

# Linguistic Trade-Offs in School-Age Children With and Without Language Disorders

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Factors influencing the occurrence of trade-off effects among linguistic components were examined. Several linguistic measures were used to represent syntactic and phonological production in order to determine whether interrelationship patterns would vary across measures. Linguistic interactions present in imitated speech were compared to those from spontaneous speech. Group effects were explored by comparing data from children with language-learning disabilities, children with reading disabilities, and normally developing children. Results indicated trade-offs between some linguistic measures and positive relationships among others. More trade-offs were present in imitated speech than in spontaneous utterances. In general, interrelationship patterns were similar across groups. Interpretation of these results in reference to current models of sentence production is offered.

**KEY WORDS:** Interrelationships, trade-offs, syntax, phonology

The issue of interrelationships among linguistic components has received substantial attention in recent years (Crystal, 1987; Prelock & Panagos, 1989). Crystal (1987) suggested that linguistic interactions were more than just "additional complications" (p. 8) and that they held considerable importance for clinical practice. Some current therapy approaches are based upon interactions among linguistic components as a theoretical rationale (Hoffman, Norris, & Monjure, 1990; Lahey, 1988; Norris & Hoffman, 1990). The present study was designed to explore interrelationships among syntax, phonology, and fluency and to identify factors that may influence the nature of these interrelationships.

## ***Theoretical Background***

Conceptual models illustrating linguistic interrelationships have been proposed by Bock (1982) and Crystal (1987). Bock's model depicts informational exchanges among six arenas for linguistic processing (e.g., semantics, syntax, phonology, etc.) and a limited-capacity working memory. This model predicts the occurrence of trade-off effects among linguistic arenas, so that increases in complexity requirements in one component are associated with decreases in complexity or accuracy in another component.

Crystal (1987) proposed a "bucket theory" to explain linguistic trade-offs. He suggested that an individual's "bucket" can hold a certain degree of linguistic water. However, a series of "holes" are present at certain levels of linguistic complexity in an individual's system. An extra "drop" into one component in the form of increased

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demands may cause the overflow of a drop into another component at the level at which the holes are operating.

These models have in common the prediction that increased demands in one component may potentially cause decreased performance in a second component (i.e., trade-offs). If this prediction holds true, we might expect to see increases in syntactic complexity associated with decreases in semantic or phonological complexity and/or accuracy and vice versa. Studies have not consistently shown such trade-off effects. For example, although Camarata and Schwartz (1985) and Prelock and Panagos (1989) found trade-offs among syntax, semantics, and phonology, others (e.g., Kamhi, Catts, & Davis, 1984) did not achieve such results.

The present study was designed to explore some factors that might influence the occurrence or absence of trade-off effects. The three factors were (a) types of linguistic measures used, (b) linguistic proficiency of the subjects, and (c) elicitation mode (i.e., imitation vs. spontaneous speech).

### ***Linguistic Measures***

The measures used to characterize linguistic production were of interest because of the various degrees of sophistication they represent for different speakers. Crystal (1987) suggested that interrelationships may vary depending upon how recently a particular linguistic structure was learned. Perhaps the "holes in the linguistic bucket" discussed by Crystal are related to how firmly established a linguistic structure is. For example, those linguistic measures representing later-learned structures might be more vulnerable (i.e., contain more "holes") to trade-off effects than those learned earlier. Previous studies offer some support for this notion. Bloom, Lightbown, and Hood (1974) explored the relationships between syntax and semantics in children between 20 and 28 months of age. Syntactic complexity was examined by comparisons between two- and three-constituent utterances. Semantic complexity in verbs was indicated by whether a verb had appeared in the child's lexicon before (i.e., old) or had not (i.e., new). Semantic complexity of nouns was explored by comparing the use of pronouns and nouns, with pronouns representing increased semantic complexity. Both forms that were considered to represent decreased semantic complexity (i.e., nouns and old verbs) appeared more often in the advanced syntactic structures (i.e., three-constituent utterances).

In contrast to Bloom et al. (1974), Streim and Chapman (1984) found no evidence of trade-offs. They used lexical accessibility as an indicator of semantic processing in 4-, 6-, and 8-year-old children. The use of frequently occurring words and the provision of discourse support were thought to increase lexical accessibility. They used mean length and mean number of verbs per communication unit to represent syntactic complexity. For these measures, Streim and Chapman did not find trade-off effects between syntax and semantics.

The difference between the conclusions regarding the semantics-syntax relationship from the Bloom et al. (1974) and Streim and Chapman (1984) studies may be related to subjects' proficiency with the measures used to represent

syntax and semantics. Differential use of old and new verbs and nouns and pronouns may have represented more significant semantic demands for the children in the Bloom et al. study than did lexical accessibility for the subjects used by Streim and Chapman. Similarly, the measures of syntax used in each study may have represented differing demands based on the subjects' level of linguistic abilities.

In order to explore the relationship between trade-offs and recency of acquisition, we used measures of linguistic performance that represented skills acquired at different points of development. Three measures were used to represent syntactic production: (a) clause structure type (i.e., unembedded, compound, embedded); (b) accuracy of grammatical marker production; and (c) accuracy of morphophonemic (bound) marker production. Clause structure type represents a syntactic ability that continues to undergo developments during the primary school years, the age of our subjects, whereas grammatical marker production is usually mastered by this age in normally developing children (Lahey, 1988; Scott, 1988).

