Available online at www.sciencedirect.com
SCIENCE DIRECT®
Brain and Language 88 (2004) 229–247
Brain and Language
www.elsevier.com/locate/b&l

"Frog, where are you?" Narratives in children with specific language impairment, early focal brain injury, and Williams syndrome

Judy Reilly,[a,*] Molly Losh,[b] Ursula Bellugi,[c] and Beverly Wulfeck[d]

[a] San Diego State University, USA, and Université de Poitiers, France
[b] San Diego State University and University of California, Berkeley, USA
[c] The Salk Institute, Laboratory for Cognitive Neuroscience, La Jolla, CA, USA
[d] School of Speech, Language, and Hearing Sciences, San Diego State University, San Diego, CA, USA

Accepted 2 April 2003

Abstract

In this cross-population study, we use narratives as a context to investigate language development in children from 4 to 12 years of age from three experimental groups: children with early unilateral focal brain damage (FL; $N = 52$); children with specific language impairment (SLI; $N = 44$); children with Williams syndrome (WMS; $N = 36$), and typically developing controls. We compare the developmental trajectories of these groups in the following domains: morphological errors, use of complex syntax, complexity of narrative structure, and types and frequency of evaluative devices. For the children with early unilateral brain damage, there is initial delay. However, by age 10, they are generally within the normal range of performance for all narrative measures. Interestingly, there are few, if any, side specific differences. Children with SLI, who have no frank neurological damage and show no cognitive impairment demonstrate significantly more delay on all morphosyntactic measures than the FL group. Quantitatively, on morphosyntactic measures, the SLI group clusters with those children with WMS who are moderately retarded. Together these data help us to understand the extent and nature of brain plasticity for language development and those aspects of language and discourse that are dissociable.

Keywords: Specific language impairment; Focal brain injury; Williams syndrome; Morphology; Plasticity; Narratives; Language development

1. Introduction

The overall goal of this special issue is to use the behavior of special groups of children to enhance our understanding of the brain bases of language and language development, and to this end, in this paper we examine narratives from four groups of school-aged children: children with early brain injury, children with specific language impairment, children with Williams syndrome and typically developing comparison children. Each population provides a different perspective on language acquisition and narrative development as well as their components. By comparing the performance of these groups of children we can directly address three critical issues in developmental neuroscience:

1. the nature and extent of neuroplasticity;
2. how general intellectual impairment with a specific genetic basis may affect the process of language acquisition and narrative development;
3. the nature of the language acquisition process itself.

Study I addresses the issue of neuroplasticity by comparing morphosyntactic development in the narratives of children with early brain damage (FL), children with specific language impairment (SLI), and typically developing comparison children (TD). To evaluate the role of a genetically based cognitive impairment, Study II juxtaposes the stories of children with Williams syndrome (WMS) with those of children with SLI as well as chronological age matched typically developing children

* Corresponding author. Present address: Department of Psychology, San Diego State University, 6330 Alvarado Court 208, San Diego, CA 92120, USA.
E-mail address: reilly1@mail.sdsu.edu (J. Reilly).

0093-934X/$ - see front matter © 2003 Elsevier Science (USA). All rights reserved.
doi:10.1016/S0093-934X(03)00101-9

in an attempt to distinguish those aspects of narratives that are cognitively based from those that are specifically linguistic. Finally, to the degree we can identify processes and milestones that are common to all our populations, we can begin to uncover core aspects of the language acquisition process itself.

1.1. Why look at narratives?

Narratives are found across different contexts, cultures, and times. From stories at the dinner table (Ochs, Smith, & Taylor, 1989) to some of our very oldest records (e.g., the Old Testament stories in the Bible and Aesop's fables), narratives continue to serve as a means to convey culturally significant information. In part due to their pervasiveness, narratives, as a discourse form, are accessible to even the youngest in society: children have some notion of "what a story is" by age 3 (Appleby, 1978). Given their frequency and 'everyday' nature, narratives provide an excellent quasi-naturalistic measure of children's spontaneous language, and reflect distinctive structural and linguistic changes through childhood and adolescence. Although, researchers agree that children are generally proficient with the majority of the morphosyntactic structures of their language by age 5 (e.g., Brown, 1973; Slobin, 1985), understanding how and when to use these structures fluently and flexibly in particular discourse genres continues to develop well into adolescence. Thus, narratives provide a rich context for evaluating multiple aspects of linguistic development in school-aged children. Indeed, numerous researchers have exploited this goldmine in both typically developing children (e.g., Bamberg, 1987; Bamberg & Reilly, 1996; Berman & Slobin, 1994; Peterson & McCabe, 1983; Reilly, 1992), as well as in atypical populations (Anderson, 1998; Bamberg & Damrad-Frye, 1991; Capps, Kehres, & Sigman, 1998; Capps, Losh, & Thurber, 2000; Dennis, Jacennik, & Barnes, 1992; Liles, 1993; Losh, Bellugi, Reilly, & Anderson, 2001; Losh & Capps, in press; Loveland, McEvoy, & Tunali, 1990; Reilly, Bates, & Marchman, 1998; Reilly, Klima, & Bellugi, 1990; Tager-Flusberg & Sullivan, 1995).

1.2. Narratives: What makes a good story?

In their seminal paper on narratives, Labov and Waletzky (1967) characterized a narrative as a sequence of temporally related clauses rendered from a particular point of view. That is, narratives include both information about the characters and events of the story, i.e., the plot or referential aspect, as well as comments that relate the narrator's perspective on their significance to the story, the evaluative aspect of narratives.

Thus, the requisite skills for producing a good narrative involve complex, linguistic, cognitive, and affective/social abilities. Linguistically, children must lexically encode information about the characters and events of the story using the appropriate morphosyntactic devices to articulate the sequence of events and their temporal relations. Cognitively, children must infer the motivation for protagonists' actions, the logical relations between events and the theme of the story. These inferences might be considered one aspect of the evaluative function as they all reflect the narrator's assessment of the meaning or significance of the events of the story. Finally, telling a story is a social activity, and an additional type of evaluation concerns the relationship of the narrator to the audience. These elements in a story we have termed social evaluative devices as they serve to engage and maintain the listener's attention. Given the range of skills required to produce a good narrative, analyzing children's stories permits us to address questions regarding not only complex language development and its use in school-aged children, but also the relationship of language development to other cognitive and affective abilities. By comparing the narratives of our special populations to those of chronologically matched typically developing children, we can begin to identify which aspects are vulnerable or more resilient in different conditions, as well as those abilities which are closely interrelated versus those which are dissociable from one another.

2. Study I: Neuroplasticity and development

2.1. Narratives of children with focal lesions and children with specific language impairment

Since the studies of Basser (1962) on children with hemiplegia, and the observations of Lenneberg (1967) noting that children with brain damage did not suffer the same irreparable damage as adults with comparable damage, the question of cerebral plasticity has intrigued scientists. From the extensive work on both neurologically healthy adults and those who have suffered unilateral strokes, (e.g., Goodglass, 1993), 150 years of research has confirmed the findings of Paul Broca: the left hemisphere mediates core aspects of language, i.e., phonology, morphology, and syntax, for approximately 95% of the population including signers using American Sign Language (Poizner, Klima, & Bellugi, 1987). Accruing evidence suggests that the right hemisphere also plays a role in language: adults with right hemisphere damage (RHD) have problems with non-literal language, discourse cohesion and coherence (Joanette, Goulet, & Hannequin, 1990; Kaplan, Brownell, Jacobs, & Gardner, 1990). However, a growing literature attests to Lenneberg's observation: children with brain damage fare much better than adults on tasks of language performance (Bates et al., 2001; Bates, Vicari, & Trauner, 1999; Eisele & Aram, 1995; Vargha-Khadem, Isaacs, & Muter, 1994; Vicari et al., 2000). Studies of children with early (pre- or peri-natal) lesions have shown initial delay in language acquisition, regardless of lesion site, and those site specific deficits which do appear, resolve consecutively. To date, studies have failed to demonstrate significant right–left differences after middle childhood (Bates et al., 1997; Reilly & Dardier, 2002; Reilly et al., 1998; Vicari et al., 2000). In studies of children who have suffered later lesions, i.e., after the first year of life, and once the language learning process is underway, the data are mixed (for reviews, see Bishop, 1993 and Eisele & Aram, 1995), with some studies showing no significant differences in language performance according to lesion site (e.g., Vargha-Khadem) and others demonstrating subtle persistent language deficits for children with left hemi-decortication (Dennis & Kohn, 1975; Dennis & Whitaker, 1976; Eisele & Aram, 1995; Vargha-Khadem, O'Gorman, & Watters, 1985). In sum, although it is clear that the prognosis for children who suffer early brain damage is better than for adults, questions remain regarding the extent of neuroplasticity and the time course of language development in children with early brain damage. Thus, tracing language development in children with early unilateral strokes will inform our understanding of how and to what degree the developing brain responds flexibly to insult.

A previous cross-sectional study of narratives with 30 children with FL ages 4–10 and their TD peers (Reilly et al., 1998) found that, although the children with early brain damage scored somewhat lower than age matched typically developing children on all measures, they performed within the normal range by 7 years of age, and few site specific differences emerged. Regardless of lesion side or site, children with FL told shorter stories than the TD group and at the younger ages (4–6), the FL group made significantly more morphological errors than comparison children; errors decreased with age. With respect to syntactic complexity, although both groups used complex sentences more frequently at the older ages, the FL group used fewer types, as well as tokens, of complex sentences in their narratives. Overall, in the FL group, regardless of lesion site, we found an initial delay in morphosyntactic performance that evolved into the normal range by mid-elementary school. Thus, while certain brain areas may be optimally suited for language, as evidenced by the pervasiveness of left hemisphere dominance for language in adults, these data clearly demonstrate the enormous plasticity and flexibility of multiple areas of the developing brain to assume a broad range of productive language functions.

