 3-8 (comprehension) and the Narration Task (production). When looking at text comprehension, it emerged that the SLI group (M=9.52, SD=1.72) showed significantly lower scores than the TD group (M=11.02, SD=1.78) in the TOR 3-8 Global Score; $t(100) = -4.33, p < 0.001, d = 0.09$, suggesting better text comprehension of children in the TD group. Moreover, administration of TOR 3-8 provided Explicit and Implicit Questions raw scores and a further analysis on these scores was conducted. The SLI group (M=2.64, SD=1.32) obtained significantly lower scores for the Explicit Questions than the TD group (M=3.48, SD=1.21), $F(1,99) = 11.67, p = .001, \eta^2 = .11$. For both groups, variability was important, as shown by high standard deviation. An analogous result was found for scores on the Implicit Questions, in that the SLI group (M=2.28, SD=1.09) performed significantly more poorly than the TD group (M=3.02, SD=1.16); $F(1,99) = 10.96, p = .001, \eta^2 = .10$ and standard deviation was high for both groups. These results suggest that children in the SLI group had poorer performance answering Explicit as well as Implicit Questions and that performance vary widely within each group.

Text production was measured by the Narration Task. For these analyses, the Cohesion Error Rate, Local Coherence Error Rate and Global Coherence Error Rate were investigated. Significant differences were found only in the Cohesion Error Rate in that the SLI group (M=0.9, SD=0.9) showed a significantly higher Cohesion Error Rate than the TD group (M=0.5, SD=0.5); $F(1,82) = 9.15, p = .003, \eta^2 = .10$. In Local Coherence Error Rate, we found no significant difference between the SLI (M=0.32,

SD=0.22) and TD groups (M=0.34, SD=0.26); $F(1,83) = 0.14$, $p = .71$, $\eta^2 = .002$. Likewise, in Global Coherence Error Rate, we found no significant difference between the SLI (M=0.14, SD=0.10) and TD groups (M=0.09, SD=0.09); $F(1,83) = 0.02$, $p = .28$, $\eta^2 = .06$. In all three measures, variability was important within each group, as shown by high standard deviations.

These results suggest that children in the SLI group performed more poorly in elaborating textual relationship within a sentence, but their performance was equivalent to that of the TD group when processing the semantic meaningfulness of the text. They also suggest that performance vary widely in both the SLI and the TD groups.

2.4. Differences in phonological memory

Phonological short term memory was measured by Forward Digit Span and Word and Non-word Repetition. Phonological working memory (phonological working memory) was measured by Backwards Digit Span.

Differences in phonological short term memory. Regarding Forward Digit Span, we found a significantly poorer performance when comparing the SLI group (M=1.80, SD=1.28) and the TD group (M=2.58, SD=1.68) after controlling for age; $F(2,117) = 12.15$, $p < .001$, $\eta^2 = .17$. These results suggest that children in the SLI group have poorer short term memory.

Concerning Non-word and Word Repetition, the total number of errors was analysed. The SLI group (M=30.48, SD=20.54) produced significantly more errors than the TD group (M=1.58, SD=3.22) when repeating non-words; $F(1,59) = 59.77$, $p < .001$, $\eta^2 = .50^+$. Likewise, the SLI group (M=25.17, SD=20.32) made more errors than the TD group (M=1.25, SD=2.66) in Word Repetition; $F(1,59) = 33.42$, $p < .001$, $\eta^2 = .36$. Differences in means between groups are very wide and for the SLI group, standard deviation is very high. These results suggest that children in the SLI group have much poorer phonological short term memory and that there is a strong variability within the SLI group.

Differences in phonological working memory. When looking at phonological working memory (Backwards Digit Span), we found that the SLI ($M=0.45$, $SD=0.84$) performed significantly more poorly than the TD group ($M=1.04$, $SD=1.17$), $F(1,98) = 14.50$, $p < .001$, $\eta^2 = .13$. This result suggests that children in the SLI have poorer phonological working memory. However, a floor effect may be affecting the mean score for the SLI group, very close to zero.

3. Comparisons between children with SLI and MLU-matched typically developing children

For comparing children with SLI to MLU-matched typically developing children subgroups were selected based on the MLU in the Narration Task. The number of matching couples obtained was 29. Children in the SLI subgroup were older than children in the TD subgroup. The mean age for the SLI subgroup was 62.10 months, with a standard deviation of 8.56. The mean age for the TD subgroup was 57 months, with a standard deviation of 9.25. The mean age of the SLI subgroup was significantly higher than the TD group, $F(1,56) = 0.22$, $p < .05$.

In this section, analogously to previous analyses, language and memory scores were compared between the subgroup of children with SLI and the subgroup of TD children, matched by MLU. When standard scores were available, independent samples t-tests were conducted. When only raw scores were available, we conducted one-way between group analysis of variances, with “age” as covariate. For some measures, model for mean comparison did not fit due to the heterogeneity of variance (Levene’s test: $< .05$), not even after transformations. This was the case of both measures of Sentence Repetition, Correct Items and Morpho-syntactic Information, for which comparison could not be done.

Results are summarised in Table 23 (see page 105).

Table 23

Comparisons between means in language and phonological memory measures (SLI subgroup and MLU-matched typically developing children)

Phonological memory and language abilities and measures	SLI subgroup		TD subgroup		Test
	n	M (SD)	n	M (SD)	
Lexical Abilities					
<i>Comprehension</i> : PPVT-R*	29	81.07 (10.62)	29	93.82 (11.10)	$p = .12$
<i>Production</i> : TFL	29	27.14 (4.96)	29	32.21 (5.59)	$p < .001$
Morpho-syntactic abilities					
<i>Comprehension</i> : Rustioni	29	45.56 (15.12)	29	68.65 (14.65)	$p < .001$
<i>Production</i> : Narration Task					
Incorrect Morphology Rate ⁺	39	0.06 (0.04)	47	0.02 (0.02)	$p < .001$
Complete Sentences	29	17.66 (12.81)	29	20.69 (7.70)	$p = .07$
Textual abilities					
<i>Comprehension</i> : TOR 3-8					
Global Score*	29	5.07 (1.96)	29	5.93 (1.85)	$p = .77$
<i>Production</i> : Narration Task					
Cohesion Error Rate	29	0.05 (0.05)	29	0.06 (0.06)	$p = .57$
Local Coherence Error Rate	29	0.28 (0.19)	29	0.37 (0.27)	$p = .52$
Global Coherence Error Rate ⁺	29	0.06(0.05)	29	0.06 (0.06)	$p = .71$
Short Term Memory					
Forward Digit Span	29	2.28 (1.22)	29	2.14 (1.77)	$p = .06$
Non-word Repetition : Errors ⁺	29	16.00 (13.33)	29	1.17 (2.54)	$p < .001$
Word Repetition : Errors ⁺	29	22.48 (15.00)	29	1.62 (3.33)	$p < .001$
Working Memory					
Backwards Digit Span	29	0.62 (0.94)	29	0.83 (1.10)	$p < .05$

*Standard scores

3.1. Differences in lexical abilities

Regarding lexical comprehension, the performances of the SLI subgroup (M=81.07, SD=10.62) and the TD subgroup (M=93.82, SD=11.10) showed no significant differences, $t(56) = -5.54$, $p = .12$, $d = 1.16$. Regarding production, the SLI subgroup (M=27.14, SD=4.96) performed significantly poorer than the TD subgroup (M=32.21, SD=5.59), $F(1,55) = 34.32$, $p < .001$, $\eta^2 = .01$. These results, together with results from comparison between children with SLI and age-matched typically developing children, suggested slightly impaired lexical comprehension and strongly impaired lexical production.

3.2. Differences in morpho-syntactic abilities

With regard to morpho-syntactic comprehension, the performance of the SLI subgroup (M=45.56, SD=15.12) in the Rustioni test was significantly poorer than the TD subgroup (M=68.65, SD=14.65); $F(1,55) = 31.41$, $p < .001$, $\eta^2 = .03$.

Concerning measures of morpho-syntactic production in the Narration Task, we obtained the following results. Grammatical Sentences did not evince significant difference between the SLI subgroup (M=17.66, SD=12.81) and the TD subgroup (M=20.69, SD=7.70); $F(1,54) = 19.84$, $p = .07$, $\eta^2 = .01$. The results from the Incorrect Morphology Rate showed significantly poorer performance of the SLI subgroup (M=0.06, SD=0.04) than the TD subgroup (M=0.02, SD=0.02); $F(1,55) = 19.40$, $p < .001$, $\eta^2 = .06^+$. These results suggested strongly impaired morpho-syntactic comprehension. Regarding production, they suggest strongly slightly impaired syntax and impaired morphology.

3.3. Differences in textual abilities

Regarding text comprehension, performance of the SLI subgroup (M=5.07, SD=1.96) and the TD subgroup (M=5.93, SD=1.85) on the TOR 3-8 revealed no significant differences $t(56) = -1.72$, $p = .77$, $d = 1.01$.

The measures of text production revealed equivalent performance of the SLI and the TD subgroups. We found no significant differences between the performances of

children in the SLI subgroup ($M=0.05$, $SD=0.05$) and the TD subgroup ($M=0.06$, $SD=0.06$) in the Cohesion Error Rate; $F(1,55) = 0.33$, $p = .57$, $\eta^2 = .003$. Likewise there were no significant differences between the SLI subgroup ($M=0.28$, $SD=0.19$) and the TD subgroup ($M=0.37$, $SD=0.27$) in the Local Coherence Error Rate; $F(1,55) = 0.42$, $p = .52$, $\eta^2 = .002$. Analogously, performances of the SLI subgroup ($M=0.06$, $SD=0.05$) and the TD subgroup ($M=0.06$, $SD=0.06$) exhibited no significant difference in the Global Coherence Error Rate; $F(1,55) = 0.14$, $p = .71$, $\eta^2 = 0.001^+$.