Three measures were used to characterize phonological production: (a) average phonemic length of individual words; (b) percentage of phonemes produced correctly; and (c) percentage of unintelligible words. Phonemic length was considered to be a measure that tapped into phonological changes occurring during the school years. Vihman (1988) reported that developments in the production of longer, more complex, sound sequences does continue throughout the school years. Such sequences would include the use of multisyllabic words and words containing consonant clusters, structures that would increase the average phonemic length of words within a sentence. Phonemic accuracy, however, should be mastered in most normally developing children by the primary school years. These syntactic and phonological variables were included in the present study to explore relationships between trade-offs and the order of acquisition associated with particular linguistic structures.

Additionally, a measure of fluency of production was included. Although Streim and Chapman (1984) did not find trade-offs between syntax and semantics in their subjects, they did find breakdowns in fluency associated with the production of words having decreased lexical accessibility. Foss and Hakes (1978) discussed the increased number of fluency breakdowns associated with complex syntactic structures. Exploration of the relationships among fluency and measures of linguistic production might provide additional insight into the nature of trade-offs.

### ***Subject Population***

The second factor of interest in the present study was the subjects' linguistic proficiency. Kamhi, Catts, and Davis (1984) suggested that children with disorders might be more likely to show trade-offs because of increased vulnerability to processing demands. Some of the discrepancies among the results from previous studies might be accounted for by the use of different subject populations. Panagos and Prelock (1982) found trade-offs between syntax and phonology in children with phonological impairments. On the other hand,

Kamhi et al. (1984) found that increases in syntactic complexity usually did not result in any changes in phonological production by normally developing preschool children. The difference in findings from these studies might be because the Panagos studies employed children with disorders, whereas the Kamhi et al. study used normal children.

In order to explore the influences of linguistic proficiency, three groups of children were included in the present study: (a) language-learning disabled, (b) reading disabled, and (c) normally developing. The children with language-learning disabilities had deficits in both oral and written language, whereas the children with reading disabilities had deficits only in written language. The inclusion of the groups with disorders allowed additional exploration of the interaction between trade-offs and order of acquisition of linguistic structures. In normally developing children, grammatical marker and phonemic accuracy are usually mastered by the school years, whereas in children with language disorders, these areas often continue to be problematic. Perhaps these skills would be more likely to be involved in trade-offs in children with disorders than in normally developing children. The children with reading disabilities were included because previous research has indicated that such children have difficulties with some linguistic skills such as phonological processing (Kamhi & Catts, 1989) and display subtle breakdowns in oral language (Vogel, 1974; Wiig, LaPointe, & Semel, 1977). We wondered if the types of linguistic interrelationships seen in children with reading disabilities would be more similar to those of children with language-learning disability or normally developing children.

### **Elicitation Mode**

The third factor considered in the present study was whether interrelationships would be different for data elicited spontaneously or by imitation. Crystal (1987) stated that most known information regarding trade-off effects has been obtained from children's productions of uncommon sentence types on abnormal tasks such as imitation. One criticism of imitative tasks is that sentences that are complex enough to cause trade-offs are unnatural and rarely used by children (Kamhi et al., 1984). Prelock and Panagos (1989) partially explored this issue and found comparable results from a sentence repetition task and an elicitation task in which children were asked to make up a sentence using a word shown in a picture. These researchers, however, did not examine speech produced spontaneously. Nelson and Kamhi (1984) compared the syntax-phonology relationship in both spontaneous and imitated utterances. They conducted a longitudinal study of four normally developing preschool children. In general, more trade-offs occurred during imitated speech than spontaneous speech, although there were individual differences.

The present study examined whether utterances produced during imitated tasks will typically yield more trade-off effects than spontaneous speech. We included school-age children with and without language disorders, and each child participated in both imitated and spontaneous conversational speaking tasks.

In summary, this study addressed the following questions:

1. Do trade-offs occur among the following linguistic measures:
  - clause structure and phonological complexity
  - clause structure and grammatical accuracy, phonemic accuracy, and fluency
  - phonological complexity and grammatical accuracy, phonemic accuracy and fluency
  - grammatical accuracy, phonemic accuracy, and fluency?
2. Do children with language-learning disabilities, children with reading disabilities, and normally developing children show different trade-off effects?
3. Are there differences in trade-off effects in imitated and spontaneous speech?

## **Method**

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### **Subjects**

Subjects were 30 children between the ages of 6:0 and 9:0 who attended an elementary school in a rural Arkansas community. Of these children, 10 had deficits in both oral and written language, 10 had deficits only in written language, and 10 were developing normally. Individual subjects were matched for mental age as indicated by the Test of Nonverbal Intelligence (Brown, Sherbenou, & Johnsen, 1982) across groups so that differences in mental ages for each triplet did not exceed 6 months. Each group consisted of 6 boys and 4 girls. All subjects passed school-wide screenings for hearing and visual problems. Screening procedures outlined by the Arkansas Department of Education were followed.

All the children with language-learning disabilities were previously diagnosed by a certified speech-language pathologist as having a language disorder that was not the result of globally depressed intellectual functioning, emotional disturbances, hearing loss, or physical defects. These children had been enrolled in language remediation for 1 or 2 years. Additionally, each child was previously identified by a certified school psychologist as having difficulties in reading severe enough to warrant enrollment in a reading resource classroom. Each child obtained a nonverbal intelligence score within normal limits as indicated by performance on the Test of Nonverbal Intelligence. Each child had a syntax-speaking quotient or a spoken-language quotient at least one standard deviation below the mean score on the Test of Language Development-Primary (Newcomer & Hammill, 1982) and scored at least one standard deviation below the mean on the Word Identification and Passage Comprehension subtests of the Woodcock Reading Mastery Tests (Woodcock, 1973).