In striking contrast to the remarkable developmental trajectory evidenced by children with early brain damage, the protracted delay of language development in children with specific language impairment represents a challenge to the notion of developmental neuroplasticity. Unlike the FL group, recall that children with SLI have *no* frank neurological damage (Trauner, Wulfeck, Tallal, & Hesselink, 2000), and they are not mentally retarded. Yet their language performance is very poor, in many ways resembling that of aphasic adults, (Leonard, 1998 and Bishop, 1997 for reviews), without clear patterns of neurological dysfunction to account for such deficits. In the first study below, we consider plasticity through this additional lens and compare grammatical production in the narratives of children with FL and TD to that of age matched children with SLI.

In sum, the children with focal brain damage have clear and specified neurological impairments, but their behavioral development with respect to language, although initially delayed, shows remarkable development. In contrast, the language deficits of children with SLI have been well documented, but as yet, there are no clear neuro-developmental patterns to account for these behavioral profiles. Therefore, by contrasting narrative development in both these groups with their typically developing peers, we will peel away another layer to reveal an additional dimension of developing brain-behavior relationships, providing insights into the nature and constraints of neuroplasticity.

2.2. Study I: Method

2.2.1. Participants

A total of 169 children ranging in age from 3;11 to 12;10 years of age participated in this study. Children from two clinical groups, specific language impaired (SLI) and children with early unilateral focal brain lesions (FL) as well as a large group of typically developing children (TD) were included and all groups were matched on mean chronological age. Children in the study included 19 children with right hemisphere damage (RHD, ages: 4;1–12;9, $M = 7;3$); 33 children with left hemisphere damage (LHD, ages: 3;9–11;9, $M = 7;0$); 44 children with specific language impairment (ages: 3;11–12;10, $M = 8;0$); and 73 neurologically intact TD (ages: 4;0–12;10 $M = 7;6$). Analyses of variance confirmed that there were no significant age differences across the three groups. Diagnostic criteria for each population are described below.

Children with focal lesions. All of the children with brain injury have unilateral focal lesions that occurred before six months of age as indicated by MRI or CT scan. All insults are of pre- or perinatal origin, except for one child who suffered a head trauma at six months of age. A subset of the children have had seizures in the past; however, for all children in this study, with one exception, seizures have been medically controlled. Intelligence quotients as measured by WISC-R or WPPSI are in the normal range. Overall, this group represents an exceptionally well-defined and homogeneous focal lesion sample. Details of neurological involvement including lesion side, site, past seizure history as well as presence and extent of subcortical involvement are included in Appendix A.

Children with specific language impairment. The SLI group, recruited from area schools and clinics had a documented language impairment. Prior to inclusion in the present study, they underwent screening to insure that they met the following selection criteria: (1) performance IQ (PIQ) of 80 or higher on the WISC-R, WPPSI or Leiter non-verbal measures; (2) no major neurological abnormalities (determined by a neurological examination); (3) expressive language composite score 1.5 or more standard deviations below the mean using the CELF-R (Semel, Wiig, & Secord, 1987); and (4) absence of known developmental disorders such as mental retardation or autism.

Typically developing children. Seventy-three typically developing children were included. All children had IQs within the normal range with no history of developmental delay.

2.2.2. Procedure

In this narrative task, children were presented with the 24-page wordless picture book, *Frog, where are you*? (Mayer, 1969) and asked to tell the story to the experimenter. This storybook is about a boy and his dog, and their search for their missing pet frog. While searching for the frog, the boy and dog encounter various forest animals that in some way interfere with their search for the frog. After several of these encounters, the boy and dog eventually find the frog with a mate and a clutch of baby frogs. The story concludes as the boy and dog leave for home with one of the babies as their new pet frog. Because it contains no words and provides a fairly rich context for language production, this picture book has been used extensively in cross-linguistic work (Berman & Slobin, 1994) and across typically and atypically developing populations (Losh et al., 2001; Losh & Capps, in press; Reilly et al., 1998; Reilly et al., 1990; Tager-Flusberg, 1995). In addition to the series of temporally sequenced events, this task requires children to make inferences about characters' relationships, thoughts, feelings, and motivations throughout the story, thus integrating the local episodic elements with the more global search theme of the story.

Testing for all children began with a warm-up and then the presentation of the book and the introduction, "Here is a story about a boy, a frog and a dog. I want you to first look through the pictures, and then I want you tell me the story as you look through them again." The children's narratives were both audiotaped and videotaped, and both were used for transcription purposes. Utterance boundaries were determined by intonation contours as well as pause length. The CHAT format from the CHILDES system was used for transcription (MacWhinney, 2000). All transcriptions were checked by a second transcriber and agreement exceeded 90%.

2.2.3. Coding procedures

Our coding scheme was originally developed by Reilly et al. (1998) and was designed to assess: (1) grammatical competence, skill, and production; (2) aspects of narrative structure (both episodic and thematic); and (3) evaluative devices. Study I concerns only the first set of measures, those focusing on grammatical production. (Study II takes a broader perspective on narrative development and includes measures in all three narrative domains.)

Overall story length by number of propositions. Children's narratives vary significantly in length. Thus, stories were first coded for length as measured by number of propositions; a proposition is defined as a verb and its arguments. From a semantic perspective, a proposition corresponds roughly to a single event. Each clause in a complex sentence was considered to represent one event, and therefore, one proposition. For example, the utterance, "The boy was mad at the dog for breaking the jar," counted as two propositions, as would "The boy was mad at the dog; he broke the jar." In contrast, "He's trying to get out" was counted as one proposition. Again, to control for varying story lengths, the number of propositions in a story was used as a denominator for the more detailed explorations of linguistic performance below.

2.2.4. Measures of linguistic structure

To assess children's grammatical production, all morphological errors as well as all complex sentences were tallied and categorized.

Morphological errors. All errors of commission or omission were tallied. The resultant measure, *Frequency of Morphological Errors*, was calculated as a ratio of morphological errors to total number of propositions in the child's story. Subcategories of morphological errors are in Appendix B.

Complex syntax. Complex sentences are multiple propositions falling within a sentence intonation contour and included coordinate and subordinate complex sentences; passive constructions were also tallied. Categories and examples are in Appendix B. The number of individual complex sentences in a child's story were tallied and the total was divided by the number of propositions in that story to yield a proportion, the *Frequency of Complex Sentences*. In addition to the frequency with which a child used complex syntax, we were also interested in the types of complex syntax employed, so the number of different sentence types occurring in the child's story (categories 1–5 in Appendix B) were counted to yield a measure of *Syntactic Diversity*.

Reliability. A second coder who was blind to group status coded 25% of the narratives for reliability; agreement for all measures exceeded 90%.

2.3. Study I: Results and discussion

2.3.1. Plasticity and development

The development of linguistic and narrative skills was addressed through comparisons of morphosyntactic performance in narratives from children with early focal brain injury, children with specific language impairment, and typically developing children. To make the data more accessible to the reader, we have placed the details of the statistical analyses for Study I in Table 1, in which group and age group differences were explored through a series of 3×3 (group; FL, SLI, TD by age group; 4–6, 7–9, 10–12) analyses of variance. Follow-up analyses to explore specific group differences and age by group interactions were conducted using two-tailed t tests. Discussions in the text itself are limited to descriptions of significant findings. Details for each analysis (degrees of freedom, F and t values), and significance levels are presented in the Table.

Prior to conducting comparisons with other groups, we investigated whether children with left versus right hemisphere damage differed significantly on any of our measures. Consistent with our past cross-sectional findings with a smaller group, there were no significant differences between children with LHD and RHD on any linguistic measure. Therefore, all subsequent analyses including children with early focal brain injury are based on one large group of children, including both those with left and right hemisphere damage.

Story length. Story length varied across ages and groups, with SLI and FL groups telling shorter stories than typically developing children and in all groups the oldest children produce longer stories than those in the youngest group (see Fig. 1).

Because of variations in story length, the frequency of morphological errors and complex syntax were analyzed

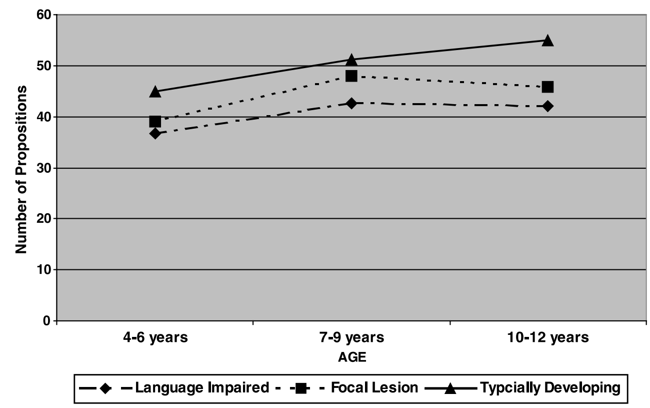

Fig. 1. Story length: FL, SLI, and TD.