These results suggest slightly impaired text comprehension and partially impaired production. In particular, these results evinced slight impairment regarding cohesion and confirmed preserved abilities related to local and global coherence of texts.

3.4. Differences in phonological memory

In phonological short term memory, equivalent performances were found in two out of three measures. In Forward Digit Span, there were no significant differences between SLI ($M=2.28$, $SD=1.22$) and TD subgroups ($M=2.14$, $SD=1.77$); $F(1,55) = 3.63$, $p = .06$, $\eta^2 = .01$. In Non-word Repetition, the SLI subgroup ($M=16.00$, $SD=13.33$) produced significantly more errors than the TD subgroup ($M=1.17$, $SD=2.54$); $F(1,55) = 116.45$, $p < .001$, $\eta^2 = 0.30^+$. In Word Repetition, as well, the SLI subgroup ($M=22.48$, $SD=15.00$) had significantly more errors than the TD group ($M=1.62$, $SD=3.33$); $F(1,55) = 113.82$, $p < .001$, $\eta^2 = 0.29^+$.

In phonological working memory, measured by Backwards Digit Span, significant differences were found. The SLI subgroup ($M=0.62$, $SD=0.94$) performed significantly more poorly than the TD subgroup ($M=0.83$, $SD=1.10$); $F(1,55) = 5.01$, $p < .05$, $\eta^2 = 0.4$. These results suggested strong impairment in phonological short term and working memory. We assumed strong impairment based on the results of Word and Non-word Repetition tasks. We chose to base our decision on the results of Word and Non Word Repetition because we think these tasks are more sensitive than Forward Digit Span. The sensitivity of these tasks lies on the number of items that composed them and the measures employed. Word and Non-word Repetition tasks are composed

of 48 items that capture differences on performances more accurately than the maximum four sequences of numbers in Forward Digit Span. For the Word and Non-word Repetition tasks, the measure used was the number of errors. The sensitivity of this measure was suggested by the wide range of score exhibited by children (88 different scores for Word Repetition and 96 for Non-word Repetition) . the narrow range of scores in the Forward Digit Span (5 different scores) depicts this task as less sensitive than Word and Non-word Repetition.

In sum, children in the SLI subgroup performed significantly more poorly than their MLU-matched peers in some language tasks, while in others their performances were equivalent. They performed significantly more poorly in tasks measuring lexical and morpho-syntactic comprehension– measured by TFL and the Rustioni test, respectively – as well as morpho-syntactic production – measured by the Incorrect Morpho-syntactic Rate. In all these cases, differences were related to a small effect size. The performances of both groups in the remaining language tasks showed no significant differences. Moreover, children had significantly different performance in three phonological memory task, while in the other, performances were equivalent. Children in the SLI subgroup performed significantly more poorly than children in the TD subgroup in Word Repetition and Non-word Repetition and Backwards Digit Span. The effect sizes related to these difference were large for Word and Non Word Repetition and small for Backwards Digit Span.

Previous mean comparisons showed that children with SLI had significantly poorer performances than age-matched typically developing children in almost all language measures and in all phonological memory measures. The exceptions for language assessment in comparisons between SLI and age-matched typically developing children were Local and Global Coherence Error Rates, two of the three measure of text production, suggesting that this ability was partially preserved. Results in such previous analysis suggested impairment in language abilities – excepting text production – and phonological memory. Moreover, current mean comparisons revealed that the performance of children with SLI on some tasks measuring such impaired abilities was significantly poorer than the performance of MLU-matched typically developing children. These results suggest that such abilities – namely, lexical

comprehension, morpho-syntactic comprehension and production and phonological memory – appeared to be strongly impaired.

4. Correlations

We present correlations among all language and phonological measures for children with SLI and typically developing children in Table 24 (see page 110). Since multiple comparisons were done, we have evidenced significant correlations at $p < .01$ and $p < .005$ levels, more conservative than $p < .05$.

Table 24

Correlations between scores of children with SLI and typically developing children

TD group SLI group		Abilities and measures																
		Phonological Memory				Lexicon		Morpho-syntax				Text						
		FDS ¹	BDS ²	WR ³	NWR ⁴	PPVT-R	TFL	Rustioni	SR ¹⁴		NT ¹³	TOR 3-8			NT ¹³			
Abilities and measures								Items	Info ⁵	comp MfSx ⁶	Global score	Exp Q ⁷	Imp Q ⁸	Chs ER ⁹	L Chr ER ¹⁰	G Chr ER ¹¹	comp Tx ¹²	
Phonological Memory	FDS ¹		0.36	-0.05	-0.01	0.19	-0.04	0.04	0.20	0.14	-0.15	0.09	0.07	0.07	-0.14	-0.15	0.27	-0.05
	BDS ²	0.18		-0.18	-0.20	0.36	0.20	0.10	0.18	0.16	-0.07	0.35	0.21	0.34	-0.13	-0.11	0.26	-0.02
	WR ³	-0.49**	0.00		0.79**	-0.01	-0.14	-0.20	-0.70**	-0.10	-0.11	-0.06	-0.03	-0.06	-0.25	-0.25	0.02	-0.27
	NWR ⁴	-0.51**	-0.01	0.89**		-0.13	-0.28	-0.28	-0.57**	-0.02	-0.07	-0.01	-0.02	0.01	-0.11	-0.03		-0.5
Lexicon	PPVT	-0.09	0.18	0.01	0.03		0.59**	0.29	0.17	0.19	-0.06	0.40*	0.33	0.30	-0.04	-0.34	0.07	-0.29
	TFL	0.39	0.07	-0.38	-0.29	0.28		0.24	0.03	-0.06	-0.05	0.41*	0.30	0.33	0.12	-0.01	0.19	0.09
Morpho-syntax	Rustioni	0.01	0.24	0.04	-0.03	0.20	0.01		0.23	0.18	-0.13	0.34	0.31	0.22	0.04	0.05	-0.25	-0.05
	SR ¹⁴ :Items	0.27	0.14	-0.58**	-0.62**	0.06	0.45*	0.23		0.56**	0.01	0.07	0.03	0.08	0.15	0.02	-0.01	0.04
	SR ¹⁴ :MfSx ⁵	0.52**	0.03	-0.79**	-0.78**	-0.18	0.27	0.03	0.67**		-0.07	-0.04	-0.19	0.13	0.12	0.05	-0.20	-0.01
	NT ¹³ : comp Morph-syntax ⁶	-0.43*	-0.06	0.33	0.30	0.19	-0.20	0.21	-0.11	-0.19		-0.40*	-0.47**	-0.16	0.71**	0.34	0.02	0.27
Text	TOR: Global Score	0.09	0.31	-0.08	-0.03	0.49**	0.19	0.23	0.29	0.05	-0.07		0.78**	0.78**	-0.28	-0.09	0.06	-0.12
	TOR: exp Q ⁷	0.00	0.21	-0.06	-0.01	0.44*	0.22	0.14	0.19	-0.07	-0.05	0.87**		0.22	-0.36	-0.31	0.09	0.32
	TOR: imp Q ⁸	0.18	0.31	-0.09	-0.05	0.36	0.08	0.26	0.31	0.20	-0.06	0.77**	0.36		-0.09	0.17	0.00	0.14
	NT ¹³ : Chs ER ⁹	-0.40	0.08	0.27	0.24	0.13	-0.10	0.14	-0.06	-0.24	0.68**	0.00	0.09	-0.12		0.55*	-0.22	0.62**
	NT ¹³ : L Chr ER ¹⁰	-0.30	0.21	0.12	0.15	0.18	-0.06	0.45**	0.11	-0.10	0.53**	0.03	0.13	-0.11	0.62**		-0.27	0.91**
	NT ¹³ : L Chr ER ¹¹	-0.26	-0.23	0.12	0.17	-0.07	-0.27	-0.30	-0.15	0.05	-0.09	-0.05	-0.03	-0.05	-0.04	-0.28		0.11
	NT ¹³ : comp Text ¹²	-0.47**	0.11	0.23	0.26	0.16	-0.18	0.29	0.01	-0.14	0.62**	0.01	0.12	-0.15	0.80**	0.88*	0.13	

1 FDS: Forward Digit Span; 2 BDS: Backwards Digit Span; 3 WR: Word Repetition; 4 NWR: Non-word Repetition; 5 MfSx Info: Morpho-syntactic Information 6; comp MfSx: composite Incorrect Morpho-syntactic Incorrect Rate; 7 Exp Q: Explicit Questions; 8 Imp Q: Implicit Questions; 9: Chs ER: Cohesion Error Rate; 10: L Chr ER: Local Coherence Error Rate; 11: G Chr ER: Global Coherence Error Rate; 12: comp Tx: composite Productive Error Rate; 13 SR: Sentence Repetition, 14 NT: Narration Task*.005 ≤ p < .05; **p < .005

5. Hierarchical regressions for the SLI and the TD groups

Fixed-order hierarchical multiple regression analyses were conducted on the total group of children (SLI and TD) and on each group. The dependent variables for each analysis were PPVT-R raw score (lexical comprehension), TFL raw score (lexical production), Rustioni raw score (morphosyntactic comprehension), composite Productive Morphosyntactic Incorrect Rate from Sentence Repetition and the Narration Task (morphosyntactic production), MLU in the Narration Task (morphosyntactic production), TOR 3-8 raw score (text comprehension) and composite Productive Text Error Rate (text production). The variable “age” was forced in the first step. In the second step, measures of memory and linguistic abilities considered as potential predictors for the dependent variable, based on the conceptual hierarchical model, were entered. In the third step, the variable belonging to the SLI or the TD group (“group”) was entered. In the fourth step, we entered interactions between the variables measuring language and memory abilities considered to be potential predictors and the variable “group”. For every regression conducted, the fourth step did not explain any additional amount of variance. For this reason, we report results only for steps one, two and three and the total variance explained by these steps.