The children with reading disabilities had no history of speech, oral language, or hearing impairments. Each child had been diagnosed earlier by a certified school psychologist as having sufficient reading difficulty to warrant placement in a reading resource classroom. The reading disorders were not the result of globally depressed intellectual functioning, emotional disturbances, hearing loss, or physical defects. Each child scored at least one standard deviation below the

**TABLE 1. Group means and standard deviations for age and criteria measures.**

Group	CA	MA	WA	PC	SSQ	SLQ
LLD	92.2 (8.5)	84.6 (11.9)	22.1 (20.1)	5.9 (5.9)	72.0 (9.8)	70.4 (10.8)
RD	91.9 (5.6)	85.4 (9.9)	11.7 (16.1)	3.6 (5.2)	102.4 (5.0)	97.6 (3.8)
Normal	83.6 (11.1)	83.3 (12.0)	29.3 (35.0)	7.3 (8.6)	100.2 (4.5)	101.7 (7.1)

*Note.* LLD = Children with language-learning disabilities. RD = Children with reading disabilities. CA = Chronological age in months. MA = Mental age in months. WA = Word attack subtest raw score. PC = Passage comprehension subtest raw score. SSQ = Syntax-speaking quotient. SLQ = Spoken language quotient.

mean on the two subtests of the Woodcock Reading Mastery Tests. Each child obtained a score that was within normal limits on the Test of Nonverbal Intelligence and had a syntax-speaking quotient or spoken-language quotient on the Test of Language Development-Primary within normal limits.

The normally developing children had no history of speech, language, or hearing impairment. Each child scored within normal limits on the Test of Nonverbal Intelligence, the two subtests of the Woodcock Reading Mastery Tests, and the Test of Language Development-Primary.

Group means and standard deviations for chronological and mental ages and test measures appear in Table 1.

### Procedures

Potential subjects were identified by the school speech-language pathologist. Each of these children was seen individually. During the first session the Test of Nonverbal Intelligence, the two subtests of the Woodcock Reading Mastery Tests, and the Test of Language Development-Primary were administered. Children meeting the criteria described above were seen for a second session and administered the experimental tasks described below. The second session lasted approximately 45 minutes.

**Sentence imitation task.** Eighteen sentences varying in syntactic and phonological complexity were taken from the list used by Panagos and Prelock (1982). The classifications regarding linguistic complexity used by Panagos and Prelock were also used in this study. Six sentences were unembedded, six contained right-embedded clauses, and six contained center-embedded clauses. Nine sentences were classified as phonologically elementary and nine were classified as phonologically complex. Levels of phonological and syntactic complexity were crossed so that there were three sentences representing each level of phonological complexity combined with each level of syntactic complexity. Sentences were presented to subjects in a random order. These sentences appear in Appendix A.

**Spontaneous speech.** Three conditions were used to elicit spontaneous speech. Subjects were first asked to describe and explain outcomes from three science experiments described in Masterson and Kamhi (1991). For example, in the first experiment a large and a small balloon were

shown to each child. The large balloon was filled with helium and the small with air. When released, the large balloon rose to the ceiling and the small one fell to the floor. Before each experiment, the subject was asked to describe what he or she saw. The examiner then performed the experiment and the subject was asked to describe what happened and then explain the results of the experiment. A confederate child was then brought into the room and the subject was asked to describe the experiment to the confederate.

Next, the experimenter told four sequential picture-stories to each subject. Each story was approximately 160 words long and described humorous events involving a boy and his dog (see Masterson & Kamhi, 1991). After two of the stories, the subject was asked to retell the story to the experimenter. For one of these stories, the subject was allowed to refer to the sequential pictures. The other story was told from memory (no visual cues given). The remaining two stories were retold to the same confederate child used during the experiment tasks. The subject was allowed to refer to the picture book for one story, but not the other story. The order of story presentation and listener (i.e., confederate vs. examiner) among subjects was counterbalanced. Data elicited from the description, explanation, and story tasks were combined in order to explore linguistic interrelationships present in spontaneous speech.

**Setting.** Experimental procedures were administered and recorded in a quiet room at the subjects' school. Responses to all tasks were recorded on a Panasonic RX-C45 cassette tape recorder with an Electrovoice Type 631 dynamic microphone. Subjects were seated so that a mouth to microphone distance of 8 inches could be comfortably maintained, and they were instructed to speak at a conversational loudness level.

### Language Measures

Utterances elicited via the procedures described above were classified according to various measures of linguistic complexity and accuracy. Each individual utterance was classified according to the measures described below.

**Clause structure assignment.** Sentences produced during the imitation task were classified according to the clause structure assignments used by Panagos and Prelock (1982). The task included six unembedded (simple) sentences, six right-embedded sentences, and six center-embedded sentences.

In spontaneous speech, clause structure assignment was used as the measure of syntactic complexity; however, the taxonomy used for the imitation task was expanded. Utterances were classified as simple, simple with compound phrases (subjects, verbs, objects, predicate nouns, or predicate adjectives), compound (two independent clauses), right-embedded (infinitive or object-modifying clause), center-embedded (infinitive or subject-modifying clause), or compound/embedded (two independent clauses that also contained at least one embedded verb). These categories and the continuum of complexity were taken from Bloom, Lahey, Hood, Lifter, and Fiess (1980); de Villiers, Tager-Flusberg, and Hakuta (1976, 1977); Hamburger and Crain

(1982); and Tager-Flusberg (1982). These studies found that children developed coordinated structures much earlier than embedded ones. Further, when completing tasks requiring embedded structures, children found it easiest to add a clause at the end of a sentence (i.e., right-embedded) rather than in the middle of a sentence (i.e., center-embedded).

