

PERFORMANCE INTERACTIONS AND DEVELOPMENTAL ASYNCHRONY
IN THE LANGUAGE OF CHILDREN WITH AND WITHOUT SLI

by

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ABSTRACT

This study investigated level of development and performance interactions between the three language domains of semantics, syntax, and morphology across and within two groups of children. Eight children with normal-language (NL), ranging in age from two to four, and eight children with SLI, ranging in age from four to six, served as subjects. For all subjects, individual language samples were collected, analysed, and coded for semantic, syntactic, and morphological characteristics. The unit of analysis for all language measures was the communication unit. For the level of development question, it was found that in comparison to a language-matched group of normally developing children, the children with SLI evidenced lower levels of development in morphology, but not in syntax and semantics. Furthermore, for both the SLI and NL children, developmental levels were only modestly correlated among the three linguistic domains. For the performance question, it was found that the morphological performance of the SLI children was reduced as a function of syntactic complexity; the same was not true for the language-matched NL children. Furthermore, the semantic elaboration of both groups of children was reduced as a function of syntactic complexity. The data were interpreted as supporting both asynchronous development, across the three language domains for both groups, and on-line processing trade-offs between the three domains, for the SLI group.

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Dedicated to
My loving parents,
With gratitude

CHAPTER ONE

INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

Specific Language Impairment (SLI) has been researched extensively by a variety of researchers from many different disciplines, for many decades (see Johnston, 1988 for a review). Classically, children with SLI have been described as having a specific deficit in language function (expressive and/or receptive), with normal performance IQ, normal peripheral hearing, and normal social-emotional function. This exclusionary definition was first proposed by the 1960 Institute on Childhood Aphasia (Johnston, 1988). Since that time, research has endeavoured to explicate the nature, character, and cause of SLI.

Many aspects of SLI have been studied and varied explanations have been offered for the patterns of linguistic, cognitive, and social performance in this population; however many questions remain unanswered (Watkins, 1994). Some unitary accounts of SLI have been postulated (Leonard, 1989; Gopnik & Crago, 1991; Clahsen, 1989). Leonard (1989) views children with SLI as normal learners dealing with a severely distorted auditory input. Leonard maintains that the language characteristics of children with SLI are a result of an interaction between this input and a fundamentally normal language learning mechanism. Gopnik & Crago (1991)

offer a missing features hypothesis as an account of the deficits seen in the SLI population. Clahsen (1989) maintains that children with SLI are impaired in their ability to form agreement relations within the English grammar. Each of these accounts suggests either a fundamental impairment in the underlying linguistic mechanism or limitations in language processing. None, however, is comprehensive on its own.

One of the most puzzling issues, still remaining, is the considerably heterogeneous linguistic profiles within the SLI population. There is, as yet, no widely accepted profile of linguistic behaviour consistently associated with this language disorder (Watkins, 1994). Children with SLI often differ in the extent of linguistic impairment, as well as in the range and degree of language domains involved. This profile leads to a great deal of heterogeneity in the SLI population. The observed variability has yet to be researched and explained in a satisfactory manner.

Review of the Literature

The Issue of Heterogeneity

Crosslinguistic research

The crosslinguistic research on the language behaviour of children with SLI has shown that a great deal of heterogeneity exists. Although in English-speaking children, morphological deficits seem to prevail, this is not always the case with non-English-speaking children with SLI. For example, it has been reported that in

Italian-speaking (Leonard et al., 1987; Leonard, Sabbadini, Volterra, & Leonard, 1988) and Hebrew-speaking children with SLI (Dromi, Leonard, & Shteyman, 1993), morphology is not significantly impaired. Furthermore, SLI children acquiring German seem to have problems with word order (Clahsen, 1989; Grimm & Weinert, 1990; Rothweiler & Clahsen, 1993). Swedish-speaking children with SLI also have problems with word order, in addition to deficits in other domains (Hansson & Nettelbladt, 1995). For example, Hansson & Nettelbladt (1995) report that one child with a very high MLU made the greatest number of word order errors. These investigators also state two children with the highest MLUs had language comprehension abilities below normal limits. Finally, the “least grammatically developed” child was the only child with SLI who had language comprehension abilities within normal limits. A review of this crosslinguistic literature demonstrates that not all children with specific language impairment have trouble with similar linguistic domains in similar degrees.

Heterogeneity within-English

Subtyping

Even in English-speaking children with SLI, there is considerable heterogeneity in observed language profiles. One popular approach attempting to explicate this variability has been to subtype groups of children, according to observed language patterns. Several attempts at describing the observed heterogeneity in the SLI population have been in the form of identifying unique subtypes or profiles of

language impairment (Aram & Nation, 1975; Rapin & Allen, 1983; Wilson & Risucci, 1986). Aram & Nation (1975) were two of the first researchers to outline a profile of specific language impairment. They identified six discrete patterns of language impairment by measuring the performance of 47 language-impaired (LI) subjects along nine language dimensions, in comprehension, expression, and repetition tasks.

Fletcher (1992) describes the research on subtyping as falling into three broad categories: clinical (e.g. Rapin & Allen, 1982), psychometric (e.g. Wilson & Risucci, 1986), and linguistic (e.g Crystal 1986; Miller, 1987). The clinical subtyping procedures rely on a clinical syndrome of identification of clusters of behaviours observed across a large number of individuals. The psychometric approach, as represented by Aram & Nation (1975), classifies children with language impairment using multivariate statistical procedures on the children's performance on a large battery of standardized tests. One of the major disadvantages of this type of classification is that the majority of the tests do not tap into linguistic abilities and limitations directly.

Linguistic subtyping procedures, on the other hand, try to identify types of disorder according to the language behaviour of children, by analyzing spontaneous language samples. For example, Wren (1980) used measures derived from LARSP syntactic profiles to identify two profiles of language disorder in a group of 30 "language

learning disabled” children between the ages of six and seven. The LARSP syntactic profiles were again used by Crystal (1986) to subtype thirty children with SLI between the ages of five and ten. Crystal also used LARSP syntactic variables, in addition to semantic and non-fluency measures.

Fletcher (1992) carried out a cluster analysis of the Crystal data, within a multi dimensional profile, in an attempt to identify subtypes of language behaviour. He included in his analysis four measures looking at various components of Crystal’s spontaneous speech sample data. The measures that Fletcher (1992) developed, examined the syntactic complexity of utterances at the sentence and phrase level, as well as morphological and syntactic errors and proportion of silent pauses. Morphological and syntactic errors included incorrect verb argument structure, lexical substitutions, and omission of auxiliaries, determiners and inflections. The syntactic complexity measure was a general measure over three different types of clause linkage in English: 1) more than one simple clause linked by coordinator or subordinator indicating a particular semantic relationship 2) complex verb complementation, and 3) relative clauses.

Based on his analyses, Fletcher (1992) was able to identify four groups of language-impaired children. The first group was characterized by fluent (minimal number of pauses within sentences), error-free output (minimal number of syntactic and morphological errors) and adequate syntactic structure building; however, the

children in this group had difficulties with discourse and semantics. The second group of children demonstrated adequate structure building with error-free output, but were dysfluent (many silent pauses within utterances). The third group of children was characterized by dysfluent output, structure building problems, and many errors. The final group's speech was fluent and error-free, but revealed difficulties with structure building. Fletcher (1992) concludes that the results support the view that the child's speech is the product of a complex interaction between subsystems operating in real time. He further states that the findings are more informative than the standard grammatical view in that they offer the prospect of multidimensional profiling for school-age language-impaired children.

Subtyping is only one way of describing the variability found in the language behaviour of children with SLI. The advantages are that it can provide principled procedures for identifying children with different types of problems. The resulting subgroups may ultimately be linked with potential etiological factors. However, three difficulties with this approach suggest that it will have limited success in reaching this goal. First, the research on subtyping usually does not include data from normal-language populations. It is possible that similar kinds of groupings may be found in normal-language children. Second, the measures used in subtyping studies are overall behavioural summaries that do not allow for distinctions between 'knowledge' deficiencies and 'performance' deficiencies. Studies like those of Fletcher (1992) and Crystal (1986) are exceptions to this rule. Third, the subtyping

studies tend to be data-driven rather than theory-driven. As such, they lack the analytic specificity that comes with hypothesis testing, and may not lead to useful levels of explanation of the heterogeneity observed in the language patterns of children with specific language impairment.

Hypothesis-driven studies of heterogeneity

Another family of studies has appealed to the information processing literature to help arrive at an explanation for some of the variability seen among children's linguistic profiles. This research has usually focused on utterance level, rather than global analyses, in an effort to investigate interactions between various language domains, and to determine whether performance limitations exist.

It is possible that developmental interactions facilitate or constrain children's performance and/or learning in one or other language domain(s). These interactions may be the result of a limited processing capacity. Kahneman (1973) and others (e.g. Kail & Bisanz, 1982) have postulated that all mental activities use a limited, and shared, pool of attentional resources. Individuals allocate resources from this central supply as needed to engage in and complete tasks of various kinds. When a task is especially demanding, a large number of resources may be needed, resulting in few resources remaining for other activities.

Kail & Bisanz suggest that the term 'attentional resources' refers to a limited reserve

of resources used to acquire knowledge. These resources are used to initiate and maintain knowledge in an active state. Some contents of the knowledge base do not require attentional resources; their activation is 'automatic'. Other contents of the knowledge base require the allocation of attentional resources to become active; in this case processing is referred to as 'controlled' or voluntary. During the course of development, many areas of knowledge seem to become more capable of automatic activation. This is particularly true in the area of grammar (Kail & Bisanz, 1982; Strand, 1992). In Bock's model (Strand, 1992), trade-offs between automatic and controlled syntactic processing are presented as an explanation for semantically similar, but syntactically different sentences. Important to Bock's model is the interaction between various domains; for example, lexical accessibility can influence syntactic structure. Therefore, Bock's model represents an interactive system in which multiple levels of processing (including working memory) may affect syntax (or other language domains) independently or simultaneously.

A small but steady stream of research findings points to the likelihood of attentional deficits in children with SLI (e.g. Macworth, Grandstaff, & Pribram, 1973; Johnston & Smith, 1989; Riddle, 1992). Assuming that the Limited Processing Capacity model applies to language behaviour, we could expect to see the consequences of attentional deficits in the form of interactions among discrete aspects of language behaviour. Performance in one language domain may constrain performance in another domain, due to inadequate processing resources. For example, a child who

is having difficulty recalling a new word may lack the resources needed for complex syntax, yielding an interaction in performance levels for these two domains. This would be especially true if activation of the requisite syntactic knowledge was not yet fully automatic. As a second possibility, the child with limited attentional resources may be more likely to pay attention to just one aspect of new sentence patterns at a time, leading to developmental advances in one linguistic domain that are asynchronous with those seen elsewhere (Johnston, Blatchley, & Olness, 1990).