Table 1
Study I statistical results for narrative length and morphosyntax in SLI, FL, and TD groups

Test/effect	Number of propositions	Proportion of morphological errors	Proportion of complex syntax	Mean syntactic diversity
Group × age				
ANOVA				
Group $F(2, 160)$	7.264***	24.013*****	26.838*****	18.877*****
Age $F(2, 160)$	5.614***	21.452*****	21.262*****	31.398*****
Group × age $F(4, 160)$	ns	4.956*****	ns	2.992*
Two-tailed t tests				
SLI vs. TD $t(115)$	−4.019*****		−6.572*****	
4–6 years $t(46)$		5.723*****		−6.672*****
7–9 years $t(40)$		5.147*****		−2.345*
10–12 years $t(25)$		3.077**		−2.114*
FL vs. TD $t(123)$	2.494*		5.628*****	
4–6 years $t(54)$		−3.734****		4.332*****
7–9 years $t(43)$		−3.141***		3.222****
10–12 years $t(22)$		ns	ns	
SLI vs. FL	ns		ns	
4–6 years $t(44)$		3.201***		−2.409*
7–9 years $t(23)$		2.326*		ns
10–12 years $t(23)$		ns		−2.109*

* $p < .05$.
** $p < .01$.
*** $p < .005$.
**** $p < .001$.
***** $p < .0005$.

as proportions of the total number of propositions in a story. This manipulation assured that these results were not affected by story length variation across groups. Means for all measures are presented in Appendix C.

Morphological errors. Overall, we found differences in performance for both group and age. In the youngest age group (4–6 years), both children with SLI and those with FL made more errors than the TD group. In addition, children with SLI made a greater proportion of errors than children with FL. A similar pattern emerged for the middle age range (7–9 years), with both diagnostic groups (SLI and FL) making a greater proportion of errors than controls. Again, children with SLI made more errors than the FL group. By the 10–12 age range, however, a different pattern emerged; although children with SLI continued to make more errors than the TD group, they no longer differed from children with FL. Moreover, children with FL no longer differed from TD. These relationships are illustrated in Fig. 2, which shows the proportion of morphological errors made by each group over time.

These data are consistent with our prior findings (Reilly et al., 1998), in which children with either right or left hemisphere damage performed equally poorly at the youngest age, and both improved significantly, such that they performed within the normal range by mid school age, demonstrating no effects of lesion site on morphological performance. In contrast, the children with SLI, who have NO frank neurological damage, at the younger age make *more* errors than the FL group until age ten. And they acquire the morphology of their language at a significantly depressed rate as compared to children with brain damage or typically developing controls, still not achieving morphological proficiency by age 12.

In spite of these differences in the rate at which English morphology is mastered, we should note here that for all populations, the *quality* of the errors is similar to those of typically developing children, as illustrated in Table 2 below.

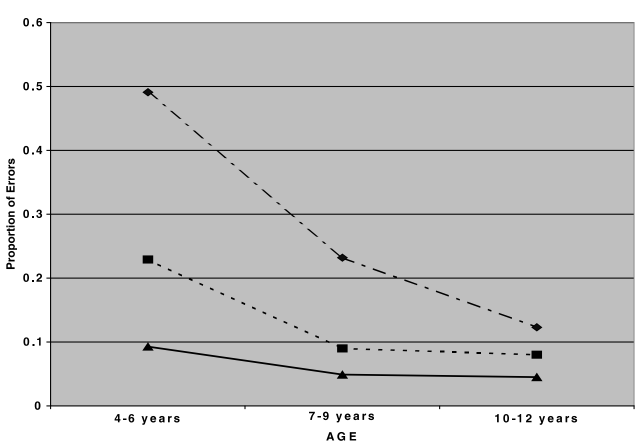

Fig. 2. Frequency of morphological errors: FL, SLI, and TD.

What can be concluded from these results is that the morphological development of these populations appears to differ *quantitatively* rather than *qualitatively*, that is, the kind of errors is similar, but the rate of acquisition is decidedly different (see also Leonard, Bortolini, Caselli, Mc Gregor, & Sabadini, 1992). We must also bear in mind that English is not rich morphologically and therefore the kinds of errors one might make are rather limited. To briefly summarize so far, with respect to morphological errors, all groups improve over time; RHD and LHD pattern together and perform similarly to typically developing controls by middle childhood; children with FL perform better than children with SLI overall and errors committed by both clinical groups are similar in kind to those made by normally developing children.

Complex syntax. As was the case with morphological performance, both group and age differences emerged, although no significant interaction was detected. Fig. 3 shows that the proportion of complex syntax increased with age in each group, and that both diagnostic groups lagged behind the TD group.

In addition to examining the frequency of complex sentences, we also assessed the number of different types of complex syntax (see Appendix B), and found both developmental and group differences, as well as a significant age by group interaction. In the 4–6 age range,

Table 2
Morphological errors

Group	Age	Example
FL	4;9	Then the boy **look** in his hat
	5;0	The dog jumped and **falled** down
	5;1	a girl **0** sleeping with a bunny
	6;0	he **get** out **0** his bowl
	6;8	The boy called **to** a hole
	11;11	They **0** yelling the frog's name
SLI	4.3	**0** frog **0** going to sleep with the dog
	4;4	The dog **get** in the bowl
	4;4	he **growl**
	6;4	The little boy **putted** his shirt on
	7;6	Then when they **woked** up in the morning they saw the frog was gone
	9;3	The frog is jumping out of the jar and the dog and the boy **is sleep**
	12.9	The dog and the boy are looking **on** the frog
TD	4;1	an' their dog was going to **broke** the glass while he was falling
	4;5	the boy **0** going for the frog
	4;6	an' then he **0** getting out when they're sleeping
	5;0	an' the little boy **felled** down
	5;4	an' then the dog **look** over an' the boy looked over
	6;11	then they **swummed** over to the side

both the SLI and FL groups used fewer types of complex syntax than TD, and children with SLI used fewer types than children with FL. In the middle age range, both children with FL and those with SLI continued to use a more restricted range of complex syntax than TD, however these two groups did not differ significantly from one another. In the 10–12 age range, children with FL performed within the normal range, although the SLI group continued to lag behind.

Unlike the morphological errors above, using complex sentences is a rhetorical choice the narrator makes when telling a story. It is grammatical, but perhaps less efficient to tell a story using a series of simple sentences and allowing the listener to infer the relations between the clauses. Developmentally, as was shown in Fig. 3, the older group of TD children uses complex sentences more frequently than their younger counterparts. Moreover, they increasingly use different types of complex sentences, with a decrease in the proportion of coordinate sentences and a concurrent increase in the use of subordination. The children with FL follow the normal trajectory, but at a slower rate, and at the oldest data point, their performance is within the normal range. Children with specific language impairment also show improvement over time, but do not reach normal performance, at least by age 12. The examples below in Table 3 provide an idea of how syntax differs across ages and across groups. The excerpts below are all taken from children's recounting the boy's search for the frog.

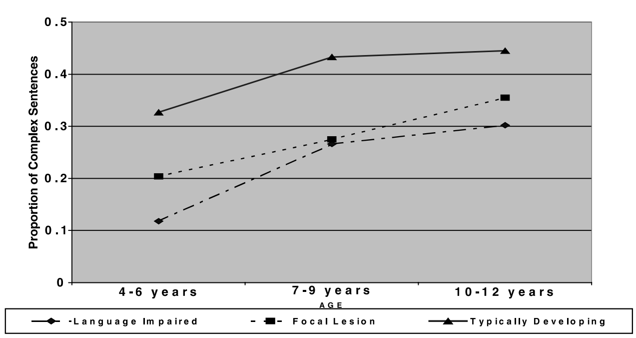

Fig. 3. Frequency of complex syntax: FL, SLI, and TD.

Overall, we found that all groups show increases in both frequency and type of complex syntax although at different rates. Finally, the pattern for syntactic development generally maps onto that of morphological development: FL perform better than SLI and both groups are delayed compared to typically developing children. However, by the end of elementary school, children with FL perform within the normal range, while children with SLI remain significantly delayed. What might account for this striking discrepancy in the acquisition of core aspects of language? And how might we explain the protracted delay witnessed in children with SLI as compared to the remarkable plasticity demonstrated by the progress of the children with FL? Although the children with unilateral brain damage have lesions of various dimensions and we do not know what additional ramifications an early lesion might have with respect to developing intra- and inter-hemispheric connections, it appears that the unaffected tissue has sufficient plasticity to assume the core language functions of morphology and syntax. That is, in spite of frank structural damage, the remaining tissue in the right or left hemisphere, can develop these core productive language functions relatively quickly. Moreover, from the patterns of development and the types of errors committed by the children, it appears that the process of acquiring language follows a similar route irrespective of the brain areas responsible for these language functions. In contrast, although the children with SLI have no frank lesions that are identifiable by MRI or CT scan (Trauner et al., 2000), there is a small and growing body of literature demonstrating subtle and possibly distributed neurological abnormalities (Jernigan, Hesselink, Sowell, & Tallal, 1991; Plante, 1996; Plante & Swisher, 1991). Thus, rather than structural lesions, as we see in the FL

Table 3
Complex syntax

FL	4;11	Then he called the frog an' he didn't hear him (Coordinate)
	6;0	The dog looks in the bowl for the frog and the boy looks in his boot (Coordinate)
	7;0	He's telling the dog to be quiet (Verb complement)
	10;11	While they lean out the window they're calling the frog's name (Adverbial)
SLI	6;1	He looked everywhere but he couldn't find his frog (Coordinate)
	7;6	The dog started to look for the frog (Verb Complement)
	10;9	He's trying to find the frog (Verb Complement)
	12;9	The deer picks the boy up by the antlers while the dog is looking for the frog (Adverbial)
TD	4;2	The boy is calling and the frog is hiding (Coordinate)
	4;3	He couldn't find him and he said "Froggie come back!" (Coordinate and Verb Complement)
	4;5	The boy is going to look for the frog (Verb Complement)
	7;0	While the dog is barking the kid is looking for the frog (Adverbial)
	7;3	He was trying to tell the dog to be quiet because his frog was in the log (Verb Complements and Adverbial)

group, we might characterize the children with SLI as suffering "functional" or "systemic" lesions. The resultant subtle and diffuse anomalies do not permit language acquisition as quickly or efficiently as the putatively "normal" non-affected cerebral tissue of the children with FL.