These six levels of clause structure complexity were used to examine the interrelationship between clause structure and phonological complexity. The levels were combined, however, when the interrelationships between clause structure complexity and fluency and grammatical and phonemic accuracy were analyzed. Simple and simple with compound subject, verb, or object utterances were combined to make the first level (simple) of clause structure complexity. Compound sentences constituted the next level, and all sentences containing embedded structures were included in the third level (embedded).

**Grammatical accuracy.** For the imitation task, the percentage of morphophonemic markers produced correctly was used as the indicator of grammatical accuracy. Each stimulus sentence included either one or two regular past tense markers. No other grammatical markers were included in the imitated utterances.

Two measures were included to examine grammatical accuracy for spontaneous data. First, the percentage of grammatical markers correct was calculated for each utterance. Grammatical markers used in this analysis included the following forms: possessive, plural (regular and irregular), copula, auxiliary, progressive (-ing), past tense (regular and irregular), past participle, infinitive, adverb (-ly), adjective (-er, -est), and relative pronoun (that, who, which). The percentage of grammatical markers correct is the converse of a measure, the Grammatical Marker Error Index, used by Kamhi and Johnston (1982) to indicate the proportion of errors a child made producing grammatical markers. In the present study, the measure reflected the proportion of markers used correctly. Second, the percentage of morphophonemic markers correct was used to indicate accuracy of production for bound grammatical markers.

**Phonological complexity.** For imitated utterances, production of the sentences classified as elementary was compared to production of those classified as complex. Average phonemic length was chosen as the indicator of phonological complexity for spontaneous speech data (Vihman, 1988). Three levels of complexity, based upon the divisions used for phonological complexity in imitated speech, were employed. Those utterances with words averaging less than three phonemes were classified as elementary; those with words averaging between three and four phonemes were classified as intermediate; those with words averaging more than four phonemes were classified as complex. These three levels were used when examining the interrelationship between phonological complexity and clause structure type. When examining the interrelationships between phonological complexity and the remaining linguistic measures, utterances previously classified as intermediate were combined with those classified as complex to form a single category labeled complex.

**Phonemic accuracy.** Two measures were used to represent phonemic accuracy in both imitated and spontaneous

speech. The percentage of phonemes correct was calculated by dividing the total number of phonemes used correctly by the total number of phonemes attempted. This measure is similar to the Percentage Consonants Correct used by Shriberg and Kwiatkowski (1982) except that vowel production was also analyzed. Additionally, the percentage of unintelligible words was calculated. Crystal (1987) discussed a child who often became completely unintelligible when attempting utterances that were more advanced syntactically and noted that interactions involving phonology may not always be discovered if only the usual vowel or consonants substitutions are analyzed.

**Fluency.** The ratio between the total number of hesitations and the number of words in each utterance was calculated and used to represent fluency of production in both imitated and spontaneous speech data. Hesitation phenomena were categorized and counted. Categories were taken from Levin and Silverman (1965) and appear as Appendix B.

### **Reliability**

Sentence productions were transcribed by the first author in standard English orthography and broad phonetic transcription. Hesitation phenomena were included. Each sentence was classified by the first author and then data from one randomly selected subject from each group was independently transcribed by a graduate student in speech-language pathology. Categories classified and corresponding reliability percentages include the following: clause structure type (98%), phonemes attempted (99%), phonemes used correctly (99%), grammatical markers required (99%), grammatical markers used correctly (99%), morphophonemic markers required (99%), morphophonemic markers used correctly (99%), total hesitation phenomena present (98%), total unintelligible words (98%), and total words used (99%). Word-by-word percentage of agreement for broad phonetic transcription was 95%.

### **Results**

A total of 2,224 utterances were collected. Approximately 40% of the spontaneous utterances occurred during the description task, 10% during the explanation task, and 50% during the story-telling task. The numbers of utterances elicited from each group were approximately the same. The children with language-learning disabilities produced a total of 766 utterances, the children with reading disabilities 728 utterances, and the normal children 730 utterances.

Because the measures used to classify group, clause structure, and phonological complexity yielded categorical data, the relationships among these variables were examined with a nonparametric procedure: the log-linear analysis (Knoke & Burke, 1980). Multivariate analyses of variance (MANOVAs) (Tabachnick & Fidell, 1989) and Pearson product moment correlations (Hayes, 1981) were used to analyze the remaining relationships. Significant MANOVA results were followed up with one-way ANOVAs and post hoc measures (Tukey). Results are presented for each set of

**TABLE 2. Percentages of spontaneous utterances classified by clause structure for each level of phonological complexity.**

Phonological complexity	Clause structure type						Total
	SMP	CSVO	CMP	RE	CE	C/E	
Elementary	43.3	11.7	23	10.2	1.5	10.2	100
Intermediate	59.5	8.7	16.6	7.4	1.7	5.9	100
Complex	88.1	6.8	0	3.4	0	1.7	100

*Note.* SMP = Simple, unembedded. CSVO = Compound subject, verb, or object. CMP = Compound. RE = Right-embedded. CE = Center-embedded. C/E = Compound with embedded structure(s).

linguistic variables examined and then group findings are provided.