Interactions between language domains

Several researchers have attempted to describe the heterogeneity within the SLI population by studying the language performance of children across several different language domains. This type of research, unlike that on subtyping, makes use of processing models, like the one described earlier, to explain its findings. This kind of research is becoming increasingly important in the child language literature and it may provide us with an explanation of the deficits seen in children with SLI. Many researchers have suggested that the different language domains interact during development, such that the use of knowledge schemes from one may be facilitated or constrained by another (Panagos, Quine, & Klich, 1979; Panagos & Prelock, 1982; Paul & Shriberg, 1982; and Waterson, 1978). These researchers appeal to information processing models (specifically the literature on limited processing capacity), as a way to explain the observed interactions.

Phonology & Syntax

The relationship between phonology and syntax during language acquisition has been studied extensively. Waterson (1978) conducted a longitudinal case study on the spontaneous speech of a child between the ages of 10 and 24 months, to determine whether there was an interaction between the child's phonological and syntactic systems. Waterson (1978) found that from 10 to 16 months, this child produced simple, familiar sounds and syllables during a period when vocabulary size was increasing and two-word utterances were emerging. The simpler consonants during this period, may have allowed for the emergence of longer utterances. It was also found that from 16 to 18 months, the child produced some new sounds, but they only occurred in familiar two-word utterances. Therefore, the complexity of sounds was now increasing, but only in two-word utterances. Waterson (1978) interprets these findings as a performance trade-off between syntactic and phonological development; the complexity of sounds increased only in short utterances, while consonant production remained relatively stable during increases in vocabulary size and syntactic complexity. Later in this review, this study will be re-interpreted within a different framework.

Panagos, Quine, & Klich (1979) confirmed the hypothesis that syntax affects children's articulatory performance, in a sentence imitation task. One variable of concern was the effect of syntactic structure (noun phrase versus declarative sentence versus passive sentence) on consonant articulation in 17 children aged 4;8 to 6;8 who

had functional articulation problems. The results revealed that as grammatical complexity increased, the number of articulation errors also increased, thereby demonstrating a performance trade-off between syntactic structure and accuracy of articulation in these children.

The hypothesis that phonological structure influences children's syntactic processing was investigated by Panagos & Prelock (1982), using a sentence imitation task. The complexity of the syllable (simple versus complex) and the complexity of declarative sentences (unembedded, right-embedded, and center embedded), were varied. Ten children (5;8 to 6;9) presenting with syntax, as well as articulation impairments, served as subjects. The investigators found that there were more errors in complex versus simple sentences and embedded versus unembedded sentences. There was also a 45% increase in syntactic deletion errors as syllable structure changed from simple to complex. The authors suggest that syntactic structure may determine the pattern of error responses, while phonological complexity leads to a further increase in the number of errors.

Phonology & Semantics

Interactions between the language domains of semantics and phonology have also been studied. Camarata & Schwartz (1985) investigated the articulation in object versus action words in six language-impaired and six normal-language subjects, at the single word level. They analyzed spontaneous speech samples and measured the

accuracy of phonetic production in object versus action words. For both groups, the percentage of correct consonants was greater in the object words than in the action words. The explanation given by the authors was that action words are more complex semantically, thereby resulting in a trade-off, and accounting for the observed difference.

The studies reviewed above suggest that phonology interacts with the syntactic and semantic language domains in important ways. In certain cases, phonological structures are simplified during the production of more complex syntactic forms. Conversely, the production of complex phonological structures leads to a simplification of syntactic elements. Note that the Panagos and Camarata studies were designed such that a child's performance in one language domain could be shown to vary as a function of the demands presented in a second domain. That is, a given child could be seen to produce a given sound, or a given sentence pattern, in one context but not in another. Such data point clearly to performance interactions of the sort predicted by a limited processing capacity model. Note also, however, that interactions between phonology and other language domains may have developmental implications as well. All children may focus on and master one aspect of language, before proceeding on to another. Due to a limited processing capacity, children with SLI cannot focus on several aspects of language learning at the same time. Instead, there is a processing trade-off over time with the resources 'withheld' from one domain serving to facilitate development in other domains.

Semantics & Syntax

The relationship among the semantic and syntactic language domains has been less well documented. Very few studies have investigated semantic and syntactic interactions in children with SLI. Johnson (1984) hypothesized that lexical aspect may influence the perfect in normally developing children, such that the perfect progressive might occur with durative verbs and the present perfect might occur with nondurative verbs. The subjects in the Johnson (1984) study included 22 children aged 4;5 to 5;11, with normal language. The experimental task involved modelling and reconstruction of two-sentence stories.

The results showed that the present progressive was used more than the present perfect. This latter finding was interpreted as "been" being an unfamiliar lexical item, as well as there being a desire to explicitly mark the repetition of the action with -ing. More importantly, certain semantic constraints were also found; the present perfect was imitated more often when the context indicated a single event that occurred in the recent past. In contrast, the present progressive occurred more often in the habit sense. Finally, it was found that the perfect was used more when verbs had momentary duration and the present progressive was used more often when verbs had a continuative duration. The above study demonstrates that even for normal-language children, activation of knowledge in one language domain can facilitate or constrain use of forms from another domain.

The findings of other studies can also be interpreted in a Limited Processing Capacity framework. Leonard et al. (1978) report some preliminary data suggesting that once grammatical morphemes appear, they occur in utterances expressing familiar and productive semantic relations. The grammatical morphemes do not appear on **new** or **recently acquired** semantic relations until later in development. Another study by Bloom, Lifter, and Hafitz (1980) investigated the relationship between the semantic organization of verbs and the emergence of verb inflections. These investigators found that the present progressive -ing inflection was first used with verbs describing durative/noncompletive events such as, 'play', 'hold', and 'ride'. It is possible that the semantic compatibility of the -ing morpheme and the durative nature of the verbs led to ease of processing. That is, both the -ing morpheme and the above verbs denote an ongoing/durative event. Therefore, for these children, there seemed to be a trade-off between the lexical items produced and the grammatical morphemes used. Bloom et al report similar findings for other grammatical morphemes.

Masterson & Kamhi (1992) investigated the possibility of "linguistic trade-offs" by looking at the complexity of clause structure, accuracy of production of grammatical morphemes, phonological complexity, and fluency in the speech (spontaneous and repeated) of a group of school-age children with and without language disorders. They found that for the SLI children, grammatical morphemes were more likely to be produced accurately in utterances containing complex phonological forms. They

suggest that this is a curious finding and that there may be a need to look more closely at which grammatical morphemes occur in which utterances.

One possibility is that the relationship between grammatical accuracy and phonological complexity may need to be investigated for different morphological forms separately. Pursuing this idea, they found that the accuracy of regular past production was significantly affected by clause structure and phonological complexity. That is, the greatest number of errors occurred when sentences were both embedded and phonologically complex. Masterson & Kamhi (1992) conclude that children with SLI have intact underlying grammatical competence, but performance limitations prevent them from applying their knowledge consistently.

One explanation, then, for observed performance patterns among the various language domains is the notion of a limited processing capacity. This idea suggests that there may be a general cognitive component that underlies the different language domains. This is a plausible explanation for the observed deficits, considering that numerous investigations (e.g. Stark & Tallal 1988, Gathercole & Baddeley 1990, Kamhi 1981, Ellis-Weismer 1985, and Gillam, Cowan & Day 1995) have found auditory memory and other cognitive deficits (recall the earlier discussion of attentional deficits) in children with language impairment. It has been reported that LI children tend to recall significantly less information than their chronologically age matched peers. The Gillam, Cowan & Day (1995) study will be reviewed briefly and

taken as representative of the others.

Gillam et al (1995) studied serial recall in a group of children with SLI matched for age to one group of NL children, and matched for reading and memory capacity to another NL group. Each subject was presented with lists of digits one item longer than his memory span, in conditions requiring either written or oral recall. The digit lists were presented either with or without a "suffix" that was capable of interfering with memory for items at the end of the list. The main finding of the Gillam et al was that the list-final suffix effect was significantly larger for the SLI children. That is, the SLI children were more prone to the interference effect of the list-final suffix, due to a memory deficit.

Taken together, findings of memory and attentional deficits in SLI children make the notion of processing trade-offs, due to a limited processing capacity, a very plausible explanation for variable language performance. A child who has limited attentional resources cannot attend to as many items simultaneously. If a child cannot attend to an item, then he is not able to encode, store, and/or retrieve it from memory. Therefore, a child with a deficient memory or attentional system is more likely to be affected by the complexity of utterances in which there are greater syntactic, semantic, and morphological demands because he is not able to allocate resources adequately to all of these domains at the same time.

Performance limitations or asynchronous development

The investigations reviewed above have all appealed to a limited processing capacity as an explanation of their findings, but they have done so with varying success. In the most convincing studies (e.g. Leonard et al., 1978; Panagos, Quine, & Klich, 1979; Bloom, Lifter, & Hafitz, 1980; Panagos & Prelock, 1982; Camarata & Schwartz, 1985; and Masterson & Kamhi, 1992), task demands were reduced (sentence imitation), or the complexity of the words/phrases/sentences was varied, in one language domain, while performance in another language domain was measured. Children who fail to produce a form in a 'complex' context are demonstrated to do so in a 'simpler' context. Other investigators (Waterson, 1978; Bloom, Lifter, and Hafitz, 1980; Johnson, 1984) have not structured their studies in ways that can reveal momentary processing interactions.

Waterson's study was a longitudinal one in which the spontaneous speech of a child between the ages of 10 and 24 months was analyzed, to determine whether there were any trade-offs between the child's phonological and syntactic systems. However, in many of her analyses, neither the complexity of the utterances, nor task demands were manipulated in any fashion. For example, the data from the 10-16 month period do not discuss the complexity or type of vocabulary being produced, only the size. Although Waterson talks about performance trade-offs for these data, her findings may be better interpreted within an asynchronous development framework. The following section will review the literature on asynchronous development and then

return to the issue of adequate explanation.

Asynchronous Development

Review of the literature

Johnston (1982) stressed the importance of studying the relationship between language domains. She discussed the relationship between major sentence patterns and inflectional morphology, in normal-language children. Johnston reports that the progressive and regular plural morphemes are mastered while children are using simple sentences. She argues that if the language-impaired child has difficulty mastering these grammatical morphemes, then the sentences produced should be more complex before noun and verb inflections are fully acquired. Similarly, if children with language disorders have difficulty mapping complex meaning relations onto a single sentence, a temporary plateau may be reached prior to the acquisition of embedding devices. These children might, therefore, use an abnormally high proportion of inflectional morphology at the earliest language stages. Clear evidence for such an argument comes from a study conducted by Morehead & Ingram (1976).