5.1. Lexical comprehension.

This regression model investigated lexical comprehension, using the PPVT-R as the dependent variable. In the first step, “age” was entered as a predictor. In the second step phonological short term memory (Forward Digit Span, Word and Non-word Repetition) and working memory (Backwards Digit Span) measures were entered. In the third step, the variable “group” was entered.

The model accounted for a substantial amount of variance (51%). The control variable, age, explained 26% of variability (see Table 25 in page 112). The variables of memory, in the second step, accounted for an additional 20%, but only the contribution of Backwards Digit span was significant. The variable “group”, entered in the third step, significantly contributed to the account of a significant additional 6% of variance. Since belonging to the SLI group or to the TD group accounted for a significant percentage of

variance in the second step, we conducted a new regression analysis for each group, excluding the last two steps.

Table 25

Fixed-order hierarchical multiple regression analysis with PPVT-R (lexical comprehension) as the dependent variable in the overall group (SLI and TD).

	R ²	ΔR ²	B	SEB	β
Step 1					
	.26	.26****			
Age			1.23	.21	.50
Step 2					
	.45	.20****			
Age			.57	.27	.23*
Forward Digit Span			1.83	1.78	.131
Backwards Digit Span			7.06	1.89	.35****
Word and Non-word Repetition			-.18	.10	-.17
Step 3					
	.51	.06***			
Age			.83	.27	.34
Forward Digit Span			1.23	1.70	.09
Backwards Digit Span			5.75	1.84	.29**
Word and Non-word Repetition			.06	.11	.06
Group			7.53	2.27	.35****

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; ****p < .001

The regressions separately conducted on each group showed that significant percentages of variance were explained only by age: 27% for the SLI group and 40 % for the TD group (see Tables 26 and 27, in pages 114 and 115, respectively). No

significant additional percentage of variance was accounted for by adding memory measures on the second step, which could be due to a lack of power due to the reduced sample size. However, for the TD group, Backwards Digit Span showed significant β , while for the SLI, β was not significant.

Results showed phonological working memory, measured by Backwards Digit Span, is a good predictor for lexical comprehension, measured by the PPVT-R. Moreover the independent variable “group” predicted the performance in PPVT-R, apart from the effect of phonological memory abilities.

Table 26

Fixed-order hierarchical multiple regression analysis with PPVT-R (lexical comprehension) as the dependent variable in the SLI group.

	R ²	ΔR ²	B	SEB	β
Step 1					
	.27	.27****			
Age			.94	.23	.52
Step 2					
	.30	.03			
Age			.86	.31	.47**
Forward Digit Span			-.16	2.32	-.01
Backwards Digit Span			3.42	2.50	.19
Word and Non-word Repetition			.01	.12	.02

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; ****p < .001

Table 27

Fixed-order hierarchical multiple regression analysis with PPVT-R (lexical comprehension) as the dependent variable in the TD group.

	R ²	ΔR ²	B	SEB	β
Step 1					
	.40	.40****			
Age			1.60	.28	.63****
Step 2					
	.49	.09			
Age			.80	.47	.31
Forward Digit Span			1.67	2.63	.12
Backwards Digit Span			6.69	2.88	.34*
Word and Non-word Repetition			-.31	.88	-.04

*.01 ≤ *p* < .05; **.005 ≤ *p* < .01; ***.001 ≤ *p* < .005; *****p* < .001

5.2. Lexical production

This regression model investigated lexical production, using the TFL as the dependent variable. In the first step, “age” was forced to control for its effect. In the second step, phonological short term memory (Forward Digit Span, Word and Non-word Repetition) and working memory (Backwards Digit Span) as well as lexical comprehension (PPVT-R) measures were entered. In the third step, the variable “group” was entered.

The model accounted for an important amount of variance, 65% (see Table 28 in page 117). In the first step, “age” explained 12%. In the second step, an additional 51% was accounted, which was accounted for by significant predictors of lexical comprehension (PPVT-R) and phonological short term memory (Word and Non-word Repetition). The variable “group” did not explain any further variability in lexical production.

Results revealed lexical comprehension, measured by the PPVT-R, and phonological memory, measured by Word and Non-word Repetition are good predictors for the performance in lexical production (TFL).

Table 28

Fixed-order hierarchical multiple regression analysis with TFL (lexical production) as the dependent variable in the overall group (SLI and TD).

	R ²	ΔR ²	B	SEB	β
Step 1					
	.12	.12*****			
Age			.30	.08	.35*****
Step 2					
	.63	.51*****			
Age			.02	.08	.02
Forward Digit Span			.34	.52	.07
Backwards Digit Span			-.15	.59	-.02
Word and Non-word Repetition			-.17	.03	-.44*****
PPVT-R			.17	.03	.48*****
Step 3					
	.65	.01			
Age			.07	.08	.08
Forward Digit Span			.27	.51	.06
Backwards Digit Span			-.24	.58	-.03
Word and Non-word Repetition			-.14	.04	-.35*****
PPVT-R			.15	.03	.43*****
Group			1.24	.72	.17

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; ****p < .001

5.3. Morpho-syntactic comprehension

The current model examined morpho-syntactic comprehension using the Rustioni test as the dependent variable. After controlling for age in the first step, phonological short term memory (Forward Digit Span, Word and Non-word Repetition) and working memory (Backwards Digit Span) as well as lexical comprehension (PPVT-R) and production (TFL) measures were entered in the second step.

The final model obtained explained a total amount of 41% of variance (see Table 29 in page 119). The control variable “age”, in the first step, did not explain any significant percentage of variability. The variables in the second step accounted for an additional 30% of the variability in morpho-syntactic comprehension. Significant contributions were made by PPVT-R (lexical comprehension), “age” and Word and Non-word Repetition (phonological short term memory). In the third step, a significant additional 10% of variability was accounted, due to the contribution of the group variable. Results showed lexical comprehension, measured by the PPVT-R, and phonological short term memory, measured by Word and Non-word Repetition, as good predictors of morpho-syntactic comprehension (Rustioni).

A regression analysis was conducted for each group, entering only the variables in the first and second step. The models did not fit our data and thus did not explain the results. This outcome may be due to the lack of power as consequence of a reduced number of cases.

Table 29

Fixed-order hierarchical multiple regression analysis with Rustioni (morpho-syntactic comprehension) as the dependent variable in the overall group (SLI and TD).

	R ²	ΔR ²	B	SEB	β
Step 1					
	.01	.01			
Age			-.18	.22	-.08
Step 2					
	.31	.30****			
Age			-.73	.28	-.34*
Forward Digit Span			-.71	1.80	-.06
Backwards Digit Span			2.80	2.04	.16
Word and Non-word Repetition			-.28	.10	-.28**
PPVT-R			.33	.10	.38****
Step 3					
	.41	.10****			
Age			-.33	.28	-.15
Forward Digit Span			-1.23	1.67	-.10
Backwards Digit Span			2.11	1.90	.12
Word and Non-word Repetition			0	.12	0
PPVT-R			.20	.10	.23
Group			9.32	2.35	.49****
Step 4					
	.42	.02			

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; ****p < .001

5.4. Morpho-syntactic production.

Two regression analyses were conducted for examining possible predictors of morpho-syntactic production. For both models, in the first step we entered “age” and in the second step, we entered the following predictors: measures of phonological short term memory (Forward Digit Span, Word and Non-word Repetition) and working memory (Backwards Digit Span) as well as lexical comprehension (PPVT-R) and production (TFL) measures and morpho-syntactic comprehension measure (Rustioni test). In the third step we entered the variable “group”. The first model had the composite Productive Morphosyntactic Incorrect Rate as the dependent variable. This model accounted for 74% amount of variability. The control variable “age”, in the first step, did not significantly explain any variability (see Table 30 in page 121). The variables in the second step accounted for 70%, due to the contribution of phonological short term memory measures, Word and Non-word Repetition and Forward Digit Span. In the third step, an additional 2% of variability was further explained, with Word and Non-word Repetition and Forward Digit Span being significant predictors. The variable “group” as well significantly contributed for explaining additional variance. Thus, subsequent regression analyses were conducted for each group. The models obtained did not fit our data and could not explain the results. The reason for this outcome may be the lack of power due to a reduced number of cases.

The second model had MLU in the Narration Task as the dependent variable (see Table 31 in page 122) and explained a substantial amount of variance, 65%. In the first step, 6% of the variance was accounted for by age. In the second step, a significant additional 59% was explained, due to the contributions of phonological memory – measured by Word and Non-word Repetition – and the variable “age”. In the third step, no significant additional amount of variability was explained. However, the significant contributor was Word and Non-word Repetition.

Results showed that phonological short term memory, measured by Word and Non-word Repetition strongly predicted performance in morpho-syntactic production tasks.

Table 30

Fixed-order hierarchical multiple regression analysis with composite Productive Morphosyntactic Incorrect Rate as the dependent variable in the overall group.