To broaden our perspective on developmental brain-behavior relations, in Study II below, we compare the stories from children with SLI to those of chronologically age matched children with Williams syndrome and their typically developing counterparts.

3. Study II: Language and cognition

At first glance, children with Williams syndrome present a reciprocally opposing profile to children with SLI. As noted earlier, the children with SLI have normal intelligence (all PIQs are 80 or above), but have language scores significantly below their cognitive levels (CELF scores are at least 1.5 *SD* below the mean). In contrast, children with Williams meet diagnostic criteria for a particular genetically based syndrome [e.g., a specific heart defect, distinctive facial features, as well as a genetic marker: absence of one copy of the gene for elastin and about 20 others on chromosome 7 (Korenberg et al., 2000)] and display a distinct behavioral phenotype (Bellugi, Lichtenberger, Jones, & Lai, 2000; Bellugi, Lichtenberger, Mills, Galaburda, & Korenberg, 1999). Children with WMS also differ from those with SLI in that they are typically mildly to moderately retarded (mean IQ is 55, with a range rarely reaching above 80). However the expressive language of adolescents and adults with WMS is remarkably preserved when contrasted with other genetic syndromes involving mental retardation, e.g., Down Syndrome. In addition to their better than expected productive language skills, individuals with WMS exhibit an extremely social and outgoing nature/personality (Bellugi, Adolphs, Cassady, & Chiles, 1999; Jones et al., 2000). Thus, in comparing the narratives from children with WMS and children with SLI (and the TD group), Study II addresses the question of the relationships of language and other aspects of general intellectual functioning by comparing not only the linguistic abilities of children with Williams syndrome, specific language impairment, and typically developing children, but also those facets of narratives that are more cognitively mediated, such as drawing inferences and integrating individual or local story episodes with the overarching theme. Finally, given the unusual social nature of individuals with WMS, we also investigate the social aspects of narratives. Specifically, we look at what we have called social evaluation (Losh et al., 2001), that is, those elements of story-telling that are intended to attract and maintain the attention of the audience.

3.1. Study II: Method

3.1.1. Participants

Thirty-six children with WMS ranging from 4;9 through 12;9 years ($M = 8.6$) were included in this study. Mean full scale IQ of individuals with WMS is 55, which is in the mild to moderate mentally retarded range. Children with WMS were selected as a contrast group to children who have SLI since the two groups broadly demonstrate contrasting behavioral profiles in the relation of language to general intellectual functioning. Participants with WMS were identified on the basis of established diagnostic criteria, including distinctive facies, a specific heart defect, mental retardation, and absence of one copy of the gene for elastin on chromosome 7 (Bellugi et al., 1999; Bellugi, Lai, & Korenberg, 2000; Bellugi, Lai, & Wang, 1997; Bellugi et al., 2000; Bellugi & St. George, 2000; Bellugi & Wang, 1999).

Children with specific language impairment. The same 44 children with SLI in Study I and the same 73 typically developing children as in Study I.

3.1.2. Procedure

The procedures and coding in this second study were identical to those of Study I. However to address cognitive and social aspects of narratives, we additionally assessed narrative structure and use of evaluation.

3.1.3. Measures of linguistic structure

Identical to those in Study I.

3.1.4. Measures of narrative performance

Following Bamberg and Marchman (1990) and Reilly et al. (1998), we examined whether children included basic components of the story. Specifically, whether children mentioned the setting and instantiation (i.e., the frog escapes), the five main search episodes, and the story's resolution (i.e., boy finds the frog) was recorded, producing a score ranging from 0 to 8. In addition, we examined the extent to which children were able to establish and maintain the story's "search" theme. Children were assigned a score ranging from 0 to 4, based on whether the child mentioned that the frog was missing and that the boy was searching for him (0–2) as well as whether the theme was reiterated throughout the story (0, no additional mentions; 1, one or two additional mentions; 2, multiple additional mentions).

3.1.5. Measures of evaluation

Stories were also coded for evaluation, i.e., those elements not directly evident within the picture book, but rather those which represent the narrator's interpretation of events (Bamberg & Reilly, 1996). Narrators use evaluative devices to build suspense and establish the point of the story (e.g., Goffman, 1974; Labov &

Waletzky, 1967) and maintain audience interest and involvement. Adapted from Reilly et al. (1998), our coding scheme is provided in Appendix B.

Summing across all exemplars of the subcategories for each child, a total score for *Frequency of Evaluation* was obtained. As with the previous measures, in the case that the groups' stories differed significantly in length, evaluation scores were analyzed as a proportion of the total number of propositions. In addition, the range of evaluative devices in the child's narrative was tallied in order to obtain a score for *Evaluative Diversity*.

3.2. Study II: Results and discussion

As for Study I, means and standard deviations are available for all measures in Appendix C, and details of the statistical results are in Tables 4 and 5.

3.2.1. Measures of linguistic structure

Story length: Number of propositions. As in Study I, significant group and age differences were detected in the length of children's stories (see Fig. 4). Children with SLI produced shorter stories than typically developing children overall, and children with WMS produced shorter stories than comparison children at the younger ages, resulting in a marginally significant difference. Story length can be viewed as an index of quantity of talk and, from age seven upward, children with WMS tended to produce stories comparable in length to those of typically developing children, consistent with observations that language is a relative strength for individuals with WMS. Talking per se appears to be a more effortful task for the children with SLI than for either the TD group or older children with WMS.

Morphological errors. As can be seen in Fig. 5, both the SLI and WMS groups made more errors than comparison children and it is only in the youngest group that children with SLI make more errors than those with WMS.

Complex syntax. Overall, both the SLI and WMS groups produced fewer complex sentences than the TD group and all groups used more complex syntax at older ages than younger ages as seen in Fig. 6.

To complement this measure of frequency, we also looked at the diversity of complex syntax and found that while children with SLI produced significantly fewer types of complex syntax than the TD group at all ages, as seen previously, by the 10th year, children with WMS produced a comparable range of complex syntactic devices to the TD group.

Perhaps the most striking finding to emerge from analyses of children's morphosyntactic abilities concerns the similarity in the quantitative profiles of children with SLI or WMS as compared to typically developing children. In spite of their cognitive impairments, children

Table 4
Study II statistical results for narrative length and morphosyntax in SLI, WMS, and TD groups

Test/effect	Number of propositions	Proportion of morphological errors	Proportion of complex syntax	Syntactic diversity
Group × age				
ANOVA				
Group $F(2, 144)$	6.89***	24.929*****	39.743*****	25.285*****
Age $F(2, 144)$	8.785*****	11.407*****	23.211*****	26.143*****
Group × age $F(4, 144)$	ns	5.751*****	ns	2.703*
Two-tailed t tests				
SLI vs. TD $t(115)$	−4.019*****		−6.572*****	
4–6 years $t(46)$		5.723*****		−6.704*****
7–9 years $t(40)$		5.147*****		−3.345*
10–12 years $t(25)$		3.077**		−2.114*
WMS vs.TD $t(107)$	1.966+		6.599*****	
4–6 years $t(36)$		−3.274***		5.106****
7–9 years $t(45)$		−7.402*****		4.538*****
10–12 years $t(22)$		−2.306*		ns
SLI vs.WMS $t(78)$	ns		ns	
4–6 years $t(26)$		2.075*		ns
7–9 years $t(25)$		ns		ns
10–12 years $t(23)$		ns		ns

+ $p = .05$.
* $p < .05$.
** $p < .01$.
*** $p < .005$.
**** $p < .001$.
***** $p < .0005$.

Table 5
Statistical results for evaluation and narrative structure and complexity in SLI, WMS, and TD groups

Test/effect	Number of story components	Thematic maintenance	Proportion of evaluation	Evaluative diversity	Social engagement devices	Cognitive inferences
Group × age ANOVA						
Group $F(2, 144)$	42.569*****	19.019*****	24.716*****	10.251*****	28.806*****	20.034*****
Age $F(2, 144)$	53.492*****	8.463*****	*ns*	6.181***	9.08*****	8.932*****
Group × age $F(4, 144)$	4.224***	ns		ns	ns	2.641***
Two-tailed t tests						
SLI vs.TD $t(115)$		ns	−3.784*****	−4.278*****	3.13***	
4–6 years $t(46)$	−5.137*****					ns
7–9 years $t(40)$	−4.31*****					ns
10–12 years $t(25)$	ns					ns
WMS vs.TD $t(107)$		6.232*****	−4.794*****	ns	−7.631*****	
4–6 years $t(36)$	7.343*****					4.48*****
7–9 years $t(45)$	7.654*****					7.888*****
10–12 years $t(22)$	4.203*****					ns
SLI vs.WMS $t(78)$		3.261***	−6.219*****	−3.864*****	−3.557****	
4–6 years $t(26)$	ns					2.658*
7–9 years $t(25)$	2.344*					6.252*****
10–12 years $t(23)$	2.119*					ns

* $p < .05$.
** $p < .01$.
*** $p < .005$.
**** $p < .001$.
***** $p < .0005$.