Morehead & Ingram (1973) investigated the development of base syntax in normal and language impaired children. The subjects used included 15 normal-language and 15 language-impaired children selected to represent the five linguistic levels determined by Brown (1973). MLU was used as the criterion for establishing linguistic level and for matching the two groups. Three children from each group

were assigned to each of Brown's five linguistic levels of development. Language samples were collected during free play, during an elicitation task while playing, and during an elicitation task while looking at a book. One of the analyses involved the comparison of the development of inflections and minor lexical items in the two groups. The most interesting finding pertaining to asynchronous development was that the language-impaired group at Brown's level III had 12 pronouns compared to 9 pronouns for the normal-language group at the same level. Furthermore, the language-impaired children had more grammatical inflections at the first three levels of linguistic development than did the normal group. Therefore, relative to the normal-language group, the SLI children were using an abnormally high proportion of grammatical morphemes at the first three levels of development. This is direct evidence for asynchronous development.

Kemp (1983) also discusses the notion of asynchronous development. Kemp defines a child with language-impairment by comparing the development of "patterns of linguistic organization" across various domains. Kemp discusses three possible patterns with their clinical implications: 1) If development is uniform and compatible with chronological age, then the child is learning language normally. 2) If development is uniform, but below chronological age, then a language delay exists. 3) Finally, if development indicates significant differences in acquisition within a pattern of linguistic organization or an asynchronism of acquisition among patterns, or both, and if development in at least one domain is at about chronological age, then

language deviance exists.

Heterogeneity and asynchronous development

An alternative approach, therefore, to dealing with the observed heterogeneity in the language performance of children, has been to describe the findings within an asynchronous development framework. Lahey, Libergott, Chesnik, Menyuk, and Adams (1992) analysed 104 language samples for the proportional use of 11 grammatical morphemes (plural -s, possessive 's, progressive, regular and irregular past, regular and irregular present, as well as the contractible and uncontractible forms of the copula and auxiliary 'be'). The subjects were 42 children at the ages of 25, 29, and 35 months. The authors found a great deal of variability across samples, whether children were grouped according to age or MLU. A comparison of the data with those reported in the SLI literature, revealed that group means were generally lower for language-impaired children. However, many of their scores overlapped with those of the normal-language children. For many of the children with SLI, morphology seems to lag behind development in other domains (as measured by MLU). However, even for the NL children, a given chronological age or MLU does not imply a specific level of use of grammatical morphology.

Ingram & Carr (1994) report a longitudinal study of a child, with SLI, between the ages of 9;4 and 10;3. During the latter time period, the child's MLU varied between 5.3 and 6.0. These authors report that this child's morphological ability was

“excellent”, however he had difficulty embedding sentences and had a restricted range of verb subcategorizations. Detailed analyses of the data revealed “near perfect” morphological usage and “simple” sentence structures. The findings of this case study again reveal an asynchrony between morphological and syntactic domains.

Johnston & Kamhi (1984) studied the relationship between grammatical morphology and semantic complexity. These investigators were interested in identifying any asynchrony between propositionality and grammaticality. The subjects used in this study were 10 language-impaired children aged 4;6 to 6;2 and 10 normal-language children aged 3;8 and 4;1, matched for MLU (4.17 to 5.48). Johnston & Kamhi examined correlations between the percentage of error on grammatical markers (GME) and the number of propositions per surface sentence (PCI), for each group. They found no relationship between the above two variables for the normal-language group. As a group, the children with SLI expressed fewer logical propositions per utterance and had more difficulty with specific morphological forms. Two of the subjects with SLI incorporated more propositions into their utterances and made more errors in their use of grammatical markers. One child evidenced the highest scores for the LI group in both the semantic and the grammatical error measures, the other child the lowest. For these two subjects, there seemed to be a performance trade-off between semantic elaboration and the use of morphology. Furthermore, Johnston & Kamhi conclude that, because subjects were matched on MLU, the

results can be interpreted in an asynchronous development framework.

Moore & Johnston (1993) investigated developmental asynchrony in a group of children with SLI. This study probably provides the clearest evidence for asynchronous rate of development. Moore & Johnston looked for formal asynchronies within a single semantic field (past time). They maintain that most studies reporting similar performance in language-impaired and normal-language children, are conducted within a single linguistic domain. They further state that evidence of normal development within a domain does not indicate normal development across all linguistic subsystems. Subsequently, studies that match SLI and NL children on MLU and find morphological deficits in the SLI children, can be viewed as asynchronous development between syntax and morphology.

Moore & Johnston state that in the Johnston & Kamhi (1984) study, it is difficult to decide whether the observed findings related to the meanings or the structural properties of specific linguistic forms. Therefore, they decided to control for meaning by comparing inflected past to lexical past in a group of normal-language and language-impaired children. These investigators found that, when the NL group was used as a standard of comparison, the performance of the children with SLI on past time adverbs resembled that of normal four-year olds, while the performance on inflected past resembled that of normal three-year olds. Moore & Johnston maintain that the nature of the underlying disorder can be viewed as a result of a relative

lexical strength or a relative morphological weakness; either way, there is a developmental asynchrony between the morphological and lexical domains.

The issue of adequate explanation

The notion of asynchronous development, although somewhat satisfying as an approach to heterogeneous language performance still leaves open the question of cause. This framework, like that of subtyping, is a descriptive one and does not help explain why heterogeneity exists. However, asynchronous development and limited processing capacity are not unrelated. It is possible to combine the notions of asynchronous development and limited processing capacity to help us begin to explain the variability in the language behaviour^c of children with and without language disorders. It is possible to imagine that the existence of a limited processing capacity may affect acquisition in one domain, as well as affecting momentary processing. As a result, when language performance is measured at a single point in time, asynchrony is observed; that is, asynchronous development is the ultimate consequence of a limited processing capacity. Therefore, the observed heterogeneity in the language behaviour of children may potentially reflect either processing trade-offs, asynchrony, or both.

Summary

The above review has aimed to demonstrate the importance of studying relationships among various language domains in studies of children with typical and atypical

language. Many studies have investigated either the possibility of performance limitations or developmental asynchrony, as an attempt to explain variable language performance, across different domains. No studies have attempted to differentiate between processing trade-offs and asynchronous development in the same group of subjects. In order to better understand linguistic heterogeneity in normal-language, as well as language-impaired children, we need to determine which type of interaction is taking place.

Statement of Purpose and Research Questions

The purpose of the present study was to further investigate the interaction between three different language domains, syntax, semantics, and morphology in a group of normal-language and language-impaired children. The importance of this study is that it attempted to distinguish between performance limitations and developmental asynchrony in a group of young children. The research questions were as follows:

Question 1. Do normal-language (NL) and language-impaired (LI) children evidence the same level of development in the semantic, syntactic, and morphological language domains?

Question 2. Do children show evidence of processing trade-offs between performance in one language domain and performance in another?

CHAPTER TWO

METHOD

Overview

The purpose of the present study was to investigate the relationship between the development of, and performance in, syntax, morphology, and semantics, in a group of normal-language (NL) and specifically language impaired (SLI) children. In particular, it was asked: do children evidence the same relative level of development in each language domain? Further, do children show evidence of processing trade-off between performance in one language domain and performance in another language domain? Data was collected from a group of typically developing children and a group of children with specific language impairment (SLI).

Subjects

Subjects were chosen from children in a larger, cross-linguistic study of morphology. All children came from English-speaking families. Further, all subjects had earned normal range performance IQ (80-120) on the Columbia Mental Maturity Scale (Burgemeister, Hollander Blum, And Lorge, 1972) or the McCarthy Scales of Children's Abilities (MacCarthy, 1972). Subjects had also passed a phonological screening for word final d/t, z/s. There was no history of hearing impairment, motor problems, or socio-affective disorder.

The children with SLI were ages 4 to 6 and had Developmental Sentence Analysis (DSS) (Lee, 1974) scores below the tenth percentile. The typically developing children were ages 2 to 4 and had DSS scores between the fiftieth and ninetieth percentile. The DSS is a broad composite measure of expressive syntax, lexical, and morphological development. The composite nature of the DSS means that subjects with similar total scores can differ in the relative strength in one or another linguistic domain.

Eight SLI children (six males and two females) were selected from the larger sample, to represent a range of ages and to maximize variance in MLU in words (MLUw). Selection was otherwise random. Eight NL children (four males and four females) were then selected with equivalent MLUw (SLI mean = 4.79; NL mean = 4.88; $T = 0.30$, $p > .05$). MLUw instead of MLU in morphemes (MLUm) was used as the matching variable, because independent measures of syntax and morphology were desired. MLUm is a more comprehensive measure than MLUw in that it takes into account grammatical morphemes as well syntactic and lexical structures. By using MLUw, it was ensured that the syntax and morphology measures overlapped to a lesser extent. A two-group T-test of DSS scores revealed that on a composite measure of expressive language development, the two groups were not significantly different (SLI mean = 5.89; NL mean = 7.24; $t = 1.45$, $p > 0.05$). However, the SLI group was significantly older than the NL group (Mean age SLI: 68.6 months; Mean age NL: 44.6 months; $t = -4.40$, $p < .001$). Individual subject characteristics for these

16 children are presented in Table 1.

Table 1: Individual Subject Characteristics

Subject	Age in months	Sex	MLU-m	MLU-w	IQ	DSS raw score
NL1	31	M	4.7	4.0	110	4.8
NL2	30	M	5.4	4.6	113	5.0
NL3	38	F	5.0	4.4	95	5.9
NL4	47	M	5.3	4.7	86	7.0
NL5	55	F	6.4	5.7	119	9.2
NL6	48	F	5.7	5.2	113	7.2
NL7	55	F	6.0	5.3	110	9.6
NL8	53	M	5.8	5.1	115	9.2
LI1	52	M	4.5	4.0	113	4.4
LI2	57	F	5.9	5.2	87	5.4
LI3	66	M	6.0	5.5	94	5.4
LI4	63	M	4.6	3.8	107	5.6
LI5	69	M	5.3	4.8	99	4.4
LI6	82	M	5.3	4.5	99	4.3
LI7	84	M	5.9	5.3	89	9.3
LI8	76	F	5.6	5.2	94	7.7

Procedures

Data Collection and Transcription

Spontaneous speech samples (conversation and narrative) were gathered from each child, as part of a larger battery of tests and experimental measures. Each child was tape-recorded interacting individually with an examiner, in a play situation. The

children with SLI were tape-recorded in a clinic or school setting, while the typically developing children were tape-recorded in their home or preschool. The tape-recorded examiner-child interactions were transcribed onto computer files using the transcription conventions of SALT. Guidelines proposed by Brown (1973) were employed for grammatical morpheme segmentation.

Transcripts were verified by a second transcriber for content and checked for adherence to transcription conventions. Transcription reliability between the first and second transcriber was calculated. Disagreements were resolved by a third checker. The total number of agreements and disagreements for the total number of surface morphemes were counted. Then a percentage was calculated for the total number of agreements over the total number of surface morphemes (the number of morphemes after review of transcripts by the third checker). Transcription reliability was 97%.

Utterance boundaries were based primarily on intonation contour and pause duration.