	R ²	ΔR ²	B	SEB	β
Step 1					
	.02	.02			
Age			0	0	-.14
Step 2					
	.72	.70*****			
Age			0	0	.04
Forward Digit Span			-.02	.01	-.27*
Backwards Digit Span			0	.01	0
Word and Non-word Repetition			0	0	.64*****
PPVT-R			0	0	.07
TFL			0	0	-.10
Rustioni			0	0	-.07
Step 3					
	.74	.02*			
Age			0	0	-.04
Forward Digit Span			-.02	.01	-.24*
Backwards Digit Span			0	.01	.01
Word and Non-word Repetition			0	0	.55*****
PPVT-R			0	0	.10
TFL			0	0	-.06
Rustioni			0	0	.02
Group			-.03	.01	-.26*

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; *****p < .001

Table 31

Fixed-order hierarchical multiple regression analysis with MLU in the Narration Task (morpho-syntactic production) as the dependent variable and in the overall group (SLI and TD).

	R ²	ΔR ²	B	SEB	β
Step 1					
	.05	.06*			
Age			.02	.01	.25*
Step 2					
	.65	.59*****			
Age			.01	.01	.20*
Forward Digit Span			.02	.04	.04
Backwards Digit Span			-.04	.05	-.07
Word and Non-word Repetition			-.02	0	-.73*****
PPVT-R			-.01	0	-.18
TFL			.01	.01	.14
Rustioni			0	0	-.01
Step 3					
	.65	0			
Age			.01	.01	.18
Forward Digit Span			.02	.04	.05
Backwards Digit Span			-.04	.05	-.06
Word and Non-word Repetition			-.02	0	-.78
PPVT-R			-.01	0	-.17
TFL			.01	.01	.15
Rustioni			0	0	.02
Group			-.07	.07	-.11

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; *****p < .001

5.5. Text comprehension

This model examined text comprehension using the TOR 3-8 test as the dependent variable. “Age” was entered in the first step. The predictors entered in the second step were phonological short term memory (Forward Digit Span, Word and Non-word Repetition) and working memory (Backwards Digit Span) as well as lexical comprehension (PPVT-R), lexical production (TFL), morpho-syntactic comprehension (Rustioni test) and production (composite Incorrect Morpho-syntactic Rate in Sentence Repetition) measures. In the third step, group was entered.

The model accounted for 35% of variance (see Table 32 in page 124). In the first step, no significant amount of variability was explained by age. In the second step, an additional 35% of variability was accounted, with the significant predictor being lexical comprehension, as measured by PPVT-R. In the third step, no significantly additional variance was explained by the model.

Results showed that only lexical comprehension, measured by the PPVT-R, predicted text comprehension.

Table 32

Fixed-order hierarchical multiple regression analysis with TOR 3-8 (text comprehension) as the dependent variable in the overall group (SLI and TD).

	R ²	ΔR ²	B	SEB	β
Step 1					
	.01	.01			
Age			.02	.02	.09
Step 2					
	.35	.35****			
Age			-.05	.03	-.24
Forward Digit Span			.07	.18	.05
Backwards Digit Span			.41	.21	.22
Word and Non-word Repetition			-.01	.01	-.06
PPVT-R			.04	.01	.38***
Rustioni			.02	.01	.15
Step 3					
	.35	0			
Age			-.06	.03	-.25
Forward Digit Span			.07	.18	.06
Backwards Digit Span			.42	.21	.22
Word and Non-word Repetition			-.01	.01	-.08
PPVT-R			.04	.01	.39*
Rustioni			.02	.01	.16
Group			-.08	.28	-.04

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; ****p < .001

5.6. Text production

This model examined text production using the composite Productive Text Error Rate as the dependent variable. “Age” was entered in the first step and phonological short term memory (Forward Digit Span, Word and Non-word Repetition) and Working memory (Backwards Digit Span) as well as lexical comprehension (PPVT-R), lexical production (TFL), morpho-syntactic comprehension (Rustioni test), morpho-syntactic production (composite Incorrect Morpho-syntactic Rate in Sentence Repetition) and text comprehension (TOR 3-8) measures were entered in the second step. In the third step, the variable “group” was entered.

The model accounted for a total of 38% of variance (see Table 33 in page 126). In the first step, a significant 26% was accounted by age. In the second step, 12% of variability was accounted due to the contribution of Forward Digit Span.

These results revealed that none of the language measures employed predicted performance in text production measured by the composite Productive Text Error Rate in the Narration Task. Phonological short term memory was the only predictor for text production.

Table 33

Fixed-order hierarchical multiple regression analysis with composite Productive Text Error Rate. (text production) as the dependent variable in the overall group (SLI and TD).

	R ²	ΔR ²	B	SEB	β
Step 1	.26	.26****			
Age			-.01	0	-.51
Step 2	.38	.12*			
Age			0	0	-.24
Forward Digit Span			-.02	.01	-.32*
Backwards Digit Span			.01	.01	.11
Word and Non-word Repetition			0	0	.29
PPVT-R			0	0	-.21
TFL			0	0	.07
Rustioni			0	0	.15
composite Incorrect Morpho-syntactic in Sentence Repetition TOR 3-8			.11	.15	.13
			0	.01	-.02
Step 3	.38	.00			
Age			0	0	.28
Forward Digit Span			-.02	.01	-.32
Backwards Digit Span			.01	.01	.12
Word and Non-word Repetition			0	0	.25
PPVT-R			0	0	-.20
TFL			0	0	.09
Rustioni			0	0	.19
composite Incorrect Morpho-syntactic in Sentence Repetition TOR 3-8			.12	.15	.14
			0	.01	-.03
Group			-.01	-.02	-.12

*.01 ≤ p < .05; **.005 ≤ p < .01; ***.001 ≤ p < .005; ****p < .001

6. Comparisons between groups with Severe Language Impairment, Mild Language Impairment and Severe Morpho-syntactic Impairment

In this section, we present compare language and phonological scores for children in the subgroups within the SLI group. These subgroups are Severe Language Impairment (severely impaired lexical and morpho-syntactic production), Mild Language Impairment (mildly impaired lexical and morpho-syntactic production) and Severe Morpho-syntactic Impairment (mildly impaired lexical production and severely impaired morpho-syntactic production). Firstly, we present the scores of these children in all measures used for comparison in Table 34 (see page 128).

Table 34

Descriptive statistics for language and phonological memory abilities in the Severe Language Impairment (Severe LI), Mild Language Impairment (Mild LI) and Severe Morpho-syntactic Impairment (Severe Morpho-syntactic I) groups

Abilities and measures	Severe LI		Mild LI		Severe Morpho-syntactic I	
	n	M (SD)	n	M (SD)	n	M (SD)
Lexical comprehension: PPVT-R*	16	48.31 (11.41)	9	61.67 (14.18)	22	61.05 (16.95)
Morpho-syntactic comprehension: Rustioni	16	48.19 (14.51)	9	45.61 (15.86)	21	47.73 (15.27)
Morpho-syntactic Production (Narration Task): composite Incorrect Morpho-syntactic Rate	11	0.39 (0.15)	9	0.32 (0.17)	17	0.31 (0.14)
Text comprehension: TOR 3-8*	16	4.50 (1.41)	10	5.60 (2.55)	23	4.96 (1.75)
Text production (Narration Task): composite Productive Text Error Rate	12	0.23 (0.06)	9	0.17 (0.14)	17	0.16 (0.08)
Phonological short term memory: Forward Digit Span	16	1.13 (1.09)	9	2.33 (1.32)	23	1.96 (1.19)
Phonological short term memory: Word Repetition	16	0.13 (0.50)	9	1.11 (1.05)	23	0.35 (0.78)
Phonological short term memory: Non-word Repetition	16	35.88 (18.96)	9	6.11 (4.43)	22	26.00 (20.02)
Phonological working memory: Forward Digit Span	16	40.00 (17.14)	9	8.56 (5.53)	22	33.45 (20.46)

*Standard scores

A multivariate analysis of covariance was performed on raw scores measuring language and phonological measures presented above, with “age” as covariate and the subgroup to which each child belonged (“subgroup”) as independent variable. An effect of the “subgroup” was found at the multivariate level; $F(22,48) = 3.38, p < .01$. Then, the effect of the subgroup on each dependent variable was searched. Significant differences were found only on measures of phonological memory: Word Repetition; $F(2,33) = 4.48, p < .05, \eta^2 = .21$ and Non-word Repetition; $F(2,33) = 7.14, p < .01, \eta^2 = .30$.

In order to identify which subgroups differ on these measures, those pairs with significantly different scores were examined. Regarding Word Repetition, all pairs showed significant differences. The Mild LI group (M=13, SD=6.11) had significantly fewer errors than the Severe Morpho-syntactic I group (M=26, SD=20.02); $p < .05$ and the Severe LI group (M=35.88, SD=18.99), $p < .05$. Moreover, the Severe Morpho-syntactic I (M=26, SD=20.02) group had significantly fewer errors than the Sever LI group (M=35.88, SD=18.99); $p < .05$.

Concerning Non-word Repetition, the mild LI group (M=16, SD=8.56) had significantly fewer errors than the Severe Morpho-syntactic I group (M=96, SD=33.45); $p < .01$ and that the Severe LIB group (M=73, SD=40); $p < .05$.

These results showed different profiles per group, regarding phonological memory. In particular, they suggest that mild or severe impairment in lexical or morpho-syntax is associated with poor or less poor Word and Non-word Repetition.

7. Logistic Regression for the SLI and the TD groups

For identifying the tasks that predicted belonging to the group with SLI, a logistic regression was performed with belonging to the group with SLI (“SLI group”) as the dependent variable (0=group with SLI, 1=TD group). In the first block, the variable “age” was forced, for controlling its effects. In the second block, language measures taken into account were entered with the forward stepwise method. The specific statistics used in the test for removing variables from the model was the likelihood ratio.

Results are summarised in Table 35 (see page 130).