**Clause Structure and Phonological Complexity**

Frequencies of utterances falling into each clause structure type across each level of phonological complexity were tabulated for each group. Two-way interactions were the highest level to reach significance LR  $X^2$  (42, 1746) = 129.9,  $p < .001$ ). This indicated that the interrelationship between clause structure and phonological complexity was the same for all groups. Table 2 shows the percentage of utterances classified according to clause structure for each level of phonological complexity. Utterances classified as phonologically complex tended to be syntactically simple (i.e., contain only one clause). Utterances classified as phonologically elementary or intermediate showed a wider distribution of clause structure types. These results suggest a trade-off effect between clause structure and phonological complexity.

**Clause Structure/Phonological Complexity and Grammatical Accuracy**

The production of morphophonemic markers in imitated utterances was significantly affected by clause structure and phonological complexity,  $F(2, 515) = 4.5, p < .01$ . The effects were generally cumulative and indicative of a trade-off, with more errors occurring when sentences were both embedded and phonologically complex (See Table 3).

In spontaneous speech, grammatical marker production and morphophonemic accuracy were analyzed only in utterances containing obligatory contexts for their use. A significant main effect for phonological complexity was present for both grammatical marker accuracy [ $F(1, 1490) = 12.0, p < .001$ ] and morphophonemic accuracy [ $F(1, 971) = 22.0, p < .001$ ]. Utterances containing complex phonological forms were produced with higher grammatical and morphophonemic accuracy than those with elementary phonological forms (Table 3). This finding did not reflect a trade-off.

**Clause Structure/Phonological Complexity and Phonemic Accuracy**

The effect of phonological complexity upon the percentage of phonemes correct in imitated utterances was significant,  $F(1,$

**TABLE 3. Influences of phonological complexity and clause structure on measures of grammatical accuracy.**

Imitated Utterances:		Phonological complexity	
Measure of grammatical accuracy	Clause structure	Elementary	Complex
		Percent MPM Correct	Unembedded
	Right-embedded	55	40
	Center-embedded	41	22

**Spontaneous Utterances:**

Measure of grammatical accuracy	Phonological complexity	
	Elementary	Complex
Percent MPM correct	78	90
Percent GM correct	81	87

*Note.* MPM = morphophonemic markers. GM = grammatical markers.

515) = 65.8,  $p < .001$ . As shown in Table 4, elementary sentences were produced with higher phonemic accuracy than were complex sentences. Significant main effects for both clause structure [ $F(1, 515) = 3.4, p < .03$ ] and phonological complexity [ $F(1, 515) = 21.7, p < .001$ ] were found for percentage of unintelligible words. Center-embedded sentences contained more unintelligible words than did right-embedded sentences, which, in turn, contained more unintelligible words than unembedded sentences. Target utterances containing complex phonological structures were produced with more unintelligible words than those with elementary phonological structures. All of the findings involving imitated utterances indicated trade-offs between clause structure and phonological complexity and phonemic accuracy.

Neither clause structure nor phonological complexity affected the percentage of phonemes correct in spontaneous speech. However, a significant 3-way interaction between group, clause structure, and phonological complexity was present for percentage of unintelligible words,  $F(4, 1673) = 4.4, p < .01$ . Follow-up analyses indicated that unintelligible words appeared more often in the multi-verb (i.e., compound

**TABLE 4. Influence of phonological complexity and clause structure on measures of phonemic accuracy in imitated utterances.**

	Phonological complexity		
	Elementary	Complex	
Percent phonemes correct	96	90	
Percent unintelligible words	0	4	
Clause structure type			
	Unembedded	Right-embedded	Center-embedded
	Percent unintelligible words	1	2

**TABLE 5. Influence of group, phonological complexity, and clause structure on percentage of unintelligible words in spontaneous utterances.**

Group	Clause structure/Phonological complexity					
	Simple		Compound		Embedded	
	Elem.	Complex	Elem.	Complex	Elem.	Complex
LLD	1	1	0	1	0	1
RD	1	2	1	1	7	1
Normal	0	0	0	29	0	0

Note. LLD = Children with language-learning disabilities. RD = Children with reading disabilities. Elem. = Elementary phonological structures.

or embedded) utterances of the children with reading disabilities and normally developing children. This effect was not present for the children with language-learning disabilities (Table 5).

Although there were differences in phonemic accuracy across clause structure types and/or levels of phonological complexity, almost all of the percentages were still quite high (see Tables 4 and 5). The difference between a percentage of phonemes correct of 90 and one of 96, although statistically significant, would likely have limited clinical importance.

**Clause/Phonological Complexity and Fluency**

A significant 2-way interaction between clause structure and phonological complexity was present for the ratio between disfluencies and words in imitated utterances,  $F(2, 515) = 3.9, p < .02$ . Follow-up analyses indicated cumulative effects of syntactic and phonological complexity. Disfluencies increased when utterances were both embedded and phonologically complex (see Table 6), indicating trade-offs. The opposite trend occurred in spontaneous speech. A significant main effect was present for clause structure on the ratio between hesitations and words,  $F(2, 1673) = 5.9, p < .01$ . Simple sentences tended to contain more disfluencies than compound sentences, indicating a positive relationship.