The following types of utterances were then excluded from all further analyses:

1. Unintelligible utterances
2. Simple labelling responses and single-word responses to yes/no questions
3. Elliptical question responses that did not contain a surface subject and predicate
4. Adjacent identical utterances

The above decisions were made in order to control for inconsistencies in examiners' questioning behaviour and to account for the repetitive nature of young children's speech. The MLUw was calculated after this set of utterance segmentation procedures, after which time the matching was done. Consequently, the MLUs are higher than they would be if calculated in the more traditional fashion, i.e. without excluding the above listed utterances.

The utterances were further segmented into *communication units* (Loban, 1976). A communication unit is defined as an independent clause and all its relevant modifiers. It must contain a noun + verb in a subject-predicate relationship. Coordinating conjunctions (e.g. and, but) and conjunctive adverbs (e.g. however, moreover) separate a sentence into two independent clauses, or two communication units. Subordinating conjunctions (e.g. so, because)¹ and relative pronouns (e.g. who, which, that) divide a sentence into an independent and a dependent clause (modifier), which together represent a single communication unit. A dependent clause is defined as part of the independent or main clause; it typically cannot stand alone and may join with the independent clause to add complexity and information. Simple phrases (e.g. a noun phrase, a verb phrase) standing alone are excluded from this analysis. They were removed from the samples and were not included in subsequent analyses. (See Appendix A for further description of coding).

Whereas SALT relies primarily on intonation and pause criteria for utterance

segmentation, Loban's analysis relies only on grammatical decision rules, independent of pause or intonation criteria. It is assumed, however, that pause and intonation go along with grammatical segmentation for the speaker. Group means for the total number of SALT utterances and the total number of communication units (Cus) are presented in Table 2.

Table 2: Group means: SALT utterances and CUs

	SALT	CUs
NL	275	206
LI	255	154

Language measures and analyses

Unless otherwise stated, the unit of analysis for all language measures was the communication unit. Measures of semantic, syntactic, and morphological complexity were developed and applied as follows.

Semantic analyses

The semantic analysis used was that developed by Johnston & Kamhi (1984). This approach focuses on the propositional units of meaning which underly words and utterances, rather than on content-defined semantic relations, vocabulary, or non-literal meanings. One advantage of this type of analysis is that the semantic complexity of utterances can be evaluated apart from particular sentence patterns and

degrees of grammaticality (Johnston & Kamhi, 1984). Another advantage is that it can reflect developmental maturity as children become more capable of packing more and more ideas into a single surface sentence. Several researchers have found that propositional analysis can capture important developmental trends in sentence formulation and communicative competence (Slobin, 1977; Parisi & Giannelli, 1979; Johnston & Kamhi, 1984; Gillam & Johnston, 1994).

Propositions are defined as idea-units consisting of a judgment, or predicate, and its affiliated arguments. The predicate is the central core of the proposition (e.g. the judgment regarding a state, relation, change of state, activity). The argument is the "object" which necessarily participates in the state, relation, process and is expressed as a noun phrase. There are four types of predicates: nuclear, adverbial, embedded, and associated.

A nuclear predicate is the pivot point in the idea network underlying a sentence and is expressed by the finite (i.e. "Tensed") verb. An adverbial predicate is one of three ways to "add" predicates to the nuclear predicate; it is a "higher order" predicate which takes the entire nuclear proposition as its argument. An embedded predicate is the second of three ways to "add" predicates to the nuclear predicate; it is a "lower order" predicate which is an argument of the nuclear predicate. An associated predicate is the third way to "add" predicates to the nucleus; it is a predicate which modifies an argument of the nucleus (see Appendix B).

All communication units were coded for nuclear and extra-nuclear propositions. Each extra-nuclear proposition in a particular CU was counted and coded individually. This allowed for further analysis, if necessary, of the specific number and nature of extranuclear propositions. Then, for each subject, a Propositional Complexity Index (PCI) consisting of the total number of nuclear and extra-nuclear propositions divided by the total number of communication units, was calculated. The percentage of extra-nuclear propositions (number of extra-nuclear propositions divided by total number of propositions), as well as the percentage of nuclear propositions (number of nuclear propositions divided by total number of propositions) were also calculated.

Syntactic analyses

For the syntactic measure, it was important to develop a system which was as independent of the semantic analysis as possible. Since one of the questions of interest in this study was the interaction between language domains, it was important that each language measure was independent of the others. Clausal complexity was chosen for the syntactic measure. Paul's (Chapter 2 in Miller, 1981) complex sentence development charts were used as the basis for the development of the syntactic measure. These charts outline milestones in the development of complex sentence production and are based on an analysis of transcripts of the speech of 59 children between the ages of 2;5 and 6;11.

For the purposes of the present study, Paul's complex sentence development was modified. The order of acquisition information for the development of various syntactic structures, according to increasing MLUm, was used, but her stage boundaries were modified to yield four levels (levels 0, 1, 2, and 3) of clausal complexity (see Appendix C). Communication units were then coded for these four levels of clausal complexity.

Level 0 included communication units with no dependent clauses plus communication units with simple infinitive verb complements with subjects that are the same as that of the main sentence (e.g. I want to go); the subject of the complement is deleted. Sentences containing catenatives were also included at this level (e.g. the chair is gonna fall). Level 1 included communication units containing "let's" or "let me", full propositional verb complements, simple non-infinitive wh-clauses (i.e. same subject as the main clause and no more than one embedding), marked by 'what', 'where', 'why', and 'how'. Level 2 consisted of communication units with a simple (e.g. level 1) plus a subordinate clause, marked by either 'because' or 'so'.

Level 3 included communication units containing i) infinitive clauses with subjects different from that of the main clause, ii) relative clauses (they may or may not contain 'that' or 'which'), iii) the conjunction "if",² iv) gerund (-ing) clauses, v) wh-clauses with infinitive verbs where the subject is different than that of the main

clause or with finite verbs where there is more than one embedding, and vi) communication units containing unmarked infinitive clauses headed by 'help', 'make', and 'watch' (i.e. where co-referential noun phrases in underlying clauses play different grammatical roles - 'you help me' + 'I make a cake' = 'You help me make a cake'). Gerunds used as adjectives were not counted at this level and were considered level 0 forms (e.g these are running shoes).

Overall syntactic complexity was then measured by calculating the percentage of communication units with clauses at levels 1, 2, and 3 (total number of communication units with level 1, 2, and 3 clauses divided by the total number of communication units). The percentage of communication units containing only simple clauses (level 0) was calculated in the same manner.

Morphological Analyses

Two composite measures of grammatical morphology were calculated across the following grammatical morphemes: third person singular, regular past, present progressive, auxiliaries and copula, infinitive particle, past participle, plural, and possessive. To measure overall *level of development* in grammatical morphology, the total number of different morphemes (# morphemes attempted; maximum possible = 12) across all communication units was used. To receive credit, a morpheme had to be attempted at least three times, with at least 50% correct use. To measure *overall performance* on grammatical morphology, a percent correct use of

grammatical morphemes in obligatory contexts (% correct morpheme), across all communication units, was calculated.

Language domain interactions

To measure interactions between morphology and syntax, as well as, morphology and semantics, two other measures were calculated. % correct morpheme was calculated separately for high and low proposition communication units. High proposition communication units were defined as those containing two or more extranuclear propositions. Low proposition communication units were defined as those containing zero to one extranuclear propositions. Additionally, separate % correct morpheme measures were calculated for communication units with high and low syntactic complexity. High syntactic complexity was defined as communication units containing Level 1, 2, and 3 dependent clauses. Low syntactic complexity was defined as CUs containing Level 0 dependent clauses only. Appendix D shows a sample transcript with all the above coding outlined.

Summary of language analysis measures

The unit for all language analyses was the communication unit = CU

Semantic

1. The percentage of extra-nuclear propositions (**% Ex Nuc Prop**) = the total number of extra-nuclear propositions divided by the total number of propositions in the sample.

2. Propositional Complexity Index (**PCI**) = the average number of propositions in a sample.

Syntactic

1. The percentage of complex clauses (**% comp cl**) = the total number of level 1, 2, and 3 clauses.
2. The percentage of simple clauses (**% simp cl**) = the total number of level 0 clauses.

Morphological

1. **# morphemes attempted** = an overall developmental measure of the total number of different morphemes attempted, with at least 50% correct use, across all CU s in a sample. In some analyses, this measure is expressed as a percentage of 12, the maximum possible.
2. **% correct morphemes** = an overall performance measure of the percentage of correct use of grammatical morphemes in obligatory contexts across all communication units.

Interactions

1. **% correct morphemes in complex CUs** = the % correct morphemes across communication units with complex clauses.
2. **% correct morphemes in simple CUs** = the % correct morphemes across

communication units with simple clauses.

3. % correct morphemes in high proposition CUs = the % correct morphemes across communication units containing two or more extranuclear propositions.

4. % correct morphemes low proposition CUs = the % correct morphemes across communication units containing zero or one extranuclear proposition.

5. PCI in complex CU s = the average number of propositions in communication units containing syntactically complex clauses.

6. PCI in simple CU s = the average number of propositions in communication units containing syntactically simple clauses.

CHAPTER THREE

RESULTS

Overview

The purpose of this study was to investigate interactions between semantic, syntactic, and morphological domains, during language development. In particular, it was asked: Do children evidence the same relative level of development in each language domain? Further, do children show evidence of processing trade-offs between performance in one language domain and performance in another?

Rate of development across language domains

Question 1: Do normal-language and language-impaired children evidence the same rate of development in the semantic, syntactic, and morphological language domains?

Between group differences

To explore differences in rate of development among the three language domains, a 2-way ANOVA with repeated measures was computed. The purpose of this analysis was to simultaneously compare the relative level of development of the SLI children, in each language domain, to that of the NL children. The variables used in this analysis were as follows:

- a) Percentage of extranuclear propositions (% Ex Nuc Prop).

- b) Percentage of dependent clauses (% comp cl).
- C) The % morphemes attempted (# morphemes attempted measure reflected as a percentage of 12)..

The means and standard deviations for these three rate of development variables, are reported in Table 3, by group.

Table 3: Means and Standard Deviations for three level-of-development variables

	Group		SLI	
	NL			
	Mean	SD	Mean	SD
% Ex Nuc Prop	50.73	5.97	48.67	7.62
% comp cl	13.69	6.13	10.45	6.02
% morphemes att.	87.50	4.45	76.04	8.26

A 2-way ANOVA with repeated measures, Group (3) x Domain (3), was computed, using the above three variables, as dependent variables. The main effect for language Domain, although significant at the 0.05 level, is uninteresting since it is highly determined by the inherent structure of the language. For example, the structure of English makes it very likely that there will be more extranuclear propositions than dependent clauses in any communication unit. Therefore, the percentages for these two measures will be quite different, even for a child with equivalent competence in the two domains. Similar arguments could be made for the other pair-wise domain

comparisons.