Table 35

Results from hierarchical logistic regression with group as dependent variable

	β	SE β	Wald χ^2	df	p	e^β (odds ratio)
First Block						
Step 1						
Age	.04	.03	1.91	1	.17	1.04
Second Block						
Step 1						
Age	.10	.04	5.75	1	.02	1.11
<i>Morpho-syntactic production: Sentence Repetition (Items)</i>	-.25	.05	23.30	1	0	.78
Step 2						
Age	.04	.06	.45	1	.50	1.04
<i>Morpho-syntactic production: Sentence Repetition (Items)</i>	-.02	.08	.07	1	.80	.98
<i>Phonological short term memory: Non-word Repetition</i>	.34	.10	12.69	1	0	1.41
Step 3						
Age	.04	.06	.40	1	.53	1.04
<i>Phonological short term memory: Non-word Repetition</i>	.36	.08	18.13	1	0	1.43
Step 4						
Age	.05	.06	.72	1	.40	1.05
<i>Phonological short term memory: Non-word Repetition</i>	.34	.10	11.00	1	0	1.40
Rustioni	-.07	.03	5.44	1	.02	.93

*.01 $\leq p < .05$; **.005 $\leq p < .01$; ***.001 $\leq p < .005$; ****.p < .001

Results showed that Sentence Repetition, which appeared in the first step, stood out as the best predictor of belonging to the SLI group. The odds ratio showed that for

each point increase on correctly repeated items, the ratio between the probability of belonging to the SLI group on the probability of belonging to the TD group decreased to 0.78. In the second step, the new entry was Non-word Repetition, appearing as the second best predictor. Results showed that higher scores on this measure – that is, more errors – increased the odds to have SLI. For each error increase, the probability of belonging to the SLI group on the probability of belonging to the TD group increased to 1.41. In the third step, no new measures appeared. In the fourth step, Non-word Repetition appeared again and the Rustioni test entered for the first time. This test is the third predictor. For each point increase on the Rustioni test, the odds of belonging to the SLI group on the probability of belonging to the TD group decreased to 0.93. In the fourth step, Non-word Repetition, Rustioni but not Sentence Repetition appeared. That is, taking into account Non-word Repetition and Rustioni, Sentence Repetition did not add any extra prediction.

In sum, the most important difference between groups was accounted by the Sentence Repetition. However, it emerged that if Non-word Repetition and the Rustioni test are considered, the weight of Sentence Repetition is superseded by these tasks. The logistic regression model showed that the Sentence Repetition task is significantly associated with the dependent variable of belonging to the SLI group. However, this relationship does not hold when the other two predictors are combined.

PART III: DISCUSSION

1. Profile of children with SLI in language abilities and phonological memory

The first aim of the current study was to identify the profile of children with SLI by assessing language abilities in comprehension as well as production and phonological memory. The performance of the group of children with SLI was compared to age-matched and MLU-matched typically developing children. Regarding the comparison to age-matched peers, our results reported a significantly poorer performance of children with SLI than typically developing children in most language measures and in all phonological memory measures, as shown in Table 36 (see page 141). Concerning the comparison to MLU-matched children, significantly poorer performance of children with SLI was found in some of these measures but not in others, as presented in Table 37 (see page 133). In those cases in which children with SLI had significantly poorer performance than their age-matched peers, the correspondent ability was considered impaired. When such performance was also significantly poorer than the performance of the group of children matched by MLU, strong impairment was assumed.

In this section, differences between groups are presented and separately examined for core (lexical and morpho-syntactic comprehension and production) and high (text comprehension and production) language abilities, and contrasting comprehension with production. Comprehension and production comparisons were important with reference to characteristics of expressive SLI shown by most children in the SLI group. The performance of 43 out of 47 children in standardised comprehension tests situated them at very low level, yet within the normal range, suggesting a diagnosis of expressive SLI. All children were treated as a single group since the diagnosis was not done previously or independently to our assessment. However, this information was useful for understanding different levels of performance in comprehension and production.

Table 36

Differences between children with SLI and age-matched typically developing children in measures assessing language and phonological memory abilities. Data are presented with reference to effect size.

	Language	
	Comprehension	Production
Lexical abilities	PPVT-R: large effect ($d=1.19$)	TFL: large effect ($\eta^2 = .44$)
Morpho-syntactic abilities	Rustioni: large effect ($\eta^2 = .37$)	Sentence Repetition: - Correct Items: large effect ($\eta^2 = .53$) - Morpho-syntactic Information: large effect ($\eta^2 = .30$) - MLU: large effect ($\eta^2 = .22$) Narration Task: - Incorrect Morphology Rate: large effect ($\eta^2 = .35$) - Grammatically Complete Sentences: large effect ($\eta^2 = .48$) - MLU: medium effect ($\eta^2 = .13$)
Textual abilities	TOR 3-8: - Global Score : small effect ($d = .09$) - Explicit Questions Score: medium effect ($\eta^2 = .11$) - Implicit Questions Score: medium effect ($\eta^2 = .10$)	Narration Task: - Cohesion Error Rate: medium effect ($\eta^2 = .10$) - Local Coherence Error Rate: no significant difference - Global Coherence Error Rate: no significant difference
	Phonological Memory	
Short Term Memory	Forward Digit Span: large effect ($\eta^2 = .17$) Word Repetition: large effect ($\eta^2 = .50$) Non Word Repetition: large effect ($\eta^2 = .36$)	
Working Memory	Backwards Digit Span: medium effect ($\eta^2 = .13$)	

Table 37

Differences between children with SLI and MLU-matched typically developing children in measures assessing language and memory abilities. Data are presented with reference to effect size.

Language		
	Comprehension	Production
Lexical abilities	PPVT-R: no significant difference	TFL: small effect ($\eta^2 = .01$)
Morpho-syntactic abilities	Rustioni: small effect ($\eta^2 = .03$)	Narration Task: - Incorrect Morphology Rate: small effect ($\eta^2 = .06$) - Grammatically Complete Sentences: no significant differences
Textual abilities	TOR 3-8: - Global Score : no significant differences	Narration Task: - Cohesion Error Rate: no significant differences - Local Coherence Error Rate: no significant difference - Global Coherence Error Rate: no significant difference
Phonological Memory		
Short Term Memory	Forward Digit Span: no significant difference Word Repetition: large effect ($\eta^2 = .30$) Non Word Repetition: large effect ($\eta^2 = .29$)	
Working Memory	Backwards Digit Span: small effect ($\eta^2 = .04$)	

1.1. Core language abilities

The performance of children with SLI showed impairment in all core language skills, namely lexicon and morpho-syntax comprehension as well as production. This result was expected, since impairment in these areas has been previously reported (for a review, see Leonard, 1998). In addition, some core language abilities exhibited strong impairment. Morpho-syntactic skills, lexical production, but not lexical comprehension were strongly impaired. Strong deficit in lexical abilities is consistent with the importance of lexical impairment in early SLI, since difficulties in this area are often

considered the first sign of SLI (Watkins, Kelly, Harbers & Hollis, 1995). Furthermore, more impaired lexical production than comprehension fits with the characteristics of expressive SLI, in which a gap between understanding and generating language is expected. Impairment in morpho-syntactic skills, even to a strong degree, was expected since grammar has become widely known as a main characteristic of SLI (Leonard, 1998). Nevertheless, it is noteworthy that strong impairment does not homogeneously affect morpho-syntactic abilities. In production, impairment was found in one measure, and not in the other. The first measure tested morphological abilities, while the other, syntactic abilities. These results suggest that even though overall morpho-syntactic comprehension was strongly impaired, within production, only morphological, but not syntactic abilities were strongly impaired. That is, regarding morphology, the impairment strongly affects comprehension and production. Concerning syntax, comprehension but not production is strongly impaired, showing a gap between understanding and generating sentences. More preserved production than comprehension represents an unusual pattern, opposite to the performance in lexical abilities, to the profile expected for expressive SLI and to data in the literature (e.g., Chilosi et al, 1995).

In sum, impairment affected all core language abilities, while strong impairment in both comprehension and production affected only morphology. Strong impairment partially affects lexical and syntactic abilities, depicting different patterns. Lexical production was more strongly impaired than comprehension, as expected for expressive SLI. On the other hand, syntactic comprehension was more strongly impaired than production in unexpected disparity.

1.2. High level language abilities

Text comprehension showed impairment while production exhibited a complex pattern. Impairment in comprehension was expected since it has been found in previous studies (e.g., Bishop & Adams, 1992; Crais & Chapman, 1987). Regarding text production, different results have been reported by previous studies. Some studies (e.g., Strong & Shaver, 1991) have shown poorer performance of children with SLI than

typically developing children, while other (e.g., Boudreau, 2007) present equivalent performances of children from both populations.

In our study, from comparisons to age-matched typically children emerged that production in children with SLI was impaired when cohesion was assessed, while it was average when local and global coherence was tested. The cohesion measure calculated the rate of broken off and unfinished sentences. The local coherence measure estimated the rate of referent omissions and the global coherence measure calculated the rate of semantically incorrect and irrelevant phrases. Impairment found for cohesion but not coherence can be explained by the different effect of syntactic and cognitive abilities in performing cohesion and coherence tasks. In general, for adequate text production, children need to integrate linguistic and cognitive abilities at many levels (Boudreau, 2007). For obtaining cohesion and coherence, children with SLI as children with typical development employ a variety of such cognitive abilities. Children with SLI can have normal or even very developed cognitive abilities and this would represent an important strength. Such strength may be an advantage for the production of coherent texts. However, weaknesses may have the opposite effect, representing disadvantage. This is the case with syntax, whereby an impaired language ability in the group of children with SLI that can have a negative effect on different tasks. Low scores in the cohesion measure can be an effect of impaired syntax on performance in textual task. Impaired syntax can be responsible for difficulties of children with SLI in creating semantically complete sentences, necessary for a high score in the cohesion measure. That is, the reason for very low production of complete sentences and high production of broken off and unfinished sentences could be the obstacle of syntactic impairment and not incapacity to represent ideas.