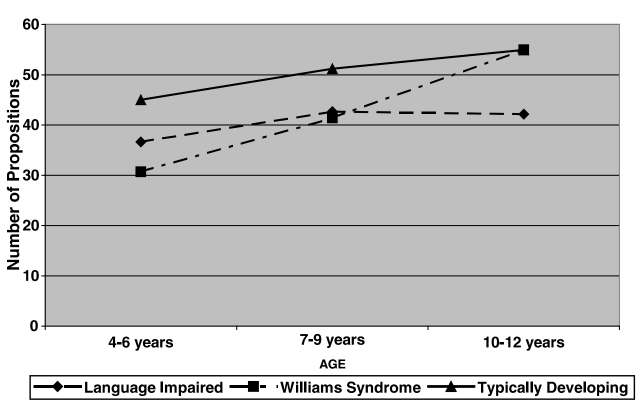

Fig. 4. Story length: WMS, SLI, and TD.

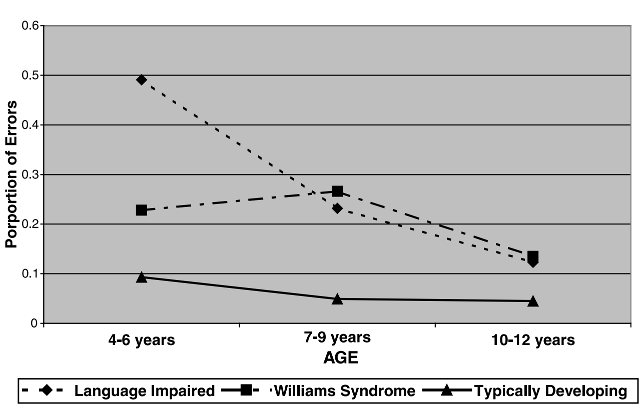

Fig. 5. Frequency of morphological errors: WMS, SLI, and TD.

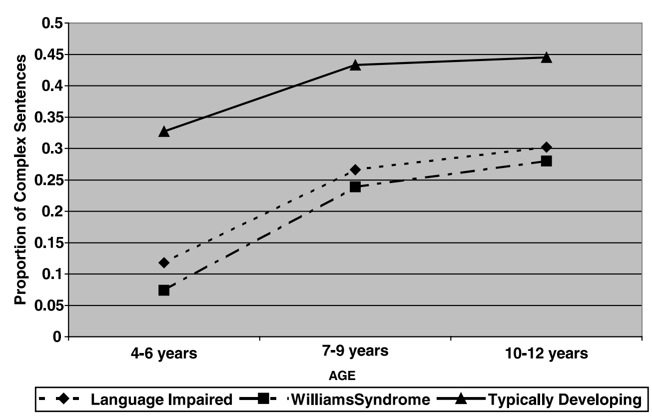

Fig. 6. Frequency of complex syntax: WMS, SLI, and TD.

with WMS appear to master the morphology of English at about the same rate and reflecting similar patterns of errors (e.g., determiners, pronouns, and verb tense) as do children who are specifically language impaired, but who are not mentally retarded. In addition, the use of complex syntax of the two groups follows the same general pattern. With age, both groups deploy complex syntactic structures more frequently. And, although children with SLI consistently produce fewer types of complex syntax than comparison children at all ages, children with WMS approach a repertoire of complex syntactic devices similar to the TD group by the 10–12 age range.

That morphosyntactic development in these two atypical populations, only one of which involves mental retardation, is similar has implications for how cognition, and specifically core structural aspects of language, might be organized. These data suggest that mental retardation per se cannot explain the slowed morphosyntactic performance in children with WMS as these children's performance closely paralleled that of children with SLI who are not retarded, implying that morphology and syntax may develop in the context of general intellectual impairment and perhaps somewhat independently of general cognitive abilities.

3.2.2. Narrative measures

To examine the episodic and thematic structure of children's stories, we first compared the number of story components included in their narratives and found both developmental and group differences. At the youngest ages both children with SLI and those with WMS included fewer story components than the TD group; at the 7–9 age range, children with SLI included fewer components than the TD group, but more than children with WMS. By the oldest age group, the SLI group performed comparably to comparison children, whereas the WMS group persistently performed worse than both groups.

With respect to children's ability to thematically integrate their narratives, the SLI group was as likely to establish and maintain the story's theme as typically developing children, and those with WMS had more difficulty with this aspect of storytelling than both the TD and SLI groups. Thus, while all children improved with age, children with SLI clustered with the TD group from early in development; both groups showed a significant advantage over children with WMS for integrating the narrative's theme. As expected, analyses of these more cognitively based aspects of narrative performance indicated that, despite initial delay, children with SLI perform more like their age matched peers, whereas children with WMS score persistently and significantly lower on cognitive measures of both structural and thematic narrative measures. To provide an idea of how their stories differ with respect to their abilities to link and integrate aspects of the narrative, in spite of their similar morphosyntactic profiles, below in Table 6, are some examples of descriptions from age matched children with SLI, WMS and TD (see Picture 1).

In spite of their developing proficiency with linguistic forms as demonstrated above, the cognitive deficits of the WMS children are reflected in their lack of reference to the goals and motivation of the protagonist (to find the frog) and their inability to relate the boy's individual behaviors to his quest. That is, while the TD group and those with SLI tended to embed each episode within the

Picture 1. Mayer (1969). Adult: "The boy is calling for the frog while the dog jumps at the beehive."

Table 6
Establishing the story's "Search theme"

Group	Age	Example
SLI	7;4	The boy looking for the frog and his dog tries to get honey.
	7;6	The dog looked into the beehive to see if the frog was in there.
	9;6	The dog is trying for the bees and the boy's looking for the frog.
	9;11	So they went and searched for the frog and they found some bees nearby.
WMS	7;11	And then all of a sudden the dog finds some bees flying.
	9;5	The beehive is down and the bees are all over him and the boy is sitting down.
	9;10	So many bees! The boy said "Ow! Somebody stung me!"
	9;11	I think that the beehive may fall onto the boy.
TD	7;0	The dog knocked down the hive and the little boy went looking in the tree for the frog.
	8;2	They looked in the beehive and in the hole but could not find the frog.
	9;8	The boy started calling for the frog and the dog was barking at the bees.
	9;10	The boy stuck his head in a hole, looking for the frog, while the dog was barking at some bees.

thematic framework of the story, the stories from children with WMS often lacked this integrative quality. Rather, children with WMS tended to focus on elaborate descriptions of individual episodes, often failing to establish ties between episodic and thematic narrative elements. These contrasting profiles of the WMS group and the SLI group, regarding the development of morphosyntactic forms and their recruitment to elaborate the theme in relation to the unfolding story, suggest an underlying dissociation between the acquisition of linguistic forms and their use to convey and integrate thematic content.

3.2.3. Evaluation

In comparing the use of evaluative devices overall, we found robust group differences, but no age effect, indicating that children with WMS employed a significantly greater amount of evaluation than either the TD or SLI groups (see Fig. 7).

We also examined the diversity of evaluative devices and found that children with SLI recruited a more restricted range of evaluative devices than both the TD and WMS groups; the WMS performed comparably to the comparison children. Thus, children with SLI and those with WMS demonstrate quite distinct profiles of narrative enrichment through the use of evaluation. Specifically, whereas the WMS group either matched or surpassed comparison children in the frequency and diversity of evaluation, the SLI group consistently lagged behind both groups.

To further explore the functions of evaluation within each group, analyses of two main types of evaluation hypothesized to distinguish groups (social engagement devices and cognitive inferences) were conducted. Because groups differed in the overall proportion of evaluation included, the use of cognitive inferences and social engagement devices were analyzed as proportions (e.g., the number of social engagement devices was divided by the number of evaluative clauses to create a proportion of social engagement devices).

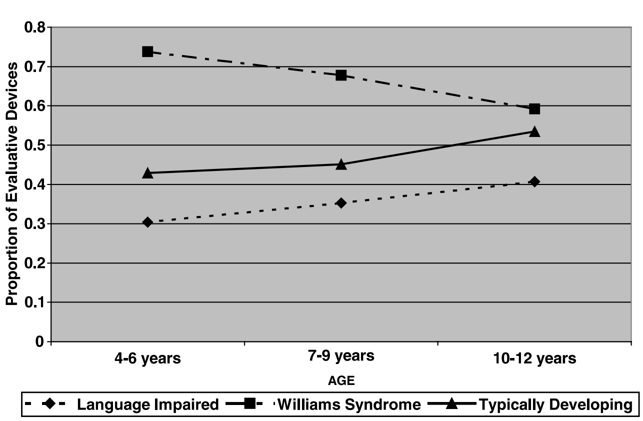

Fig. 7. Frequency of evaluation: WMS, SLI, and TD.