The main effect for Group was significant, $F(1, 14) = 6.36; p < 0.05$. The Group X Language domain interaction was also significant, $F(2, 28) = 7.24, p < 0.05$. The main effect for Group is interesting, but is essentially subsumed by the Group X Domain interaction. As can be seen Table 3, children in the NL group performed at higher levels than children in the SLI group in all three domains. However, the magnitude of the group difference was much greater in the domain of morphology than in the other two domains. For the SLI group, the rate of development for morphology seems to lag behind rates of development in syntax and semantics.

Within group differences

To further explore whether children evidence the same relative level of development in each of the three language domains, Kendall Coefficients of Concordance (W) were computed for each group, separately. This coefficient is essentially an average of the pair-wise correlation coefficients, and indicates the degree to which a child who shows high levels of achievement in one linguistic domain will show similarly high levels of achievement in other domains. The focus of this analysis is, therefore, on variability among the linguistic profiles of individual children, rather than on groups as a whole. The same three level-of-development variables, outlined previously, were used in this analysis (% Ex Nuc Prop, % comp cl, and % morphemes attempted). The children in each group were ranked on each domain, so

that each child received a rank from one to eight. This ranking served as the basis for calculating the Kendall concordance coefficients. This coefficient is a measure of the degree to which each child's rank in one domain concords with his rank in the other domains. A high Kendall concordance coefficient means that the child ranked at about the same level on each domain, while a low coefficient means the child rank on individual domains is very different.

For the NL group, $W = 0.51$ and for the SLI group, $W = 0.61$. For both groups, this represents only a moderate level of agreement in the relative level of development of three language domains. Analysis of the individual ranks of children in each group, illustrates the variation across language domains. Subject LI2 ranked highest in the semantic and morphological development, but ranked only fourth in syntactic development. Conversely, subject LI4 ranked lowest in semantic and morphological development, but ranked fourth in syntactic development. Four of the children with SLI rank lowest in morphology, but higher in semantics and syntax; the reverse was true for the other four.

Similar results were found in the NL group. Subject NL3 ranked second in morphological development, but seventh and eighth in syntactic and semantic development, respectively. Conversely, subject NL5 ranked fourth in semantic and third in syntactic level, while ranking seventh in morphological development. Four of the NL children rank highest in morphology; one ranks the same across all three

domains; two rank highest in semantics and syntax; and one ranks highest in semantics and morphology.

In summary, the results of the above analyses provide two main answers to the first research question. First, relative to the NL group, the SLI group is progressing at a slower rate in their learning of grammatical morphemes. Second, children in both groups show variability in their profiles of linguistic development.

Performance across language domains

Question 2: Do children show evidence of processing trade-offs between performance in one language domain and performance in another?

Between group differences

To explore whether SLI and NL children show evidence of processing trade-offs between performance in one language domain and performance in another, 2-way ANOVAs were computed. Three 2-way ANOVAs with repeated measures, Group (2) x Complexity (2), were computed, with complexity treated within subject. Two of the analyses looked at the effect of syntactic complexity on grammatical morphemes, and on semantic elaboration, respectively. Average percent-correct-morphemes, and average number of propositions was calculated for communication units that were, and were not, syntactically complex (syntactically complex communication units contained level 1, 2, or 3 dependent clauses). The third

analysis looked at the effect of semantic complexity on grammatical morphemes, contrasting percent-correct-morphemes in communication units that have many (three or more) versus few (two or less) propositions. Group means and standard deviations for the resulting variables are provided in Tables 4 and 5.

Table 4: Group Means and Standard Deviations for the morphology and semantic variables as a function of syntactic complexity

Units		Syntactically Complex Units		Syntactically Simple	
		NL	SLI	NL	SLI
% correct morphemes	Mean	94	63	94	83
	SD	6.4	26.0	3.0	7.2
PCI	Mean	1.63	1.55	2.18	2.18
	SD	0.13	0.14	0.30	0.30

Table 5: Group Means and Standard Deviations for the morphology variable as a function of semantic complexity

		Semantically Complex Units		Semantically Simple Units	
		NL	LI	NL	LI
% correct morphemes	Mean	94	84	93	83
	SD	7.6	7.4	1.6	7.1

The first analysis looked at % corr morph in syntactically complex versus syntactically simple communication units. The purpose of this analysis was to test whether level of morphological usage differed as a function of syntactic complexity, and to see if this effect differed according to group. There were significant main effects for Group, $F(1, 14) = 17.9, p < 0.05$ and Syntactic Complexity, $F(1, 14) = 4.5, p < 0.05$. There was also a significant Group X Syntactic Complexity interaction, $F(1, 14) = 4.4, p = 0.05$.

Children in the NL group used a higher percentage of grammatical morphemes in obligatory contexts (94%) than did children in the LI group (83%). Across groups, grammatical morphemes were used correctly in syntactically simple CUs more often (89%), than in syntactically complex CUs (78%). However, inspection of Table 4 indicates that, virtually all of this difference was due to the performance of the LI

group.

The second analysis looked at the average number of propositions (PCI) in syntactically simple versus syntactically complex communication units. The purpose of this analysis was to test whether semantic elaboration differed as a function of syntactic complexity, and to see if this effect differed according to group. There was a significant main effect for syntactic Complexity, $F(1, 14) = 100.4; p < 0.05$. Children in both groups had a higher PCI in syntactically simple communication units, than in syntactically complex communication units. There was no significant main effect for Group, at the 0.05 level. There was also no significant Group X Syntactic Complexity interaction.³

The third analysis looked at % corr morph in semantically complex versus semantically simple communication units. The purpose of this analysis was to test whether morphological usage differed as a function of semantic complexity, and to see if this effect differed according to group. There was a significant main effect for Group, $F(1, 14) = 13.12; p < 0.05$. Children in the NL group used a higher percentage of grammatical morphemes in obligatory contexts (94%) than did children in the LI group (83%). There were no significant main effects for semantic complexity. There was also no significant Group X Complexity interaction. No analysis of syntactic level as a function of semantic complexity was performed.

In summary, this set of ANOVA provide clear answers to the second research question. Findings indicate that complexity in one domain does affect performance in a second domain. For the SLI group, accuracy of morphological usage is reduced with increased syntactic complexity. For the NL group, there is no such effect on morphological usage. In both the NL and SLI group, the average number of propositions expressed is fewer in syntactically complex communication units.

Individual subject performance

The purpose of the next set of analyses was to explore variability in language performance within the groups of SLI and NL children. The focus of the investigation was on individual profiles of children and on those domains where the ANOVA indicated that performance was affected by linguistic complexity: That is, morphological performance as a function of syntactic complexity, and semantic elaboration as a function of syntactic complexity.

Morphological performance as a function of syntactic complexity

The mean for % correct morphemes in syntactically complex communication units was 83.6, with a standard deviation of 13, across both groups of children. The mean for % correct morphemes in syntactically simple communication units was 88.9, with a standard deviation of 7.9, across both groups of children.

The individual scores for % correct morphemes in syntactically complex versus

syntactically simple communication units, for children in the SLI group, are shown in Table 6.

Table 6: Individual scores of LI children for % corr morph as a function of syntactic complexity

Subject	% corr morph syn comp	% corr morph syn simp	difference
LI 1	67	76	+ 9
LI 2	80	93	+ 13
LI 3	80	85	+5
LI 4	65	90	+25
LI 5	67	73	+6
LI 6 *	0	86	+86
LI 7	69	87	+18
LI 8	71	77	+6

Inspection of Table 6, reveals that, on average, children in the SLI group use grammatical morphemes 10% more successfully in syntactically simple communication units. Some interesting findings regarding variability in morphological performance in syntactically complex versus syntactically simple utterances can be observed. First, all of the children in the SLI group use grammatical morphemes more successfully in syntactically simple communication units. Individual profiles are, therefore, in accord with the previously reported group findings.

Second, there is a some observed variability between the children in the group. This effect is seen in varying degrees from child to child. Five of the children with SLI (LI 1, LI 4, LI 5, LI 6, and LI 7) fall more than one standard deviation below the mean for % correct in syntactically complex communication units. Only two of these same children (LI 1, LI 5), however fall more than one standard deviation below the mean for % correct in syntactically simple communication units. This suggests that the remaining three subjects were the primary contributors to the observed group effect. Inspection of Table 1 indicates that these three children cannot be distinguished from the other five by virtue of gender, age, or performance IQ. They do, however, represent the midrange of MLU-w values in this sample.

The performance of subject LI 6 proved to be misleading. Although, he scored 0 on % correct morphemes in syntactically complex communication units, inspection of the data revealed that he produced only a single complex communication unit. Only a single grammatical morpheme was attempted. His performance cannot be taken as indicative of anything. Therefore, the ANOVA for % correct morphemes in syntactically complex versus syntactically simple communication units, was computed again, excluding subject LI 6. The following results were found: A significant main effect for Group, $F(1, 13) = 38.74, p < 0.05$; a significant main effect for Syntactic Complexity, $F(1, 13) = 13.67, p < 0.05$; and a significant Group X Syntactic Complexity interaction, $F(1, 13) = 13.08, p < 0.05$. These findings are in full agreement with those reported earlier on the full sample. If anything,

reduction of the SLI group variance led to a sharpening of trends.

The scores for individual children in the NL group, for % correct morphemes as a function of syntactic complexity, is shown in Table 7.

Table 7: Individual profiles of NL children for % correct morphemes as a function of syntactic complexity

Subject	% corr morph syn comp	% corr morph syn simp	difference
NL 1	80	89	+9
NL 2	96	93	-3
NL 3	100	94	-6
NL 4	100	97	-3
NL 5	94	97	+3
NL 6	93	91	-2
NL 7	92	95	+3
NL 8	97	97	0

Inspection of Table 7 shows that, there is, on average only about 4 % difference in use of grammatical morphemes in syntactically simple versus syntactically complex communication units. For the NL children, there is far less variability than was seen in the SLI group. All of the children score within one standard deviation of the mean for % correct morphemes in syntactically complex communication units. All except one child (NL 1) score within one standard deviation of the mean for % correct

morphemes in syntactically simple communication. It is interesting to note that NL 1, who uses grammatical morphemes more successfully in syntactically simple communication units is also the youngest subject.

Semantic performance as a function of syntactic complexity

The means and standard deviations for PCI as a function of syntactic complexity, across both groups, are shown in Table 8.

Table 8: PCI means and standard deviations, as a function of syntactic complexity, across both groups

		Syntactically Complex Units	Syntactically Simple Units
PCI	Mean	1.59	2.18
	SD	0.14	0.29

Individual profiles for semantic elaboration, as a function of syntactic complexity, for the children in the SLI group, are outlined in Table 9.