Regarding the comparison to MLU-matched typically developing children, no significant differences emerged from any measure of text comprehension or production. Considering also the results from comparisons to age-matched typically developing children, this outcome suggests no strong impairment in any measure. Text comprehension was slightly impaired, while text production mainly preserved. In particular, the ability to generate texts with cohesion appeared slightly impaired, while the capacity to produce coherent texts seemed undamaged.

In sum, while text comprehension showed impairment, production appeared to be mainly average for children with SLI. They exhibited significantly lower scores than typically developing children in measures regarding tasks heavily affected by syntactic abilities. We think that typical cognitive abilities in these children allow them to exhibit typical performances in text production tasks and that this is an important strength in their language use.

1.3. Language comprehension and production

Comparing comprehension and production aimed to determine if the general language profile presented a gap between them. A clear pattern of preserved comprehension and impaired production was not found, yet some differences arose. Lexical comprehension was better than production, in line with an expressive SLI profile. Textual abilities, even though not strongly impaired, were better for production than for comprehension, showing an opposite pattern from expressive SLI. A possible explanation for this is that expressive SLI profile is reflected only on core language abilities. Stronger impairment in production than comprehension has been reported by previous studies mainly in lexical and morpho-syntactic areas (e.g. Chilosi et al, 1995). Since performance in textual tasks heavily rely on cognitive abilities, patterns of adequacy may be affected by linguistic and cognitive skills to different degrees and generate a complex outcome. Moreover, the interaction between the level of cognitive abilities and the design of the tasks and can have a combined effect on performance. The TOR 3-8 measures text comprehension in a controlled environment, creating a situation whereby children have to choose one out of four pictures for demonstrating that they have understood the story heard. The Narration Task, on the other hand, presents a picture or a sequence of pictures that children have to describe, creating a story. Such a free context allowed children to produce words, sentences and texts choosing them within a certain range of freedom. Children can use their typical cognitive abilities for elaborating a text partially avoiding those aspects of language that are more problematic for them.

1.4. Phonological memory

Phonological short term and working memory appeared to be impaired if compared to age-matched typically developing children. In comparison to MLU-matched typically developing peers, we found impairment as well, evidenced by two of the three measures of short term memory and by the only measure of working memory. These results suggest strong impairment in phonological memory, in line with previous studies reporting impaired phonological memory in children with SLI (e.g., Bishop et al, 1996; Conti-Rasmden, 2003).

Overall results gave a profile of SLI in which core language abilities and phonological memory were the most affected areas, while textual skills were partially preserved. This suggests that the impairment partially affected language competence. Moreover, it affected phonological memory. The relationship found among such impaired and relatively preserved skills concerned the second aim of the study, presented below.

2. Relationships between language and phonological memory

The second aim of the study was to identify how language abilities were related among themselves and how they were connected to phonological memory skills. The best predictors of language performance were searched following a conceptual hierarchical model including language and memory abilities. The relationships between language and memory were examined in the overall group of children and the effect of belonging to the group of children with SLI or the typically developing group was observed. A synthesis of these results is shown in Table 38 (see page 139), in the following order. First, results regarding each predictor for language abilities were examined, then scrutinised relationships between comprehension and production in the same language area (lexicon, morpho-syntax and textual areas) were scrutinised and finally, we evaluated the effect of belonging to the group of children with SLI or the typically developing group on the performance in language tasks was evaluated.

Table 38

Best predictors for language performance among language and phonological abilities in the overall group of children. Those cases in which belonging to the SLI or TD groups was also predictive are noted with a G.

	Language	
	Comprehension	Production
Lexical abilities	<i>Test: PPVT-R^G Predictor: Working memory</i>	<i>Test: TFL Predictors: Lexical comprehension, short term memory</i>
Morpho-syntactic abilities	<i>Test: Rustioni: Predictors: Lexical comprehension, short term memory</i>	<i>Test: Narration Task (measure: composite Incorrect Morpho-syntactic Rate^G): Predictor: Short term memory</i>
		<i>Test: Narration Task (measure: MLU) Predictor: Short term memory</i>
Textual abilities	<i>Test: TOR 3-8: Predictor: Lexical comprehension</i>	<i>Test: Narration Task (measure: composite Productive Text Error Rate) Predictor: Short term memory</i>

G: Belonging to the TD or the SLI groups was predictive for the performance in these tasks and/or measures.

2.1. Phonological memory

Phonological memory – predominantly short term memory – was the best predictor for language performance, as evinced in Table 38. Phonological memory predicted performance of children with SLI and typically developing children in most language tasks, except text comprehension. These results highlight the importance of phonological memory and its relationship with language. Previous analyses showed that phonological memory was strongly impaired in children with SLI. Moreover, these data showed that having good or poor phonological memory led to good or poor performance in linguistic tasks, independently of belonging to one group or the other. These outcomes depicted SLI in these children as a condition where phonological memory was impaired and the degree of such impairment predicted the level of performance in linguistic tasks, as in a continuum with typical development. The nature of the relationship between phonological memory and language cannot be determined

by this study. Further research is necessary to distinguish if such a strong link is the consequence of simple association or a cause-effect relation.

2.2. Language abilities

The only predictor for language performance among core language skills was lexical comprehension. It was predictive for lexical production as well as morpho-syntactic and text comprehension. Regarding comprehension, the relationship between lexical, morpho-syntactic and textual abilities depicted it as structurally organised from basic to more elaborated abilities. In this picture, competence in the most basic area, the lexicon, is important for comprehension of more elaborated areas in typical as well as impaired language development. Concerning production, such a pattern was not found. A possible explanation for these different results can be related to the characteristics of expressive SLI found in most children of our study group. These children exhibited comprehension levels that are low, yet normal. That is, their competence in comprehension appeared to be similar to typically developing children. This could be the reason for the single pattern emerging from performance in comprehension tests of children with SLI and their typically developing peers. On the contrary, children with SLI may differ in various degrees and aspects of production from typically developing children. Such heterogeneity could be the reason of the absence of a pattern in production.

It is remarkable that the relationship between phonological memory and language abilities concerned only core language skills. The performance in textual tasks appeared to be partially independent from the level of phonological memory. The independence of textual abilities from phonological memory may be an extra explanation for preserved or slightly impaired performance of children with SLI on textual tasks. That is, children with SLI showed their best performances in tasks in which their developed cognitive abilities are useful and their strongly impaired phonological memory skills do not play a central role.

2.3. Comprehension and production

In the hierarchical conceptual model adopted, we considered comprehension abilities to be potential predictors for production skills in the same area. We found that only regarding lexicon, comprehension predicted production. This suggests that while lexical abilities reflected the expected relationships between comprehension and production, regarding morpho-syntactic and textual skills unexpected dissociations arose. This implies that having better or poorer morpho-syntactic comprehension will not lead to better or poorer morpho-syntactic production. An analogous implication can be done for textual abilities. This confirms differences between comprehension and production proposed above. While abilities in comprehension were structured as in typical development, abilities in production did not show the same pattern. Such differences can be the reason for an absent correspondence between comprehension and production at the same level.

2.4. SLI and TD groups

Results showed that belonging to the group of children with SLI or to the typically developing group explained an extra variance only regarding performance in lexical comprehension (PPVT-R) and morpho-syntactic production (composite measure). This means that differences between groups, not grasped by the phonological memory and language measures used, had an effect only on lexical comprehension and morpho-syntactic production. Moreover, absence of an extra effect of the group on the remaining language measures suggests a similar pattern of relationships in children with SLI than typically developing children. This supports the idea that competence on SLI yet being impaired, can form a continuum with typical development, showing relationships among skills that in some aspects show an analogous pattern.

3. Different profiles within the group of children with SLI

The third aim of this study was to recognise if children with SLI presented the same pattern of performance in language and memory tasks or if different profiles emerged. Four subgroups were created from combining severe and mild deficits in lexical and morpho-syntactic production. Deficits were classified as severe when the

score in the correspondent measures was equal or below two standard deviations under the mean obtained from the typically developing group. Mild impairment referred to deficits over such threshold. Four groups composed of different numbers of participants were obtained, as shown in Table 39.

Table 39

Groups and number of children with severe or mild impairment in lexical and morpho-syntactic production.

		Morpho-syntactic Production	
		Severe	Mild
Lexical Production	Severe	Severe Language Impairment (Severe LI) 16	Severe Lexical Impairment (Severe Lexical I) 1
	Mild	Severe Morpho-syntactic Impairment (Severe Morpho-syntactic I) 23	Mild Language Impairment (Mild LI) 10

The number of participants in each group suggested an unbalanced distribution of the impairment. A group of participants had mild impairment in both lexical and morpho-syntactic productions (Mild LI). If two standard deviations under the mean is considered as the limit between impairment and typical performances, children in this group would be situated in the range of typical development, yet in the lower levels. The group with severe lexical and morpho-syntactic impairment (Severe LI) was formed by those children with the more pervasive type of SLI. The other two groups have different combinations of lexical and morpho-syntactic impairment (Severe Lexical I and Severe Morpho-syntactic I).