**TABLE 6. Influence of clause structure and phonological complexity on the ratio between hesitations (H) and words (W).**

Imitated Utterances:		Clause structure type		
Disfluency measure	Phonological complexity	Un-embedded	Right-embedded	Center-embedded
H/W ratio	Elementary	.06	.11	.13
	Complex	.26	.41	.52

  

Spontaneous Utterances:		Clause structure type		
Disfluency measure		Simple	Compound	Embedded
H/W ratio		.19	.13	.16

**TABLE 7. Correlation matrix for each group for imitated utterances.**

	Language-learning disabled			
	PPC	UNW	MPMC	HWR
PPC	—	-.146* (.027)	.249* (.001)	-.148* (.03)
UNW	—	—	-.112 (.057)	.03 (.349)
MPMC	—	—	—	-.121* (.05)

  

	Reading-disabled			
	PPC	UNW	MPMC	HWR
PPC	—	-.09 (.124)	.235* (.001)	-.025 (.370)
UNW	—	—	-.289* (.001)	.274* (.001)
MPMC	—	—	—	-.227* (.001)

  

	Normal			
	PPC	UNW	MPMC	HWR
PPC	—	-.234* (.001)	.354* (.001)	-.253* (.001)
UNW	—	—	-.222* (.001)	.286* (.001)
MPMC	—	—	—	-.258* (.001)

Note. PPC = Percent phonemes correct. UNW = Percent unintelligible words. MPMC = Percent morphophonemic markers correct. HWR = Hesitations/words ratio. \*Significant correlation.

**Grammatical Accuracy, Phonemic Accuracy, and Fluency**

Pearson correlation coefficients were calculated to explore the relationships among fluency, grammatical accuracy, and phonemic accuracy for each group. The correlation matrices for imitated utterances appears in Table 7. Even though several correlations were significant, most fell within the low range. For children with language-learning disabilities all except those involving percentage of unintelligible words were significant. For children with reading disabilities all correlations were significant except for the ones between percentage of phonemes correct and percentage of unintelligible words and the disfluency ratio. All correlations were significant for the normal children. When correlations were significant, higher phonemic accuracy was weakly associated with higher morphophonemic accuracy and lower disfluency ratios. Higher morphophonemic accuracy was weakly associated with lower disfluency ratios.

Pearson correlation coefficients were also calculated to explore the relationships among fluency and grammatical and phonological accuracy in spontaneous utterances for

**TABLE 8. Correlation matrix for each group for spontaneous utterances.**

Language-learning disabled					
	PPC	UNW	HWR	GMC	MPMC
PPC	—	-.157* (.001)	-.013 (.373)	.141* (.001)	.125* (.01)
UNW	—	—	.027 (.25)	-.123* (.002)	-.13* (.008)
HWR	—	—	—	-.065 (.064)	-.029 (.296)
GMC	—	—	—	—	.874* (.001)
Reading-disabled					
	PPC	UNW	HWR	GMC	MPMC
PPC	—	.004 (.460)	.02 (.316)	.087* (.025)	.111* (.019)
UNW	—	—	.035 (.205)	-.006 (.448)	-.139 (.005)
HWR	—	—	—	-.050 (.133)	-.05 (.176)
GMC	—	—	—	—	(.001)
Normal					
	PPC	UNW	HWR	GMC	MPMC
PPC	—	-.035 (.200)	.044 (.144)	.087* (.025)	.058 (.145)
UNW	—	—	.019 (.325)	.016 (.363)	-.174* (.001)
HWR	—	—	—	-.067 (.065)	.009 (.437)
GMC	—	—	—	—	.736* (.001)

Note. PPC = Percent phonemes correct. UNW = Percent unintelligible words. MPMC = Percent morphophonemic markers correct. HWR = Hesitations/words ratio. GMC = Percent grammatical markers correct.

\*Significant correlation.

each group. These correlation matrices appear in Table 8. Once again, all significant correlations were in the low range with the exception of the two variables representing grammatical marker production. The disfluency ratio was not significantly related to the other linguistic measures for any of the groups. The relationship between percentage of phonemes correct and percentage of unintelligible words was significant only for the group of children with language-learning disabilities. Grammatical accuracy was significantly related to percentage of phonemes correct for all groups. Morphophonemic accuracy was significantly related to percentage of phonemes correct for the children with language-learning and reading disabilities and to percentage of unintelligible words for the normal children. As was the case in imitated utterances, significant relationships were weak, pos-

itive associations between phonemic and grammatical accuracy. That is, utterances that tended to contain fewer phonemic errors also tended to contain fewer grammatical errors. Taken together, the results from both imitated and spontaneous utterances do not indicate trade-offs between fluency and grammatical and phonemic accuracy, but rather suggest positive relationships among these variables.

### Group Differences

In general, patterns of linguistic interrelationships were the same for the children developing normally, those with reading disabilities, and those with language-learning disabilities. Only one significant interaction involved the group variable (see Table 5), and the actual differences among the means involved in this comparison were slight. Correlations among fluency and phonemic and grammatical accuracy were comparable among groups for imitated utterances (Table 7). Most correlations present in spontaneous speech were comparable among groups; however there were two exceptions (Table 8). First, the relationships between percentage of unintelligible words and both percentage of phonemes correct and percentage of grammatical markers correct were significant only for the children with language-learning disabilities. Second, morphophonemic accuracy was significantly related to both percentage of phonemes correct and percentage of unintelligible words in the children with language-learning disabilities, but only to percentage of phonemes correct in the group of children with reading disabilities and only to percentage of unintelligible words in the normally developing group.

As expected, several main effects for group were present. On most measures, the children with reading disorders and the normally developing children scored significantly higher than the children with language-learning disabilities. Additionally, the log linear analysis indicated a significant relationship between clause structure type and group, with children with language-learning disabilities using relatively more simple sentences and relatively fewer embedded utterances than the children with reading disabilities and the normally developing children. The one exception to this trend was the finding regarding fluency. Follow-up to the main effect for group on fluency indicated that the performance of the children with reading disabilities was more similar to that of the children with language-learning disabilities. Both the children with language-learning disabilities and those with reading disabilities were significantly more disfluent than the normally developing children. Group effects appear in Table 9.