Table 9: Individual profiles for semantic performance X syntactic complexity for SLI subjects

Subject	PCI syn comp	PCI syn simp	difference
LI 1	1.4	1.7	+ 0.3
LI 2	1.7	2.5	+ 0.8
LI 3	1.6	2.3	+ 0.7
LI 4	1.6	1.8	+ 0.2
LI 5	1.5	2.1	+ 0.6
LI 6	1.3	2.2	+ 0.9
LI 7	1.6	2.3	+ 0.7
LI 8	1.7	2.5	+ 0.8

Inspection of Table 9 reveals that, on average, children's semantic elaboration is about 0.6 units higher in syntactically simple communication units, and that all of the children in the SLI group express more propositions in the syntactically simple communication units. There is some variability among the children within the SLI group. Two of the subjects (LI 1 and LI 6) score more than one standard deviation below the mean for PCI in syntactically complex communication units. However, LI 6 scores more than one standard deviation above the mean for PCI in syntactically simple communication units; LI 1 scores within one standard deviation. Two other subjects (LI 2 and LI 8) score more than one standard deviation above the mean for PCI in syntactically simple communication units, but within one standard deviation

for PCI in syntactically complex communication units.

Table 10 Individual profiles of semantic performance X syntactic complexity for NL subjects

Subject	PCI syn comp	PCI syn simp	difference
NL 1	1.6	2.0	+ 0.4
NL 2	1.5	1.9	+ 0.4
NL 3	1.7	1.9	+ 0.2
NL 4	1.4	1.9	+ 0.5
NL 5	1.7	2.3	+ 0.6
NL 6	1.7	2.3	+ 0.6
NL 7	1.8	2.7	+ 0.9
NL 8	1.7	2.4	+ 0.7

On average, there is about a + 0.5 units difference in semantic elaboration as a function of syntactic complexity for children in the NL group. All of the children in the NL group express more propositions in syntactically simple communication units. There is very little variability for individual children between semantic performance in syntactically complex versus simple communication units. NL 4, scored more than one standard deviation below the mean for PCI in syntactically complex communication units, but within one standard deviation in syntactically simple communication units. All other subjects scored within one standard deviation in both performance domains.

In summary, the individual subject performance analysis indicates that there is some interesting variability in the degree to which morphological performance and semantic elaboration, is affected by syntactic complexity. For both variables, there was more significant variation among children in the SLI group. The individual subject data, however, substantiate the findings from the grouped ANOVA reported earlier.

Morphological performance versus morphological development: one dimension or two?

In this study, two different, composite measures of morphology were used in an effort to distinguish between developmental level and on-line performance. The developmental measure, *# morphemes attempted*, was the number of different morphemes that children attempted, and for which performance reached at least 50% accuracy on at least three attempts. The total number of grammatical morphemes analyzed was 12. The performance measure, *% correct morphemes*, was the combined percent correct use in obligatory contexts for the same 12 grammatical morphemes, a measure which has been used in most studies of morphology. Both of these measures were taken across all communication units.

The final analysis in this study was carried out to determine if there is a link between these two variables; that is, the on-line use of grammatical morphemes and overall developmental level. As operationalized here, the question becomes: Do children

with a high % correct morphemes also show a high number of morphemes attempted? In Table 11, the morphological performance and morphological development measures for the SLI children are shown.

Table 11: Morphological performance versus morphological development variables for the SLI children

% correct morphs			
70-79	80-89	90+	# morph att
*		*	8
**	**		9
	*	*	10-11

Inspection of Table 11 shows that there is some link between the two measures, as expected. However, this association is quite weak as demonstrated by a Kendall rank correlation coefficient of only 0.38. There seems to be considerable independence between morphological performance and level of morphological development, for the group of children with SLI. Two of the eight subjects receive 90% and higher in the performance measure; however one receives the lowest and one the highest score, in developmental attainment. Conversely, two other subjects are low in developmental attainment, with one being high in performance and one being low.

A similar analysis was carried out for the NL group. However, there was too little variance in this group for the analysis to be revealing. Six out of the eight NL

children performed at or above 90% correct morpheme use and all of the children attempted at least 10 morphemes. Therefore, there was insufficient variance to make further analysis worthwhile.

The above analysis clearly demonstrates that the two composite measures of morphology used in this study were not just two sides of the same coin. A high score in the performance measure did not necessitate a high score in the developmental measure. The converse was also true.

Summary of significant findings

Level of development

1. In comparison to a language-matched group of normally developing children, the SLI children in this study evidence lower levels of development in morphology, but not in syntax or semantic complexity.
2. For both SLI and NL children, developmental levels are only modestly (0.5 to 0.6) correlated among the linguistic domains of morphology, syntax, and semantics.

On-line language performance

1. Morphological performance of SLI children is reduced as a function of syntactic complexity. The same was not true for language-matched NL children.

2. Morphological performance of neither SLI, nor NL children is affected by semantic complexity.
3. Semantic elaboration of both SLI and NL children, taken together, is reduced as a function of syntactic complexity
4. The effect of syntax on morphological performance varied considerably among the SLI children.
5. For the SLI children, there was only a low correlation between level of development in morphology and accuracy of use of morphology.

CHAPTER FOUR

DISCUSSION

Overview

The present study was designed to explore interactions between semantic, syntactic, and morphological language domains, in a group of language-impaired and a group of normal-language children. Two major research questions were asked: 1) Do children evidence the same relative level of development in each language domain? 2) Do children show evidence of processing trade-offs between performance in one language domain and performance in another? For each research question, separate between- and within-group analyses were carried out.

Based on the relevant research literature, reviewed in Chapter One, it was expected that children would demonstrate both on-line performance interactions and developmental asynchrony among language domains. Unlike previous investigations, this study attempted to differentiate between these two kinds of relationships in the same group of children. It also is one of only a few studies to combine analyses of three linguistic domains: semantics, syntax, and morphology. Interesting and significant results were found for both developmental and performance relationships.

Review of results: rate of development

The first set of findings relates to the rate of development across the semantic, syntactic, and morphological domains. The results presented in the previous chapter indicate that a child's level, and hence rate, of development can differ from one aspect of language to another. The between-group analyses reveal that children in the SLI group generally used forms at somewhat lower levels, in the three domains investigated. However, the magnitude of the group difference was much greater in the domain of morphology than in the other two domains. For the SLI group, the rate of development in morphology seems to lag behind rates of development in syntax and semantics. Therefore, the findings confirm previous reports of morphological weakness in the SLI population (see Johnston, 1988 for a review), albeit in variable degrees from child to child.

However, the findings from this study fail to confirm previous research that has found that SLI children express fewer propositions per utterance relative to a group of language-matched normal-language children (Johnston & Kamhi 1984, Gillam & Johnston 1992). It is important to recall that in this study children were matched according to MLU in words, whereas in the two studies cited above, children were match on MLU in morphemes. Therefore, the differential findings are probably due to the different matching strategies. The current data indicate a moderately high correlation between MLU in words and Propositional Complexity Index for all children (Kendall rank correlation = 0.60). As a result, matching children on MLU

in words leads to a parallel match in PCI.

The within-group analyses indicate that rates of development among aspects of language can vary for NL children also. This set of analyses investigated the variability among the linguistic profiles of individual children by comparing within-group rankings for each domain. For children in each group, only a moderate level of agreement was found in the relative level of development of the three language domains. For children in the LI group, morphology always stood out on its own. That is, four out of the eight children ranked higher in morphology than in semantics and syntax; for the other four, the reverse was true. For the NL group, more diversity existed, so that a single domain was not always ahead or behind the others.

Despite a considerable range of ages both within, and across groups, the range of language competencies found in subjects in this study was actually quite limited, at least as indicated by the MLU measures used here. It remains possible that there would be higher correlations among linguistic domains if a wider developmental range had been sampled. Nevertheless, the findings reviewed above do provide evidence for asynchronous development in both groups of children.

Moore & Johnston (1993) argue that this kind of asynchrony may be evidence for the selective nature of the underlying disorder seen in SLI children. As a group, they can be argued to show a relative strength in the semantic and syntactic domains. An

alternate view would be that they demonstrate a relative weakness in morphology. Moore & Johnston (1993) argue that if the former is true, than one could argue that this relative strength can be seen as evidence of a mature conceptual processor that has supported semantic and syntactic learning. Conversely, if the latter is true, then the relative weakness could be taken as evidence of an inefficient perceptual processing mechanism that has further impeded morphological learning. Moore & Johnston, therefore, argue that the same cognitive mechanisms that guide other human behaviour, also guide the language performance of children with SLI. In one case, they argue that a strong cognitive mechanism is guiding learning, while in another case, a weak perceptual system impedes learning. Bates, Bretherton, and Snyder's (1988) explanations for developmental patterns are very similar to those outlined by Moore & Johnston, however they extend their arguments to normal-language children.

Bates et al (1988) argue that not all normal-language children learn all aspects of language the same way. For example, in the earliest phases of acquisition there is considerable evidence to suggest that the individual phonological repertoire of children's babble serves as the basis for the subsequent organization of their lexicons. Children thus show idiosyncratic preferences for certain consonant places and manners in both their canonical babble and their first word productions. Therefore, Bates et al (1988) comment that there are qualitative, as well as quantitative variations in the language learning process. These individual differences in the

“content” of early language development may lead to the identification of universal “mechanisms” responsible for that content. Bates and her colleagues argue for an interactionist view of language acquisition.

“Language is an interactive system that depends crucially on processes and representations from a variety of cognitive domains. Acquisition of language will be shaped and timed by the emergence and development of these requisite cognitive systems (Bates et al 1988, p. 7)”.

According to Bates et al, language performance or behaviour is shaped by the same cognitive systems (e.g. memory, reasoning, attention) that shape other human behaviour. Therefore, to the extent that such general cognitive mechanisms have definable boundaries and differing capabilities, asynchronous development is possible. This line of argument, of course, presumes the relevance of general cognition in language acquisition, this a viewpoint that is not universally accepted. Nativists, who favour several specific language modules, might take asynchrony as proof of their position. However, a number of studies, outlined below, demonstrate that asynchronous development can arise from a single learning mechanism, and hence suggest that the strong modular view is not necessarily supported by evidence of asynchrony.

Plunkett and Marchman (1993) studied the acquisition of the English past tense by an artificial neural network. They found that this network, like children,

underwent several changes in language performance over the course of mastering a system of inflectional morphology. They investigated the acquisition of irregular (lexical) and regular (inflectional) past tense, separately. Plunkett and Marchman found that the neural network learned the regular and irregular past tense simultaneously, with the same mechanism and shifting levels of relative mastery between the systems. They also found that with continued increases in vocabulary size, the network began to make more over regularization errors, in the same way that children go through a period of overgeneralization of the past tense. Plunkett and Marchman argue that this is convincing evidence that shifting levels of mastery within and between various systems, as demonstrated by variable language performance in the 'real world' does not necessitate the existence of more than one learning mechanism. Instead, they suggest that a single learning mechanism is involved in children's acquisition of English verb morphology. This learning mechanism is capable of attending to, encoding, storing, and retrieving, specific linguistic items, as well as generalizing across patterns of forms.