In the groups where lexical and morpho-syntactic production were impaired to a different degree, a clearly uneven distribution was found. The group with mild lexical impairment and severe morpho-syntactic impairment was the largest, while the group showing the opposite pattern of performance was composed of just one participant. The association of impairments in the Severe Morpho-syntactic I group fits with the sub-

type of SLI reported by van der Lely and colleagues (van der Lely, 1999; van der Lely & Battell, 2003, van der Lely, 2005), so-called Grammatical-SLI (G-SLI). G-SLI is characterised by deficit in morpho-syntax that have been described with details by these authors. This kind of information is not available for our group with severe morpho-syntactic impairment and mild lexical impairment. The similarities between Van der Lely's G-SLI group and our Severe Morpho-syntactic I are only referred to the core deficit. For van der Lely (2005), in Grammatical SLI, stronger impairment in morpho-syntax than lexicon is due to the fact that the vocabulary deficit is, at least partially, caused by grammatical deficits. It is possible that the association of severe morphosyntactic impairment and mild lexical impairment in our Severe Morpho-syntactic I group was the outcome of a relationship between deficits similar to the G-SLI. Such potential relationship could be attributed to links between syntax and lexicon; as for example, the relationship between syntactic bootstrapping and word acquisition. The association of deficits found in the second group has not previously been reported, to our knowledge. The disparity in the distribution of children between the two groups in our study and in the literature may suggest higher probabilities of finding the first combination of impairments than the second.

The performance of children in the Severe LI, Mild SI and Severe Morpho-syntactic I groups was examined and compared. The Severe Lexical I group was excluded because comparison with a one-element group would not be statistically valid. Moreover, the comparison of the remaining groups was important because they may be related to potential sub-populations in SLI.

The performance of children in lexical, morpho-syntactic and textual abilities as well as phonological memory was compared. Those tasks that were used for establishing the criteria of impairment in morpho-syntactic and lexical production used for constructing the four groups were excluded from comparisons. The performances of children in language tasks were compared: lexical production as well as lexical, morpho-syntactic and text comprehension. The performances in phonological short term and working memory were also compared. Significant differences among groups were found only in short term phonological memory, in particular in Word and Non-word Repetition. Information about scores on these tasks is in Table 40.

Table 40

Performances in phonological memory tasks of the Severe Language Impairment (Severe LI), Mild Language Impairment (Mild LI) and Severe Morpho-syntactic Impairment ((Severe Morpho-syntactic I) groups

Abilities and measures	Severe LI		Mild LI		Severe Morpho-syntactic I	
	n	M (SD)	n	M (SD)	n	M (SD)
Word Repetition	16	0.13 (0.50)	9	1.11 (1.05)	23	0.35 (0.78)
Non-word Repetition	16	35.88 (18.96)	9	6.11 (4.43)	22	26.00 (20.02)

From comparisons, differences among groups in lexical and morpho-syntactic comprehension that would suggest a specific pattern of language impairment per each group did not emerge. That is, patterns of impairment associated with the type of deficit characterising each group were not found. At the beginning of the study, children with severe impairment on lexical production were expected to have poorer performances in lexical comprehension tasks than children with mild impairment. Likewise, we expected children in the groups with severe impairment in morpho-syntactic production to have poorer performances in morpho-syntactic comprehension tasks than the other two groups. The absence of differences in lexical and morpho-syntactic comprehension confirmed the independence of performance in production tasks from performance in comprehension tasks suggested by previous analyses.

Moreover, the performances of children in the groups were equivalent for text comprehension and production. These results suggest that none of the groups was advantaged or disadvantaged for textual tasks, based on the level of lexical and morpho-syntactic production.

In sum, differences in the language profile of children in the different groups did not emerge. The only aspect that distinguished groups was lexical and morpho-syntactic production used as criteria for creating groups as well as phonological memory, measured by Word and Non-word Repetition.

3.1. Word repetition

Regarding Word Repetition, the performance of each group was significantly different from the others. First, the groups with mild lexical impairment (Mild LI and Severe Morpho-syntactic I) had significantly better performances in Word Repetition than the group with severe lexical impairment (Severe LI). Performance in Word Repetition task, yet measuring phonological memory, is affected by richness of vocabulary. It is possible that differences between groups on Word Repetition and lexical abilities in production were related to the same underlying knowledge, a rich vocabulary. Children with the richest vocabularies may have the best scores on language production tests, such as naming tasks. They have more elements among which pick the correct one to describe the picture shown to them. Likewise, children with the richest vocabulary may have more likelihood of recognising words in the Word Repetition task. Such recognition helps in remembering those words. This can explain the differences between Mild LI and Severe Morpho-syntactic I, on one side and Severe LI, on the other.

In addition to this, we found differences related to the degree of the general impairment. That is, the less impaired group (Mild LI) had the best performance, the most impaired group (Severe LI) had the poorest performance and the group with the intermediate degree of impairment (Severe Morpho-syntactic I) was situated in the middle. These results appeared to be coherent with an idea of pervasive effect of the impairment. The Mild LI group, the one with typical-like profile, would be the most advantaged one and analogously, the Severe LI group, the most impaired one, would be the most disadvantaged. As presented before, differences between these groups regarded lexical but also morpho-syntactic abilities. Differences in lexical abilities were reflected in the best performance in the Word Repetition task by children with mild lexical impairment and the reason could be the richness of vocabulary, as discussed above. Differences in morpho-syntactic abilities were also related to the performance in Word Repetition. The group with the best performance was the Mild LI group, the only one with mild morpho-syntactic impairment. These results suggest a relationship between morpho-syntactic abilities and performance in Word Repetition that cannot be associated with vocabulary. It is possible that this was the consequence of the

relationship between phonological short memory and morpho-syntactic abilities. In previous analysis, we saw the strong link between phonological short term memory and morpho-syntactic production in the overall group of children (with SLI and typical development). Measures of phonological short term memory were the best predictors for both morpho-syntactic indicators, showing that children with the best phonological memory had the best performance in the morpho-syntactic assessment. Likewise, children with the poorest phonological memory had the poorest performance in the morpho-syntactic assessment. This outcome is in line with the data about subgroups, indicating that the group of children with typical-like morpho-syntactic abilities was also the groups with the best phonological memory. Analogously, the groups with the severely impaired morpho-syntax were also the group with the poorest phonological memory.

3.2. Non-word Repetition

Concerning Non-word Repetition, the performance of the Mild LI group was significantly better than the other two. Between the Severe LI and the Severe Morpho-syntactic I groups there were no significant differences. The equivalent performance of these two groups, which differ only in the degree of lexical impairment, suggests an independence between lexical production and Non-word Repetition. While regarding Word Repetition, a rich vocabulary appeared to be an advantage, in Non-word Repetition it did not. This absence of differences can be explained by the fact that Non-word Repetition is a more pure task of phonological memory, since it is not affected by lexical abilities. The remarkable difference was found between the Mild LI group and the Severe LI and Severe Morpho-syntactic I groups. The Mild LI group, the group with the typical-like morpho-syntactic production, performed significantly better than the other two. This can be explained by the pervasiveness of the deficit and the link between phonological short term memory and morpho-syntactic abilities, as discussed for the Word Repetition task.

These results together suggest that short term phonological memory in the subgroups is mainly related to the degree of the morpho-syntactic impairment. In both Word and Non-word Repetition tasks, the groups with typical-like morpho-syntactic

abilities had the best phonological memory. Analogously, the groups with severely impaired morpho-syntactic abilities had the poorest phonological memory. These results confirm the strong relationship between phonological memory and morpho-syntax found in children with SLI and typically developing children.

4. Discriminating measures for distinguishing between children with SLI and typically developing children.

The fourth aim of the current study was the attempt to give a practical contribution. As known, it is important for clinical practice to identify children with SLI using the minimum number of tests and the easiest measures to be obtained. The aim was to identify which language or phonological memory tasks discriminated between children with SLI and typically developing children in our groups. Selecting those measures, the intention was not to find clinical markers. Neither the design of the study nor the analysis performed would fulfil the requirements of sensitivity, specificity and accuracy needed for correctly identifying children with SLI. Previous studies have already proposed clinical markers for SLI, as phonological memory measured by Non-word Repetition, Sentence Repetition as well as syntactic tense marking (e.g., Bishop, North, & Donlan, 1996; Campbell, Dollaghan, Needleman, & Janosky, 1997; Rice, Wexler & Hershberger, 1998; Conti-Ramsden, Botting, & Faragher, 2001). Our aim was to identify discriminating measures among a wide range of language and phonological memory measures. This would be suitable for confirming the usefulness of tasks related to markers when compared to other phonological measures and language measures that include lexical, morpho-syntactic and textual assessment in comprehension as well as production.

For identifying among the tasks in our assessment the best predictors of belonging to the SLI group, a logarithmic regression model was employed. The independent variables were the simplest measures for each task and the dependent variables was belonging to the group with SLI (0=TD group, 1= SLI group). In order to select the best model, after forcing “age” in the first block, we employed the forward stepwise method for selecting the best predictors among language and phonological memory measures. The best fitting model included Non-word Repetition (measure:

number of errors) and the Rustioni test (measure: raw scores). Although Sentence Repetition (measure: number of correctly repeated items) was selected at the first step of the stepwise procedure, it was not selected in the final model. That is, even though the Sentence Repetition task was significantly associated with the dependent variable of belonging to the SLI group; this relationship did not hold when the effect of Non-word Repetition and the Rustioni test were combined.

At this point it was important to consider which abilities were being tested by these tasks and how they are related to clinical markers. While there is agreement about Non-word Repetition measuring phonological short term memory (Bishop, North & Donlan, 1996; Sothard, Snowling, Bishop, Chipchase & Kaplan, 1998), the ability measured by Sentence Repetition is not so easily identified, as pointed out by Conti-Ramsden et al. (2001) and Stokes, Fletcher, Wong and Leonard (2006). Poor performance in Sentence Repetition of children with SLI may be due to language impairment, reduced phonological memory or both. The Sentence Repetition task we employed consisted of 27 simple sentences illustrated by drawings. The test was designed to assess the ability of young typically developing children acquiring Italian to imitate verbal input and evaluate morphological and syntactic aspects of the sentences produced. It was proposed by its authors (Devescovi & Caselli, 2007) as a measure of early grammatical development. In addition, drawings are expected to reduce the load for phonological memory. For this reasons, in the current study we used Devescovi and Caselli's Sentence Repetition task as a measure of grammatical competence and not as a measure of phonological memory. However, the performance in this task could also be affected by the level of phonological memory.