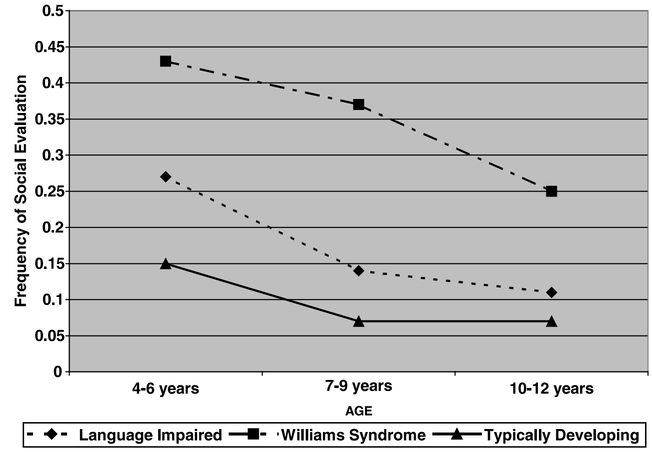

Fig. 8. Frequency of social evaluation: WMS, SLI, and TD.

Social engagement devices. As illustrated in Fig. 8, we found that children with WMS used a greater proportion of social engagement devices than the TD group and children with SLI. Furthermore, children with SLI included a greater proportion of social engagement devices than typically developing children, with an overall relative decrease in frequency in the older group.

Cognitive inferences. Investigations of children's use of cognitive inferences revealed that in the youngest age group, children with WMS used fewer cognitive inferences than typical participants and children with SLI, who did not differ from comparison children. This profile holds for the middle group as well. However, by the oldest age, the three groups no longer differed. Overall, both the SLI and WMS groups demonstrated a sharp increase with age in the proportion of cognitive inferences, while normal comparison children's use of these devices remained fairly stable.

An important function of evaluation involves maintaining audience interest and involvement by enriching the story through dramatization techniques which capture and maintain attention (e.g., affective prosody, use of character voice, emphatics, etc.). In line with prior studies (Jones et al., 2000; Losh et al., 2001; Reilly, Bernicot, Vicari, LaCroix, & Bellugi, in press; Reilly et al., 1990), findings of elaborate and extreme use of such devices among children with WMS appear to reflect one of the phenotypic aspects of this neurodevelopmental disorder, i.e., a highly social nature. The WMS group's increased reliance on evaluation relative to children with SLI or TD *throughout school-age*, and their abundant use of *social* evaluation in particular (see Table 7), is consistent with reports of extreme sociability commonly associated with this population (see Picture 2).

In sum, in spite of the similar profiles that children with WMS and SLI exhibit in productive morphology and syntax, with respect to both cognitive and social components of narrative ability, the two clinical groups display differential narrative profiles. Children with SLI,

Table 7
The use of evaluation in the resolution of the story

Group	Age	Example
SLI	9;3	They found a family of frogs. That's it.
	10;4	And the boy and the dog are **happy** and the boy gots a frog.
	10;9	They take one of the babies and go.
WMS	9;0	And he said "**Hey frogs**, **we're all together!**" The end! **That was great wasn't it?**
	10;0	Here's the frog and he's in **love**! And he says "**Hooray! Hooray! Hooray! I found my froggie!**" And then he says "**Byeeee**!"
	10;9	And they found the frog and they lived **happily ever after**.
TD	9;6	And then the boy took the frog and said **goodbye** to the other ones. That's it.
	9;8	**I guess** the one frog is his **so** he gets one of the frogs and that's it.
	10;0	And the family **lets** the boy have a little frog and they say **goodbye**.

Picture 2. Mayer (1969). Adult: "A happy ending, the boy, the frog and the frog family say good-bye."

although initially delayed, generally group with typically developing children on measures of narrative structure which implicate inferencing and integrative abilities, whereas the lower performance of children with WMS in this domain reflects their general intellectual impairment. With respect to the social aspects of narratives, i.e., social evaluation, children with WMS far outstrip both those with SLI and typically developing children, again reflecting the characteristic sociability of people with WMS and their skill and propensity to use language for social purposes.

4. Overall discussion and conclusion

In these studies of narrative development we have compared several groups of school-aged children as a means to reveal new insights into brain–language relationships. Our findings have been somewhat unexpected and together now allow us to return to our original three issues:

1. *The nature and extent of neuroplasticity in the developing brain*. In Study I we saw that by age 10, children with early focal brain injury performed within the normal range. In contrast, children with SLI performed below the TD group at all ages on morphosyntactic measures; moreover, they did not demonstrate the rapid improvement observed in the FL group. Examining these profiles, it becomes clear that children with FL are acquiring language by recruiting many areas of the brain. And from our data, it appears that the putatively normal remaining cerebral tissue of the children with FL can assume the responsibility for learning a language. In spite of the fact that more than 95% of adults are left hemisphere dominant for language, our data make clear that multiple areas of the brain can, if

necessary, assume language functions. Nonetheless, the significant and persistent delay evidenced by the children with SLI suggests that in order to acquire language structures, there must be sufficient unaffected areas to adopt responsibility for this system. Further, a frank unilateral structural lesion does not inhibit the language learning process to anywhere near the same extent as the diffuse and 'systemic' lesions of the children with SLI.

2. *The role of general intellectual impairment in the process of language acquisition and narrative development.* From Study II, we have seen that quantitatively, the children with WMS (who have significant cognitive impairment) are acquiring the morphology and syntax of English at a comparable rate to the children with SLI (who are not retarded). However, in comparing these groups on narrative measures which tap cognitive inferencing skills, (e.g., story structure, theme), the SLI group, quickly achieves developmentally appropriate levels of performance, whereas the WMS group is consistently delayed relative to both the SLI and TD groups.

In spite of these divergent profiles, groups performed similarly on structural linguistic measures, and children with WMS surpassed the SLI group in their ability to produce elaborated and socially engaging narratives. Later language development is thought to be an increasing proficiency with a broader repertoire of structures and an increasing fluency in different discourse genres. What we see in the WMS group is an increase in morphology and syntactic structures without the parallel development of acquiring the cognitive aspects and subtleties of this particular genre. Rather, children with WMS tend to exploit their linguistic resources to involve and engage their interlocutors. In contrast, the children with SLI are able to convey the critical aspects of narrative, yet they continue to show deficits in the linguistic structures that would articulate these relations and inferences, critical to a good story. Thus, whereas linguistic development is indeed slower than normal in the WMS children, and is similar to the trajectory of the SLI group, in both groups it appears that language is developing somewhat independently of other cognitive abilities: for the group with WMS, it is a relative strength compared to other cognitive functions and for those with SLI an area of vulnerability. On the other hand, the lack of integration and inferencing in the stories from the WMS group, as compared to the SLI group, reflects a weakness that may well be linked to their lower overall IQs. So, although mental retardation may impede the process of morphosyntactic development, it does not necessarily inhibit the final levels of performance, nor from these data does it appear to change its basic course of development. However, these data suggest that cognitive impairments do significantly affect skills necessary to a good narrative, e.g., extracting and maintaining the theme of the story and using language to convey these more complex aspects of discourse.

3. *The nature of the language acquisition process.* One striking development that emerged from our data from both Studies I and II is that in all groups of children that we studied, (TD, WMS, SLI, and FL), the types of morphological errors in their stories were quite similar. That is, errors of omission and commission found in the stories of SLI, WMS, and FL groups were of the same categories as those found in the stories of younger typically developing children. Moreover, the types of syntactic structures, as well as the frequency of recruiting such structures, increased with age for each of the groups. In addition, younger children in each group used more coordinate sentences than complex sentences with subordinate clauses, whereas in the middle and older groups the proportion of subordinate structures outstripped coordinates. Thus, even internal developmental patterns were consistent across groups. In sum, the process of acquiring language, at least for English, appears to be robust and somewhat rigid. We can tentatively conclude from these measures that it is the speed, rather than the nature, of the process that seems to differ across groups. What is perhaps most extraordinary is that the children in these groups come to the language learning task with very different brain structures and organizations, nonetheless, the acquisition of the morphology and syntax of English appears to follow a similar path. Although the process appears to be robust, the neurological and cognitive differences in our groups suggest that language learning can be mediated by a variety of neural substrates and that different factors underlie the linguistic abilities of each group.

Narratives are complex tasks that draw on a range of linguistic, cognitive and social abilities, and in our studies, each population responded differentially to specific aspects of the challenge that narratives represent. None of the experimental groups matches the "gold standard" provided by controls, yet the patterns evidenced in each of our groups which are consistent with their neurobehavioral profiles of strengths and vulnerabilities, have provided additional lenses into the nature of the language acquisition process and its neural underpinnings.

Acknowledgments

The research reported here was supported in part by funding from NIH-NINDS Grant P50 NS22343 and NIDCD PO1 1289. We thank the children and parents who participated in this study.