According to Marchman and Bates (1994), strong modular views tend to argue that the modular boundaries of acquisition mechanisms are determined by separate and distinct linguistic domains. In such views, there are separate morphosyntactic, phonological, or lexical-semantic domains, each guided by a

separate and distinct acquisition mechanism. If this were the case, we would not expect to observe interactions among language domains, like those found in the present study. If there is indeed a separate syntactic learning mechanism and a separate morphological learning mechanism, then these two domains should not be overlapping in any way or influencing each other in any fashion. However, as shown by the present findings, this is clearly not the case. Children's morphological performance was affected by the syntactic complexity of utterances. This kind of data is evidence against strong modular views.

Marchman and Bates also argue that inter-domain correlations in early language acquisition studies disprove the existence of separable mechanisms or processors, in both normal-language and language-impaired populations. For example, Bates, Bretherton and Snyder (1988) found that vocabulary development is a strong predictor of subsequent achievements in morphology and syntax. Furthermore, the best predictor of MLU at 2;4 was size of vocabulary at 1;8. These strong cross-domain, as well as within-domain, correlations suggest that there are clear developmental continuities between language domains, and could well indicate that they are shaped and guided by a single acquisition mechanism.

Based on the research studies reviewed above, data from the current study cannot be easily taken as evidence of nativist and strong modular positions. Variable rate of

development among different language domains does not necessitate the existence of more than one learning mechanism. Children, by virtue of individual differences in cognitive strengths and limitations, will show variable performance in language profiles. For English-speaking children with SLI, this language profile includes delayed learning in grammatical morphology.

Review of results: Processing trade-offs

The findings of this study are similar to those reported by studies of interactions between language domains, reviewed in Chapter One (e.g. Panagos, Quine, & Klich 1979; Panagos & Prelock, 1982; Paul & Shriberg 1982; and Camarata & Schwartz 1985).

Three different analyses were conducted to explore the possibility of processing trade-offs between performance in one language domain and performance in another domain.

Two of the analyses looked at the effect of syntactic complexity on the use of grammatical morphemes, and on semantic elaboration. The third analysis looked at the effect of semantic complexity on the use of grammatical morphemes.

The first analysis revealed that the morphological performance of children in the NL group was not affected by either semantic or syntactic complexity. Conversely, the morphological performance of the SLI children dropped significantly in syntactically complex communication units, but not in semantically complex ones. The third significant finding was that the semantic performance of both groups of children seemed

to be negatively affected by the syntactic complexity of communication units. That is, both the language-impaired and the normal-language children seemed to express fewer propositions in communication units containing complex dependent clauses. Analyses of individual subject performance largely confirmed these grouped findings.

An appeal to models of limited processing capacity helps guide us towards an explanation of these findings. Recall, from chapter One, that according to this view, there is a limited amount of attentional resource that can be allocated to different tasks at any one time. It is possible that SLI children have a lesser amount of attentional resource to allocate, as compared to a normal-language group. Another possibility is that SLI children have an attentional pool that is equivalent in size to that of normal-language children, but do not use it as efficiently. It may be that for the SLI children, the use of grammatical morphology has not yet been fully automatized. Children with SLI would then need to allocate more attentional resource to performing adequately in the morphological domain, which is under controlled processing. Once they attempt to express syntactically complex utterances, in an already taxed system, they would begin to run out of attentional resources, eventually resulting in a drop in morphological performance.

One explanation for morphology being the vulnerable domain for these children is that it is the 'least important' in expressing meaning in English. That is, it is more detrimental

to the meaning of utterances to leave out syntactic structures than it is to omit morphological inflections. During the course of acquisition, the SLI children have “chosen” to allocate available resources to syntactic and semantic learning. Therefore, the morphological system has “suffered” in that it is not yet fully automatic and continues to be under controlled processing. Morphology is not vulnerable in normal-language children, because for them this domain is under automatic control. It is possible that in very young normal-language children, grammatical morphology will be affected in the same way as it is for the SLI children in this study.

The body of literature showing memory and attentional deficits in children with SLI (Macworth et al., 1973; Riddle, 1992) strengthens further the plausibility of arguments that a limited processing capacity affects language performance. A child with an impaired attentional system will not be capable of making efficient and economical use of available attentional resources. Note that the interaction between the morphological and syntactic domains seems to be a constraining one, at least for this group of SLI children as compared to the NL group.

Semantic elaboration seemed to be affected by syntactic complexity in both groups of children. The interaction observed between these two domains is not a reflection of the vulnerability of one or the other system, however, but a question of possibility. That is, clauses with relatively simple verb phrases (low “syntactic complexity”, as measured

here) free up more resource for semantic elaboration elsewhere in the sentence. Semantic elaboration in the form of adverbials, noun phrase elaboration, and negation is more likely to occur in syntactically simple clauses than in syntactically complex clauses because of reduced formulation demands in these latter clauses. Therefore, the interaction between the syntactic and semantic domains seems to be a facilitative one: simple syntactic clauses allow for greater semantic elaboration in parts of the sentence structure not directly related to the verb phrase.

The findings of this study failed to find an interaction between the morphological and semantic domains, for either group of children. This finding may reflect the nature of English grammatical morphology, rather than any universal distinction between these two domains. In the propositional complexity analysis used here, the nucleus is expressed by the main (i.e. tensed) verb of the CU and every CU contains a nuclear proposition. This means that all CU s, regardless of semantic complexity, have relatively similar amounts of verb morphology. In English, the majority of grammatical inflections are expressed on the verb phrase, while noun phrase inflections are very limited. Extra-nuclear semantic elaboration had little or no implication for increased use of morphology. It is possible to imagine that in languages that are richer in noun phrase morphology, such that a greater number of grammatical morphemes appear on extranuclear predicates, an interaction between performance in morphology and performance in semantics could be observed. It is also possible that such an interaction could be observed, even in English, for children

with less control of verb morphology.

Morphological performance versus morphological development

Recall, that in this study two different measures of morphology were used in an effort to distinguish between developmental level and on-line performance limitations. This type of distinction was not possible for the other two domains. It is possible to make this distinction in the domain of morphology because it is possible to track attempts. It could be argued that in the syntactic domain, a comparable measure of performance would be word order or noun phrase errors and/or omissions. However, children in this study made very few word order errors (on average, one or two per sample), making it impossible to develop this as a measure of syntactic performance. For the semantic domain, it is difficult even to imagine a pure performance measure, as it not possible to track attempts or count unexpressed propositions.

In the morphological domain, however it was possible to demonstrate that children with SLI not only **know** less about grammatical morphology, but also **use** less of what they do know. The two measures of morphology used in this study were clearly measuring different capacities: one measured morphological competence, the other morphological performance. High performance on one measure did not necessarily imply high performance on the other. These findings relate more generally to current debates (e.g. Bishop, 1994) about linguistic competence versus linguistic performance in children with

SLI. The morphology data demonstrate, however, that there is a relationship, albeit imperfect, between developmental level (delay in morphology) and performance errors. Asynchronous development and limited processing capacity were both seen in the same group of children. It is possible to imagine, based on these findings, that asynchronous development is a consequence of a limited processing capacity. A limited processing capacity could affect the acquisition of specific linguistic structures as well as the momentary processing of these structures.

Conclusions

The findings of this study provide clear answers to both of the research questions posed: evidence of asynchronous development, as well as processing trade-offs were found, in both groups of children. The present study provides a new perspective on the issue of heterogeneity. The relative strengths and weaknesses of children in various domains may need better differentiation. Perhaps we can distinguish between, at least, three groups of children: those with performance limitations only, those who are less competent, and those with performance limitations and less competence. This latter typology may be a better way of classifying children with specific language impairment, because it is no longer a simple description of observed phenomena, but also implies an explanation.

This study also raises a final interesting issue: perhaps synchrony is merely a statistical artifact. That is, it is possible to imagine that synchrony does not exist in the 'real world'.

Perhaps, children will never demonstrate equivalent competence in all language domains. That is, sampling across ages and developmental levels may show that children will always show relative strengths and weaknesses across the different language domains. Therefore, it seems futile to use the notion of asynchronous development as the defining feature of SLI.

Research implications: Methodological considerations

The two major methodological implications of this study pertain to the study of interactions and to the communication unit as a unit of analysis. In this study, syntactic performance and semantic elaboration were not studied as a function of morphology because it was impossible to develop a satisfactory definition of morphologically simple versus morphologically complex CUs. That is, it was very difficult to devise a “morphologically complex” measure at the sentence/utterance level. One possibility would be to make a distinction between late versus early learned morphemes, such that, those CUs containing late learned morphemes would be considered complex, while those containing early learned morphemes would be considered simple. However, there is, as yet, no widely accepted consensus in the literature on the order in which grammatical morphemes are acquired. A second alternative would have been to count the number of morphemes in each CUs and set an arbitrary criterion. For example, CUs containing one to two grammatical morphemes could be considered simple, while those containing more than two (the maximum possible would probably be three) could be considered

complex. However, this type of arbitrary assignment based on number of morphemes is not supported by any previous research. Furthermore, the range of grammatical morphemes between 'complex' and 'simple' utterances would be so minimal, that any conclusions regarding trade-offs would be virtually impossible to make. Other researchers may be able to solve this problem. However, the notion of semantics and syntax being controlled by morphology ultimately runs counter to intuitions about logical and functional priorities.

The second major methodological implication stemming from the present study is the use of the communication unit as the unit of all linguistic analyses. The consequence of using the CU is that the variability among and within groups of children is reduced, because the variety of types of utterances is reduced. Also, all utterances are guaranteed to have a basic syntactic and semantic load. These two consequences taken together assure that children start out from a more "level playing field". One negative consequence of having a "level playing field" is that ultimately, it overestimates the competence of the SLI children. That is, it may not be representative of relative abilities and limitations. However, it served the purposes of the present study well, since any variance due to child or examiner conversational style was reduced. Also, it limited utterances to those with the greatest processing load.

Research implications: Future directions

This study represents one of only a handful of studies investigating interactions between language domains as a way to explain heterogeneity in linguistic performance.

Furthermore, it is probably the only study to look at performance and developmental relationships in the same group of children. Many more studies looking at interactions between two or more language domains are needed. It is important that these studies investigate performance and developmental relationships at the same time.

One of the disadvantages of the current study was its cross-sectional nature. There is a need to track a group of NL and SLI children longitudinally, while looking at performance and developmental relationships among language domains. This will help determine if the amount or type of asynchrony and/or processing trade-offs vary over time and in the same way for NL and SLI children. That is, does asynchrony always exist or are there points in development when language domains are all at the same developmental rate, relative to an average standard. Perhaps, there is a point at which asynchronous development is no longer observed; if there is indeed such a thing as “synchrony”. Finally, crosslinguistic studies are needed that investigate interactions between language domains in the same way. This kind of research will not only expand our knowledge and understanding of language disorder, but also normal language acquisition.