The Rustioni test, which assessed morpho-syntactic comprehension through the selection of the correct picture, out of four options, for each sentence heard. This task has not been related to any clinical marker, as far as we know. However, it includes items testing syntactic tense, which has been proposed as a possible marker (e.g., Rice et al., 1998). In addition, this task is frequently used in Health Service Units for initial assessment in order to identify language impairment.

In sum, measures discriminating children with SLI from typically developing children were Sentence Repetition, Non-word Repetition and the Rustioni test. Sentence Repetition, the best predictor was assumed to test morpho-syntactic production, yet it could also be testing phonological memory. The second and third predictors measured phonological memory and morpho-syntactic comprehension, respectively. They were included in the best fitting model, while Sentence Repetition was excluded. These results suggest that for clinical assessment the best test is Sentence Repetition. If two tests can be administered, then the best tests are Non-word Repetition and the Rustioni test, since Sentence Repetition would not add any extra information if these tests are administered. It is possible that the value of the Sentence Repetition task is given by the capacity to measure grammatical knowledge and, in a certain degree, phonological memory. This could be the reason why testing separately phonological memory and grammatical knowledge by Non-word Repetition and the Rustioni test excluded Sentence Repetition as a predictor.

General Discussion

For the current dissertation, we conducted two studies on SLI driven by different motivations. In the first study, we carried out a detailed linguistic analysis on the morpho-syntactic production of a child with SLI. We aimed to explain its characteristics taking into account the main linguistic hypotheses on the deficit underlying SLI. The strength of this study was the deep analysis of production which required examining a large language corpus. This kind of analysis was only possible for the production of one child. Since SLI is a heterogeneous and complex deficit, the examination of the production of a single participant represented the first limitation of this study. The study of a group of children would be needed in order to capture the variety of profiles within SLI. The second and most important limitation was the focus of attention restricted to morpho-syntax for the analysis and the selection of linguistic hypotheses. Even though morpho-syntax has been widely recognised as a main impairment in SLI, other language areas are also affected to different degrees (Leonard, 1998). Moreover, recent studies have shown that, in addition to language, other aspects of cognition may be affected. For non-linguistic hypotheses, these data are explained by an underlying deficit affecting general or specific cognitive abilities (for a review on this topic, see Leonard, 1998). The approach of the first study did not allow us to measure other language areas apart from morpho-syntax nor to consider impairment of other cognitive abilities. In order to overcome this limitation, we conducted the second study on a group of children, tested for lexical, morpho-syntactic and text comprehension and production as well as phonological memory. We aimed to offer a more comprehensive description of the phenomenon, evincing preserved and impaired abilities and the relationships that connect them as well as providing profiles based on such abilities. The strengths of the group study were the large number of participants and the wide range of abilities

measured. The study group was composed of fifty children previously selected for having language impairment that affects lexicon and morpho-syntax, namely expressive and expressive-receptive SLI. The large number of participants and the selection of types of SLI that affected core language abilities allowed us to create subgroups of children that differed in the severity of the deficit in such abilities. The wide range of tasks tested permitted us to identify relationships between impaired skills.

Two main results emerged from the group study. First, we identified the important role of phonological memory in SLI and its relationship with language abilities. Our results showed that phonological memory is seriously affected in children with SLI and the degree of such impairment is strongly related to deficits in language abilities. Moreover, different profiles exhibited by children within the group of SLI also revealed the strong relationship between phonological memory and language, in particular, morpho-syntax. Subgroups with mild impairment in morpho-syntactic production showed less impaired phonological memory than groups with severe morpho-syntactic production. Second, our data suggest a complex pattern of language impairment, with core language abilities mainly impaired and textual abilities, in particular production, partially preserved.

We expect these results to offer a contribution to research on the topic and to clinical practice. Regarding the relationship emerging between impaired phonological memory and impaired language abilities in children with SLI, the relevance of our results was to highlight the role of phonological memory in the profile of children with SLI. This does not reinforce the idea of simple association between deficits, but motivates further investigations on the nature of the strong relationship between impaired phonological memory and language. The current study had as limitation that did not afford examination of the nature of such a relationship. We could not investigate if phonological memory and language impairment are connected by a reciprocal link, a cause-effect relationship or are both consequences of the same underlying deficit. A reciprocal relationship could evolve during development, explaining continuous effect of each deficit in the other until the moment of assessment in which both phonological memory and language were strongly impaired. Such a reciprocal relationship could originate from one ability being impaired prior to the other, or from both abilities being

impaired from the beginning. A series of studies on SLI have proposed a deficit in phonological memory as the key impairment, in a cause-effect relationship with language problems (e.g. Gathercole and Baddeley, 1990); while to our knowledge, no studies have proposed language deficit as underlying phonological memory difficulties. Other studies (e.g. Ullman and Pierpont, 2005) have proposed deficit in general cognitive mechanisms that could be the link between impaired language of children with SLI and impairment concerning different cognitive skills, such as phonological memory tasks. Further research needs to be conducted for deeply examining the relationship between language and phonological memory impairment in SLI and determining its nature. Moreover, it is necessary to establish if such relationship exclusively links phonological memory and language or if other cognitive abilities are also involved. Future studies should take into account other cognitive abilities apart from phonological memory in order to identify among a wide range of skills which are impaired in SLI. Recent studies have already started on this line of research, such as Leonard et al. (2007), which examines the relationship between processing speed and working memory on the one hand, and language impairment on the other. We think a comprehensive assessment would provide important results if carried out on very young children, aiming to test abilities as early as possible, instead of examining them when they have already been reciprocally affected to a large extent. Concerning the contribution to clinical practice, the role of phonological memory on language performance in children with SLI that emerged from our study motivated recommendations for intervention. We think training in phonological memory ability, in addition to pure language therapy, would be useful for enhancing language development in children with SLI. Improvement in phonological memory should have a positive effect on language performance, disregarding which ability is the origin of the deficit.

Concerning the profile of children with SLI, our study showed a complex pattern of impairment differently affecting language areas, characterised by very impaired core language abilities and partially preserved textual skills. In particular, text production appeared to be unimpaired. This suggests that children with SLI, in order to produce texts, make representations at an abstract level as typically developing children do. When performing tasks assessing text production, children need to use cognitive

strategies for constructing a coherent representation of the story to be produced. At this level, previous to linguistic formulation, the representation does not have yet a linguistic form. The unimpaired performance of children with SLI on text production tasks reflects a coherent pre-linguistic representation. That is, even though linguistic formulation is often strongly impaired in children with SLI, their capacity to construct pre-linguistic representations seemed to be undamaged.

The profile of language impairment that emerged from this study aimed to contribute to research showing a detailed picture of which abilities are impaired or preserved, in comprehension or production and the degree of such impairment. Unfortunately, this linguistic profile lacks information about competence on phonology. Phonological impairment, even though often considered as a peripheral deficit in SLI, is extremely frequent in children with SLI (Leonard 1998). Moreover, it is a language area strongly related to phonological memory and auditory processing. Research on impaired phonological abilities would complete the profile and, in addition, give extra information for determining the role of phonological memory in the language performance of children with SLI. Phonological deficit in SLI has been investigated from early studies on the topic (e.g. Compton, 1976); while very recent studies have refined the analysis, focusing on the overlap between phonological deficit and other impairments, such as dyslexia (e.g. Wong et al., 2010; Fraser et al, 2010). The specific characteristics of the phonological deficit in SLI that emerged from these investigations should be taken into account for selecting phonological tasks in comprehensive assessment for future studies. For a comprehensive assessment, it would be convenient to additionally test pragmatic abilities. These abilities have not systematically been investigated in children with SLI as deeply as phonology; however, recent studies are focusing in these areas (e.g., Laval et al, 2009; Ryder, Leinonen & Schulz, 2008). Comprehensive assessment in future studies should consider this language domain for attesting the capacity of children with SLI to use their impaired language abilities in contextualised situations. From this kind of analysis, not only weaknesses but also important strengths may emerge. It is essential to consider all language abilities for a complete profile of children with SLI that evince their strength and weaknesses. This would provide important implications for addressing the study on SLI as well as

offering valuable recommendations for clinical practice. Drawing attention to the strengths in language competence of children with SLI would allow planning interventions focused on enhancing preserved abilities that could trigger improvement of impaired skills.

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Appendix

List of Words and Non words, used in the Word and Non-word Repetition tasks. Both words and non words are written in standard Italian orthography.

Words	Non words
BAVA	BÓFO
NEBBIA	NÓDDIE
GALERA	GORÉLO
DILUVIO	DIRÚSIA
CALAMITA	CATASÉPO
SACERDOTE	SOVERLÓCHE
FRASE	FRÍVE
VULCANO	VIRTÓMA
DAMIGIANA	DAVERÚMA
VELLUTO	VILLÓPA
MELANZANA	MUPONZÁNO
SEME	SÍMI
MATERASSO	MOLATÁFFO
MARMOTTA	MOLMÍTTO
MULINO	MORÚNA
CAMPANILE	CANFANÓLA
CORVO	CÁNSA
CUBO	CÓBE
TAMBURO	TUNDÁLO
BOLLITORE	BINNUTÁRA
MUNICIPIO	MUDEGÉFIO
TORRE	TÁMMO
PALMA	PÁRNA
POMATA	PANÓCO