Appendix A. Children with focal brain damage

Neurological profiles				
Id	Lesion side	Lesion site	Subcortical involvement	History of seizures
1	LHD	T-P-O-F	Yes	Yes
2	LHD	F-T-P-O	Yes	No
3	LHD	T	Yes	No
4	RHD	T-P	Yes	Yes
5	RHD	F-T-P	Yes	No
6	RHD	P	Yes	No
7	LHD	F	Yes	Yes
8	LHD	F	Yes	No
9	LHD	O-P	Yes	No
10	RHD	F	Yes	No
11	LHD	P-T-F	Yes	No
12	LHD	T	Yes	No
13	LHD	P-T-F	Yes	Yes
14	LHD	F	Yes	No
15	RHD	F-T-P-O	Yes	Yes
16	LHD	P	Yes	No
17	LHD	P-T	Yes	Yes
18	LHD	T-P-O	Yes	No
19	RHD	T-P	Yes	No
20	LHD	F-P-T-O	Yes	Yes
21	LHD	F-P-T	Yes	No
22	LHD	F	Yes	No
23	RHD	F-T-P-O	Yes	No
24	LHD	Subcortical Only	Yes	No
25	LHD	T-P-O	Yes	Yes
26	RHD	P	Yes	Yes
27	RHD	F	No	No
28	LHD	F	Yes	No
29	LHD	P-O	No	No
30	LHD	F-T-P-O	Yes	Yes
31	RHD	P-F-T-O	Yes	Yes
32	RHD	T-P	Yes	No
33	LHD	T-F-P-O	Yes	No
34	RHD	?	?	?
35	LHD	F-T-P-O	Yes	Yes
36	RHD	F-P-T	Yes	Yes
37	LHD	P	Yes	No
38	RHD	F-P	Yes	No
39	RHD	P	Yes	Yes
40	LHD	Subcortical only	Yes	Yes
41	LHD	P	Yes	Yes
42	LHD	Subcortical only	Yes	Yes
43	LHD	P-T-O	?	Yes
44	RHD	Subcortical only	Yes	No
45	LHD	Subcortical only	Yes	No
46	LHD	F	?	Yes
47	LHD	T-P-O	Yes	Yes
48	RHD	Subcortical only	No	Yes
49	RHD	P-T-F	Yes	No
50	RHD	F	Yes	Yes

Appendix A. (*continued*)

Neurological profiles				
Id	Lesion side	Lesion site	Subcortical involvement	History of seizures
51	LHD	O-P	?	?
52	LHD	Subcortical only	Yes	Yes

LHD, left hemisphere damage; RHD, right hemisphere damage; f, frontal lobe involvement; T, temporal lobe involvement; P, parietal lobe involvement; and O, occipital lobe involvement.

Appendix B. Coding conventions

B.1. Coding of morphological errors

1. Errors in pronouns (e.g., 'him lost it');
2. Verb auxiliaries ('they 0 hollering at him or they was hollering');
3. Determiners ('0 dog run faster than the bee');
4. Noun plurals, ('he found lotsa frog 0');
5. Verb tense ('he fall down in there');
6. Number marking ('he have his horns stickin' up'); and
7. Prepositional errors ('he's lookin' up those woods')

B.2. Coding of complex syntax

1. Coordinate sentences (*and*, *or*, *or but*), e.g., 'The boy is on the deer and the dog is running along side';
2. Adverbial clauses (*when*, *where*, *since*, *because*, *if*, *then*, *and so*), e.g., 'While the boy was sleeping, the frog snuck out';
3. Verb complements (*say (that)+S*, *try+V*, *start+V*, *keep+V*, *want+V/S*) as in 'He kept looking for his frog';
4. Relative clauses, e.g., 'The boy was calling for the frog that was lost';
5. Passive sentences, both full, 'the dog's being chased by bees' and 'got' passives 'he got throwed in the water.'

B.3. Coding of evaluation

1. Cognitive inferences, e.g., inferences of character motivation, causality, and mental states, as in "The boy turned around and accidentally pushed his dog off" or "He thinks the frog might be under the log".
2. Social engagement devices: using phrases or exclamations to capture addressee attention, e.g. sound effects, character speech, and audience hookers, as in "The boy's telling the dog Be quiet!" or "Look at the cute little doggy!"
3. References to affective states or behaviors, as in "He was crying".
4. Intensifiers included repetition, as in "He looked and looked for the frog" and Emphatic Markers as in "The boy was very tired".
5. Hedges indicating a level of certainty/uncertainty, as in "He probably is/might be/maybe is in the hole".

Appendix C. Means and standard deviations for all measures and populations

Narrative length and morphosyntax across populations and age groups (means, with standard deviations below).

Appendix C. (*continued*)

	FL Group			SLI Group			WMS Group			TD Group		
	4–6 years ($n = 27$)	7–9 years ($n = 14$)	10–12 years ($n = 11$)	4–6 years ($n = 19$)	7–9 years ($n = 11$)	10–12 years ($n = 14$)	4–6 years ($n = 9$)	7–9 years ($n = 16$)	10–12 years ($n = 11$)	4–6 years ($n = 29$)	7–9 years ($n = 31$)	10–12 years ($n = 13$)
No. propositions	39.11	48.07	45.82	36.63	42.64	42.14	30.67	41.38	55.00	45.03	51.19	54.92
	14.34	*21.82*	*8.95*	*11.29*	*12.25*	*11.28*	*15.41*	*12.57*	*30.72*	*14.11*	*10.86*	*12.16*
% Morph. errors	.23	.09	.08	.49	.23	.12	.23	.26	.14	.09	.05	.05
	.18	*.08*	*.06*	*.36*	*.19*	*.08*	*.13*	*.16*	*.13*	*.07*	*.03*	*.04*
% Complex syn.	.20	.28	.36	.12	.27	.30	.07	.24	.28	.33	.43	.45
	.11	*.14*	*.10*	*.12*	*.11*	*.15*	*.09*	*.09*	*.13*	*.12*	*.12*	*.17*
Syn. diversity	2.19	2.86	4.09	1.47	2.91	3.14	1.33	2.56	3.40	3.28	3.65	4.00
	1.0	*.66*	*.94*	*.96*	*1.14*	*1.23*	*1.32*	*.72*	*1.2*	*.88*	*.80*	*.82*

Study II measures of evaluation and narrative structure across populations and age groups (means, with standard deviations below)

	SLI group			WMS group			TD group		
	4–6 years	7–9 years	10–12 years	4–6 years	7–9 years	10–12 years	4–6 years	7–9 years	10–12 years
% Evaluation	.30	.35	.41	.74	.68	.59	.43	.45	.54
	.15	*.15*	*.12*	*.33*	*.29*	*.31*	*.18*	*.12*	*.15*
% Social eval.	.27	.14	.11	.43	.37	.25	.15	.07	.07
	.20	*.12*	*.12*	*.27*	*.18*	*.18*	*.15*	*.05*	*.08*
No. story	4.15	6.54	7.14	3.11	5.56	6.27	6.48	7.52	7.69
	2.06	*.82*	*.94*	*1.53*	*1.21*	*1.10*	*1.09*	*.57*	*.48*
No. search	2.78	3.72	3.78	1.77	2.18	2.81	3.24	3.90	3.92
	1.75	*.64*	*.42*	*1.56*	*1.42*	*1.32*	*1.18*	*.30*	*.07*

References

Anderson, D. (1998). *Language impairment: Morpho-syntactic development and its neurological correlates*. Unpublished doctoral dissertation, Joint Program in Clinical Psychology at San Diego State University, University of California, San Diego.

Appleby, A. (1978). *The child's concept of story*. Chicago: University of Chicago Press.

Bamberg, M. (1987). *The acquisition of narratives*. Berlin: Mouton de Gruyter.

Bamberg, M., & Damrad-Frye, R. (1991). On the ability to provide evaluative comments: Further explorations of children's narrative competencies. *Journal of Child Language, 18*(3), 689–710.

Bamberg, M., & Marchman, V. (1990). What holds a narrative together. The linguistic encoding of episode boundaries. *Papers in Pragmatics, 4*, 58–121.

Bamberg, M., & Reilly, J. S. (1996). Emotion, Narrative and Affect. In D. I. Slobin, J. Gerhardt, A. Kyratzis, & J. Guo (Eds.), *Social interaction, social context and language. Essays in honor of Susan Ervin-Tripp*. Norwood, NJ: Erlbaum.

Basser, L. (1962). Hemiplegia of early onset and the faculty of speech with special reference to the effects of hemispherectomy. *Brain, 85*, 427–460.

Bates, E., Reilly, J., Wulfeck, B., Dronkers, N., Opie, M., Fenson, J., Kriz, S., Jeffries, R., Miller, L., & Herbst, K. (2001). Differential effects of unilateral lesions on language production in children and adults. *Brain and Language, 79*, 223–265.

Bates, E., Thal, D., Fenson, J., Aram, D., Eisele, J., & Nass, R. (1997). From first words to grammar in children with focal brain injury. *Developmental Neuropsychology, 13*(3), 275–343.

Bates, E., Vicari, S., & Trauner, D. (1999). Neural mediation of language development: Perspectives from lesion studies of infants and children. In H. Tager-Flusberg et al. (Eds.), *Neruodevelopmental disorders* (pp. 533–581). Cambridge, MA: MIT Press.

Bellugi, U., Adolphs, R., Cassady, C., & Chiles, M. (1999). Towards the neural basis for hypersociability in a genetic syndrome. *NeuroReport, 10*, 1653–1657.

Bellugi, U., Lai, Z. C., & Korenberg, J. (2000). Genes, brains and behavior: What genetic disorders reveal about behavior. In E. Bizzi, P. Calissano, & V. Volterra (Eds.), *Frontiere della Biologia Vol. 4: The brain of Homo sapiens* (pp. 127–135). Rome, Italy: Istituto della Enciclopedia Italiana.

Bellugi, U., Lai, Z.C., & Wang, P. (1997). Language, communication and neural systems in Williams syndrome. In: T. Dolan (Ed.), Communication processes in children with developmental disabilities [Special issue]. *Mental retardation and developmental disabilities research reviews 4*,(3), 334–342.