Clinical implications

The findings of this study also have important implications for speech and language clinicians working with children with language disorders. First, taking a single composite measure of language behaviour may lead to an inaccurate profile of the abilities and limitations of children. Clinicians need to compare children to each other, as well as to themselves on a variety of tasks across several language domains. Second, clinicians must consider and have a better understanding of the effects of linguistic complexity and task demands on the language performance of children with language disorders. For example, clinicians could select a set of 'syntactically complex' utterances from the spontaneous speech sample of a child and analyze it for morphological error. This measure could then be compared to morphological error in 'syntactically simple' utterances. Both of these measures can then be compared to a global, overall measure of morphological competence. In this way, the clinician could determine whether the observed language behaviour is due to performance limitations or inadequate competence. Similar analyses could be carried out in all the other language domains. Therefore, it is important to measure language behaviour in different ways so as to differentiate between performance limitations and actual developmental level. Making such distinctions will allow clinicians to make more informed decisions about the nature of the language disorder, as well as to help them devise a sound intervention plan.

REFERENCE NOTES

1. Following Loban's conventions, 'so' was counted as a subordinate conjunction, despite it not being one. There were only minimal instances of this conjunction in the utterances of the children.
2. Following Paul's conventions, 'if' was included at this level even though the distinction is a lexical and not a syntactic one. However, the number of clauses marked by 'if' was extremely low.
3. No test was made of the possibility that syntactic complexity would vary as a function of semantic complexity. From a limited processing capacity perspective, a maximal semantic load could well compromise the grammatical integrity of an utterance. In reality, and as operationalized in this study, however, such an interaction seemed either uninteresting, or impossible to measure. Increased propositional complexity has obvious and direct implications for increased syntactic complexity. It is, after all, the function of grammar to convey relational meanings. Comparison of the two analysis schemes reveals that many sorts of extra-nuclear propositions are necessarily expressed in higher level clause and verb phrase structures. This guarantees some level of correlation between syntactic and semantic measures and reduces the possibility of interaction effects. The correspondence between the two schemes is far from total, however. The syntax measure does not attend to noun phrase elaboration (other than relative clauses), negation, or lexical and phrasal adverbs. This means that many sorts of associated or adverbial propositions could be present in the semantic network without contributing to the syntactic index.

This being so, greater and lesser degrees of elaboration in one part of a semantic network could have consequences for the syntactic realization of a different part of the network. For example, an intent to specify the time of an event or the size of an agent could, in principle, lead to simplification of a verb phrase. There are, however, at least two problems with this line of argument, one theoretical and one practical. First, this argument presumes that all components of a communicative intent have equal value. This is clearly not the case. One proposition underlying each sentence receives the major focus, i.e. serves as the nucleus. Whatever syntactic means are required by this proposition with its embedded arguments, would presumably be preserved under processing pressures. Simply put, if there is a competition for resources between the main verb and a descriptive adjective, the verb will win. And this introduces the second, practical problem. The semantic measure is of necessity, indirect, using lexical cues to infer underlying ideation. Hence, in our hypothetical competition there would be no way to know that the adjective lost out. We can note that a noun phrase is simple, but we cannot know whether this simplicity represents a failed intention.

Given all of the above, there is only one small arena in which it might be possible to observe the effects of high vs. low semantic loading on syntactic complexity, namely verb phrase error. Sentences with more negatives, adjectives and adverbs (i.e. those in which adverbial and associated propositions were successfully expressed) might contain greater word order error or omission of obliged noun phrase arguments. For the present study, additional syntactic measures of this sort could have been created to allow for a test of a syntax x semantics interaction. Preliminary analyses indicated, however, that these types of syntactic errors were exceedingly rare in the speech of children sampled here. In short, there did not seem to be a plausible test of the possible processing effects of semantic complexity on syntax, and none was carried out.

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Appendix A

The Communication Unit (Loban, 1976)

Key concepts for this analysis:

1. Communication units are independent clauses and their modifiers.

- A. Independent clause: a complete sentence that usually has a noun + verb in a subject-predicate relationship.
- B. Dependent clause: Part of the independent or main clause; typically cannot stand alone; joins with independent clause to add complexity and information; has a subject + verb, serves as noun, adjective, or adverb in the independent clause. Dependent clauses are marked between [].

Examples:

- i) The boy [who my father knows] went home.
- ii) Look [what she can do].
- iv) When you close your hand [that's how big your heart is].
- v) Those are all the kind of food [that're good for you].
- vi) But soon I'm gonna get a cat [that's white with black spots].

2. Clause structure and compound clauses.

A. Clauses headed by the following lexical items are considered structurally complete and could stand alone as separate communication units (two independent clauses)

- 1. Coordinating conjunctions to include: and, but, for, or, nor, yet

Example: I was hungry [but could not find a restaurant].

- 2. Conjunctive adverbs to include: however, moreover, consequently

Example: The children wanted to play outside, [however it was raining].

B. The following are dependent clauses which modify the main clause and cannot stand alone

1. Subordinating conjunctions to include: because, so , if, since, when, although

Example: [If you finish], you may go to the park.

2. Relative pronouns to include: who, which, what, that

Example: I wonder [who she call/ed].

To illustrate how communication units are identified using the above procedure, an example is provided (communication units are marked by (/))

Example 1: and his mother says "now don't be ridiculous"/ you know you're eating an orange/ and how can you starve to death while you're eating an orange?"/ (3 communication units)

Example 2: and so Johnny said "well if I weren't may I go down to the lollipop store?"/ and she said "no, you've been down to the lollipop store too many times this week."/ (2 communication units)

Appendix B

The Propositional Complexity Analysis (Johnston & Kamhi, 1984)

1. Assumptions

- i) Utterances may contain more than one idea-unit
- ii) Children gradually learn to compress more idea-units into one utterance

2. Definitions

- i) Propositions - an idea-unit or a judgement about something consisting of a predicate with its affiliated arguments.
- ii) Predicate - the central core of the proposition; the judgement regarding a state, relation, change of state, activity.
- iii) Argument - the “objects” which necessarily participate in the state, relation, process; expressed as noun phrases.
- iv) Nuclear Predicate - the pivot point in the idea network underlying an utterance; expressed by the finite (tensed) verb.

Examples

- a) I saw grandma yesterday.
- b) I know how to play that game.
- v) Extranuclear Predicates - one of three ways to “add” predicates to the nuclear predicate

A. Adverbial Predicate - takes the entire nuclear proposition as one of its predicates

Example

- a) I was playing in the kitchen.
- b) I love chocolate because it's sweet.

B. Embedded Predicates - an argument of the nuclear predicate

Examples

- a) I told mommy not to go away.
- b) I think that game is hard.

C. Associated Predicates - modifies an argument of the nucleus

Examples

- a) The red car is coming.
- b) Read me a story about the three bears.

3. What counts as a predicate

- i) Nuclear predicates or embedded predicates = main verb, modal verb, BE + predicate adjective, BE + preposition, BE + predicate noun.
- ii) Associated predicates = any of the above when they occur inside a relative

clause, modifying adjectives, prepositional phrases (usually of, about).

- iii) Adverbials = subordinating conjunctions, adverbs, adverbial prepositional phrases, negatives, and possessive nouns and pronouns.

4. What does not count as a predicate

- i) Prepositions that only mark the argument type (e.g. those that are associated with verbs of motion, location or transfer and passives).

Examples

a) We gave the apple to Adam.

b) I put the ball in the bucket.

- ii) Auxiliary verbs BE and HAVE because they only indicate the tense and aspect of their affiliated predicates.
- iii) The copula BE when followed by a predicate adjective, a predicate noun, or a prepositional phrase.
- iv) There + BE + Quantifier + NP. These kinds of sentences have only one underlying predicate.

5. How to calculate the Propositional Complexity Index (PCI)

- i) Code or otherwise mark all nuclear and extranuclear predicates
- ii) Count the total number of predicates
- iv) Divide the total number of predicates in the sample by the total number of utterances/sentences/communication units.

Appendix C

Levels of Clausal Complexity

Level 0

1. Communication units containing a simple clause with no dependent clauses
2. Communication units containing simple infinitive clauses

Examples:

- a) They're not shoes.
- b) He has to go.
- c) She wants to stay.
- d) We need find an ambulance
- e) I wanna play.
- f) He like to eat birds.

Level 1

1. Communication units containing "let's" or "let me"

Examples:

- a) Let's get in.
 - b) Let me see.
 - c) Let me do it.
2. Communication units containing full propositional complements, headed by verbs like 'think', 'guess', 'wish', 'wonder', 'know', 'hope', 'show', 'remember', 'pretend', 'forget', 'say', and 'ask'. The clause

may or may not be marked by 'that'.

Examples

- a) The doctor says that baby's crying.
 - b) Pretend you did that.
3. Communication units containing a single, simple, finite wh-clauses marked by 'what', 'where', 'why', 'how' with the same subject as the main clause.

Examples

- a) I know what we could play.
- b) Look how tall I am.
- c) Remember where it is?

Level 2

1. Communication units containing a simple plus a subordinate clause marked by 'because' or 'so'.

Examples

- a) It's not a bulldozer, because it don't have that.
- b) He wants to go home so I'm gonna take him.

Level 3

1. Communication units containing infinitive clauses with

subjects different from that of the main sentence.

Examples

- a) This is the way you have to do it.
 - b) I want it to go over there.
2. Communication units containing relative clauses; they may or may not contain 'that' or 'which'.

Examples

- a) This kind is not the kind that I want.
 - b) I like those toys you have.
3. Communication units containing the conjunction 'if'

Example

- a) We always go outside if it's not raining.
4. Communication units containing gerund clauses; gerunds used as adjectives are not counted (e.g. These are running shoes; The stacking cups are red).

Examples

- a) I felt like turning it.
 - b) We could make it start working with this.
5. Communication units containing wh-infinitive clauses with the subject different than that of the main clause or more than one embedding

Examples

- a) He tells her how to make one.
- b) I don't know where to put the car.
- c) I want you to show me what to do.

6. Communication units containig unmarked clauses headed by 'help', 'make', 'watch', 'let' with subjects different from that of the main clause.

Examples

- a) She made him eat brocolli.
- b) Help me pick these up.

Appendix D

Portion of a Transcript showing child A's utterances, with Complete Coding

A (They/'re too tight with s* with) they/'re [NP] too [ENP] tight with [ENP2}
tights on [SC] [CU]

A (Um) I forget [NP] what size they are [ENP] [SC] [DC1] [CU].

A Look, they/'re>

A I guess [NP] I have [ENP] to take [ENP2] my [ENP3] tights off [SC] [DC1]
[DC1] [CU].

A But (I/'m) soon [ENP] I/'m gonna [NP] get [ENP2] a cat that/'s white [ENP3]
with [ENP4] black [ENP5] spot/s [SC] [DC3] [CU].

KEY:

CU = Communication Unit

NP = Nuclear Predicate

ENP= Extranuclear Predicate

DC1 = Level 1 dependent clause

DC3 = Level 3 dependent clause

SC = Simple Clause (level 0)