### Discussion

The results of this study indicate that patterns of linguistic interrelationships are affected by two of the factors investigated: linguistic measures and elicitation mode. Subject population was not a significant influence, and children varying in linguistic abilities generally seem to show similar patterns of interrelationships. The first section of the discussion will focus on the influence of various linguistic measures.

**TABLE 9. Main effects for group.**

<b>Imitated Utterances:</b>			
<b>Linguistic measure</b>	<b>Group</b>		
	<b>LLD</b>	<b>RD</b>	<b>Normal</b>
Percent phonemes correct	88	95	96
<b>Spontaneous Utterances:</b>			
<b>Linguistic measure</b>	<b>Group</b>		
	<b>LLD</b>	<b>RD</b>	<b>Normal</b>
Percent phonemes correct	93	98	99
Percent GM correct	74	86	91
Percent MPM correct	70	88	91
Hesitations/words ratio	.19	.19	.13
<b>Percentage of total utterances classified by clause structure type</b>			
Simple	64	57	59
Compound	19	23	20
Embedded	17	20	21

*Note.* LLD = Children with language-learning disabilities. RD = Children with reading disabilities. GM = Grammatical markers. MPM = Morphophonemic markers.

The next sections will address the findings regarding group differences and methods of elicitation.

### **Linguistic Measures**

Recall that Bloom et al. (1974) found trade-offs between semantics and syntax, whereas Streim and Chapman did not. We suggested that the discrepancy in findings might be due to the use of different measures to represent syntactic and semantic production and the degree of proficiency subjects had with each. The results from the present study regarding spontaneous speech support this suggestion. Relationships between some of the measures included were negative (trade-offs), others were positive, and still others were not significant.

When clause structure and phonemic length were used to represent syntax and phonology respectively, the resulting relationship was a trade-off. This finding may be due to the significant syntactic or phonological demands associated with the use of embedded sentences and longer words. Normally developing children are still acquiring the use of embedded structures during the primary school years (Lahay, 1988). Similarly, phonological developments during this stage include improvements in temporal coordination (Vihman, 1988), more of which are required for the production of longer words and consonant clusters. Perhaps the use of embedded structures and longer words required too much processing capacity for both to occur at the same time. The present methodology did not allow the direction of influence between syntax and phonology to be identified. It is possible that a child selected a given clause structure first and then filled in with words that were characterized by a manageable degree of phonological complexity. Conversely, it is feasible that the words that were necessary in a given speaking task

were chosen first and then a manageable clause structure type was selected. We have suggested elsewhere (Masterson & Kamhi, 1991) that the former possibility is the likely scenario due to pragmatic influences on syntactic selection. If elicitation conditions can be correlated with the use of specific syntactic structures, then future studies might vary the degree of phonological complexity of words that are involved in different elicitation conditions. Such methodologies may further pinpoint directions of syntax-phonology relationships. Additionally, it is possible that the influence of semantic factors may be involved. Words with greater phonemic length are typically less familiar to a child, so perhaps the relationships identified in this study were due to interactions between semantics and syntax as well as phonology and syntax. This issue could be explored in future studies regarding the syntax-phonology relationship by the use of nonsense words in speaking tasks. This would control for semantic factors such as degree of familiarity.

When phonemic accuracy and grammatical marker production were used to represent phonology and syntax, a different relationship was present. The correlations among indicators of these two variables and fluency were positive. Instead of trade-offs, increases in accuracy in one component were associated with increases in accuracy in the other components. This finding may be due more to the similar effects upon accuracy and fluency caused by speaking conditions than to a direct relationship among the variables themselves. Perhaps the factors that cause decreases in fluency also cause decreases in grammatical and phonemic accuracy. We have discussed the influence of various elicitation conditions upon fluency and grammatical/phonemic accuracy elsewhere (Masterson & Kamhi, 1991).

We predicted that the inclusion of a measure of disfluency would result in additional significant linguistic trade-offs. However, this was not the case. The effects found on fluency in imitated utterances were similar to those operating for grammatical and phonemic accuracy. The significant finding involving fluency in conversational speech was somewhat surprising. Simple sentences were actually produced with more disfluencies than compound sentences. This effect is opposite to a trade-off relationship and may have been due to the influence of sampling conditions. The subjects usually produced simple sentences while describing objects or pictures, whereas they used compound sentences more often when telling a story. When offering descriptions, the subjects tended to pause often, ensuring that they would include all the pertinent details. This increased the disfluency ratio associated with descriptions. Because of the close association between description and the use of simple sentences, the disfluency ratio associated with simple sentences also increased.

The findings from the present study offer some support for the limited capacity models suggested by Bock (1982) and Crystal (1987). According to these models, trade-offs should occur only when linguistic performance in different components represents significant demands upon processing capacity. In the present study, clause structure and phonemic length did trade off. From a developmental perspective, these two measures are the least firmly established, and consequently may represent significant processing demands. In

contrast, the measures of grammatical and phonemic accuracy did not trade off. Perhaps this finding is due to these skills' being more firmly established and requiring less processing capacity in primary-school-age children.