Bellugi, U., Lichtenberger, L., Jones, W., Lai, Z., & St. George, M. (2000). The neurocognitive profile of Williams syndrome: A complex pattern of strengths and weaknesses. In: U. Bellugi, & M. St. George (Eds.), Linking cognitive neuroscience and molecular genetics: New perspectives from Williams syndrome [Special issue]. *Journal of Cognitive Neuroscience 12*,(1), 1–29.

Bellugi, U., Lichtenberger, L., Mills, D., Galaburda, A., & Korenberg, J. R. (1999). Bridging cognition, brain and molecular genetics: Evidence from Williams syndrome. *Trends in Neurosciences, 5*, 197–208.

Bellugi, U., & St. George, M., (Eds.) (2000). Linking cognitive neuroscience and molecular genetics: New perspectives from Williams syndrome [Special issue]. *Journal of Cognitive Neurosciences 12*,(1), 1–107.

Bellugi, U., & Wang, P. P. (1999). Williams syndrome: From cognition to brain to gene. In G. Adelman, & B. H. Smith (Eds.), *Encyclopedia of Neuroscience* (pp. 2163–2165). Amsterdam, New York: Elsevier.

Berman, R., & Slobin, D. I. (1994). *Relating events in narrative: A crosslinguistic developmental study*. Hillsdale, NJ: Erlbaum.

Bishop, D. (1993). Language development after focal brain damage. In D. Bishop, & K. Mogford (Eds.), *Language development in exceptional circumstances* (pp. 203–219). Hove, UK: Erlbaum.

Bishop, D. V. M. (1997). *Uncommon understanding: Development and disorders of language comprehension in children*. Hove, UK: Psychology Press.

Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.

Capps, L., Kehres, J., & Sigman, M. (1998). Conversational abilities among children with autism and developmental delay. *Autism, 2*, 325–344.

Capps, L., Losh, M., & Thurber, C. (2000). The frog ate a bug and made his mouth sad: Narrative competence in children with autism. *Journal of Abnormal Child Psychology, 28*(2), 193–204.

Dennis, M., Jacennik, B., & Barnes, M. (1992). The content of narrative and discourse in children and adolescents after early-onset hydrocephalus and in normally-developing age peers. *Brain and Language, 46*(1), 129–165.

Dennis, M., & Kohn, B. (1975). Comprehension of syntax in infantile hemiplegics after cerebral hemidecortication. *Brain and Language, 2*, 472–482.

Dennis, M., & Whitaker, H. A. (1976). Language acquisition following hemidecortication: Linguistic superiority of the left over the right hemisphere. *Brain and Language, 3*, 404–433.

Eisele, J., & Aram, D. (1995). Lexical and grammatical development in children with early hemisphere damage: A cross-sectional view from birth to adolescence. In P. Fletcher, & B. MacWhinney (Eds.), *The handbook of child language* (pp. 664–689). Oxford: Basil Blackwell.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. New York: Harper & Row.

Goodglass, H. (1993). *Understanding aphasia*. San Diego: Academic Press Inc..

Jernigan, T., Hesselink, J., Sowell, E., & Tallal, P. (1991). Cerebral structure on magnetic resonance imaging in language- and learning-impaired children. *Archives of Neurology, 48*, 539–545.

Joanette, Y., Goulet, P., & Hannequin, D. (1990). *Right-hemisphere and verbal communication*. New York: Springer-Verlag.

Jones, W., Bellugi, U., Lai, Z., Chiles, M., Reilly, J., Lincoln, A., & Adolphs, R. (2000). Hypersociability in Williams syndrome. In U. Bellugi & M. St. George (Eds.), Linking cognitive neuroscience and molecular genetics: new perspectives from Williams syndrome [Special issue]. *Journal of Cognitive Neuroscience 12*,(1), 30–46.

Kaplan, J., Brownell, H., Jacobs, J., & Gardner, H. (1990). The effects of right-hemisphere damage on the pragmatic interpretation of conversational remarks. *Brain and Language, 38*, 315–333.

Korenberg, J., Chen, X.-N., Hirota, H., Lai, Z., Bellugi, U., Burian, D., Roe, B., & Matsoka, R. (2000). Genome structure and cognitive map of Williams syndrome. In U. Bellugi, & M. St. George (Eds.), Linking cognitive neuroscience and molecular genetics: New perspectives from Williams syndrome [Special issue]. *Journal of Cognitive Neuroscience 12*,(1), 89–107.

Labov, W., & Waletzky, J. (1967). Narrative analysis: Oral versions of personal experience. In J. Helm (Ed.), *Essays on the verbal and visual arts*. Seattle: University of Washington Press.

Lenneberg, E.H. (1967). *Biological foundations of language*. Wiley: New York.

Leonard, L. B. (1998). *Children with specific language impairment*. Cambridge: The MIT Press.

Leonard, L., Bortolini, Caselli, C., Mc Gregor, & Sabadini, L. (1992). Morphological deficits in children with specific language impairment: The status of features in the underlying grammar. *Language Acquisition: A Journal of Developmental Linguistics, 2*(2), 151–179.

Liles, B. (1993). Narrative discourse in children with language disorders and children with normal language: A critical review of the literature. *Journal of Speech and Hearing Research, 36*, 868–882.

Losh, M., Bellugi, U., Reilly, J., & Anderson, D. (2001). The integrity and independence of evaluation in narratives: Evidence from children with Williams syndrome. *Narrative Inquiry, 10*(2), 1–26.

Losh, M., Capps, L. (in press). Narrative ability in high-functioning children with Autism or Asperger's Syndrome. *Journal of Autism and Developmental Disorders*.

Loveland, K., McEvoy, R., & Tunali, B. (1990). Narrative story-telling in autism and Down syndrome. *British Journal of Developmental Psychology, 8*, 9–23.

MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk*. Hillsdale, NJ: Erlbaum.

Mayer, M. (1969). *Frog, where are you?*. New York: Dial Press.

Ochs, El, Smith, R., & Taylor, C. (1989). Dinner narratives as detective stories. *Cultural Dynamics, 2*, 238–257.

Peterson, C., & McCabe, E. (1983). *Developmental psycholinguistics: Three ways of looking at a child's narrative*. New York: Plenum Press.

Plante, E. (1996). Phenotypic variability in brain-behavior studies of specific language impairment. In M. Rice (Ed.), *Toward a genetics of language* (pp. 317–335). Hillsdale, NJ: Erlbaum.

Plante, E., & Swisher, L. (1991). MRI findings in boys with specific language impairment. *Brain and Language, 41*, 52–66.

Poizner, H., Klima, E., & Bellugi, U. (1987). *What the hands reveal about the brain*. Cambridge: MIT/Bradford Books.

Reilly, J. S. (1992). How to tell a good story: The intersection of language and affect in children's narratives. *Journal of Narrative and Life History, 2*(4), 355–377.

Reilly, J., Bates, E., & Marchman, V. (1998). Narrative discourse in children with early focal brain injury. *Brain and Language, 61*, 335–375.

Reilly, J., Bernicot, J., Vicari, S., LaCroix, A., & Bellugi, U. (In press). Narratives in children with Williams syndrome: A cross-linguistic perspective. In D. Ravid & H. Batzeev Shyldkrot (Eds.), *Perspectives on language and language development; Essays in honor of Ruth A. Berman*. Dordrecht, Netherlands: Kluwar.

Reilly, J., & Dardier, V. (2002). La plasticité et la cohésion chez les enfants tout venant et cérébro-lésés: les pronoms et les connecteurs. A la journée d'étude: La cohésion chez l'enfant. Leaple-Université Paris 5. May.

Reilly, J., Klima, E., & Bellugi, U. (1990). Once more with feeling: Affect and language in atypical populations. *Development and Psychopathology, 2*(4), 367–391.

Semel, E., Wiig, E., & Secord, W. (1987). *Clinical evaluation of language fundamentals—revised (CELF-R)*. San Antonio, TX: The Psychological Corporation.

Slobin, D. I. (Ed.). (1985). *The crosslinguistic study of language acquisition (Vols. 1–2)*. Hillsdale, NJ: Erlbaum.

Tager-Flusberg, H. (1995). Once upon a rabbit: Stories narrated by autistic children. *British Jouranl of Developmental Psychology, 13*, 45–59.

Tager-Flusberg, H., & Sullivan, K. (1995). Attributing mental states to story characters: A comparison on narratives produced by autistic and mentally retarded individuals. *Applied Psycholinguistics, 16*(3), 241–256.

Trauner, D., Wulfeck, B., Tallal, P., & Hesselink, J. (2000). Neurologic and MRI profiles of children with developmental language impairment. *Developmental Medicine and Child Neurology, 42*, 470–475.

Vargha-Khadem, F., O'Gorman, & Watters, G. (1985). Aphasia and handedness in relation to hemispheric side, age at injury and severity of cerebral lesion during childhood. *Brain, 108*, 677–696.

Vargha-Khadem, F., Isaacs, E., & Muter, V. (1994). A review of cognitive outcome after unilateral lesions sustained during childhood. *Journal of Child Neurology, 9*(Suppl.), 2S67–2S73.

Vicari, S., Albertoni, A., Chilosi, A., Cipriani, P., Cioni, G., & Bates, E. (2000). Plasticity and reorganization during language development in children with early brain injury. *Cortex, 36*, 31–46.