### **Subject Population**

Most of the previous studies exploring interrelationships had used either disordered children or normally developing children. We included both and hypothesized that the children with disorders would be more likely to show trade-offs. This was not the case, however, as patterns of linguistic interactions were similar across the three groups of children. The single exception was the finding regarding the use of unintelligible words. The normally developing children and those with reading disabilities tended to produce more unintelligible words when faced with increased linguistic complexity, yet the children with language-learning disabilities did not show such a trend (see Table 5). Most of the error percentages involved in this comparison were low (1 or 2%). However, the percentage of unintelligible words increased quite a bit (29%) for normally developing children during the production of compound sentences with complex phonological forms. This finding suggests that the presence of unintelligible words indicates something different for children with and without language-learning disabilities. The production of unintelligible words by children with language-learning disabilities is likely indicative of a phonological breakdown. This is supported by the significant correlation between percentage of phonemes correct and percentage of unintelligible words found for the group with language-learning disabilities. On the other hand, the use of unintelligible words by children without language-learning disabilities may be due to different factors. The correlations between percentage of phonemes correct and percentage of unintelligible words in spontaneous speech were not significant for the children with reading disabilities and normally developing children. Perhaps they used unintelligible words to mark the place of utterance components they felt should be included, but were unable to produce.

As expected, the children with language-learning disabilities consistently made more linguistic errors than did the other two groups of children. However, despite the use of a variety of linguistic measures, the *relative* number of breakdowns associated with increased linguistic complexity was no higher in children with language-learning disabilities than in either of the two other groups. These results suggest that primary-school-age children with language-learning disabilities are not more vulnerable to processing demands nor are their language systems more interdependent, as hypothesized by Kamhi et al. (1984). However, their study involved younger children. Our results indicate that primary-school-age children with language-learning disabilities use their processing capacity in a manner similar to that of children without disorders.

### **Elicitation Mode**

The results from the present study indicate that interrelationship patterns present in imitated speech are often differ-

ent from those present in spontaneous speech. Generally, trade-off effects occurred more often in imitated utterances than in spontaneous speech. Relationships found in spontaneous speech often were either insignificant or in the positive direction. For some relationships examined, effects were actually in the opposite directions for imitated and spontaneous utterances. For example, morphophonemic accuracy decreased in embedded clause structures in imitated utterances, yet increased in embedded clause structures in spontaneous speech.

The contrast between elicitation modes may be related to differences in the way processing demands are handled in each. One explanation for the findings in the Kamhi et al. (1984) study was that they did not use sentences that were complex enough to tax the system and cause trade-off effects. However, the results from the present study suggest that forcing the use of unnatural sentences, which sufficiently tax the system, results in breakdowns that are different from the accommodations children normally make in the sentence production process. For example, our results suggest that accommodations made in spontaneous speech are less damaging to intelligibility than those made in imitated utterances. It is likely that the trade-off between word length and clause structure would go unnoticed by anyone other than individuals studying child language. Given a speaker's access to a variety of linguistic structures for use during normal speech, he or she may choose to use a less complex one when other constraining factors, such as complex lexical items, are present. Such a choice would allow the speaker to operate within the confines of processing capacity, yet not interfere with intelligibility to a significant degree. On the other hand, eliminating this choice and forcing the speaker to attempt a particular syntactic construction in connection with complex lexical items may deplete most of the available resources and cause noticeable linguistic breakdowns, such as phonemic and grammatical errors.

Whatever the cause of the differences between imitated and spontaneous speech, the results from this study suggest that caution should be used in generalizing results from studies involving imitation tasks to spontaneous language production. The data from the present study suggest that the accommodations made to handle processing limitations may vary between elicitation modes.

In summary, the results of this study suggest that patterns of linguistic interrelationships are related to an individual's proficiency with the skills being examined. The likelihood of trade-offs appears to decrease for measures representing skills that are more fully developed. Additionally, interrelationships appear to be similar for both disordered and normally developing children. Finally, linguistic interrelationships present in imitated speech are not necessarily representative of patterns found in spontaneous speech. Future studies might further explore directions of influence among syntax, semantics, and phonology.

### **Acknowledgments**

We appreciate the comments and suggestions on this manuscript provided by Carol Stoel-Gammon, Stephen Camarata, and John

Panagos. We are grateful to Ann Carpenter and the Marion Public Schools for their assistance in obtaining subjects. Thanks also goes to Julie Cook, John Richardson, and Susan Terwilliger for their assistance in reliability checks. An earlier version of this paper was presented at the 1985 Symposium on Research in Child Language Disorders in Madison, Wisconsin.

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Received February 11, 1991

Accepted November 25, 1991

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## Appendix A

### *Imitated Utterances\**

#### *Elementary/Unembedded*

The wife checked the map in the book.  
The kid pushed the car in the room.  
The uncle cleaned the pan in the sink.

#### *Elementary/Right-embedded*

The man chopped the log the dog jumped.  
The goat chewed the hat the bear licked.  
The cat licked the milk the baby spilled.

#### *Elementary/Center-embedded*

The maid the guy liked opened the door.  
The cow the bull kicked chewed the grass.  
The lady the uncle liked sewed the coat.

#### *Complex/Unembedded*

The detective smashed the car in the driveway.  
The monster buried the skeleton in the cemetery.  
The customer smeared the chocolate in the napkin.

#### *Complex/Right-embedded*

The librarian dusted the furniture the janitor stacked.  
The grandmother carried the magazine the mailman delivered.  
The traveller photographed the elephant the hunter followed.

#### *Complex/Center-embedded*

The gorilla the vampire surprised climbed the building.  
The stranger the waitress served crumbled the cracker.  
The athlete the reporter questioned bounced the basketball.

\*Taken from Panagos and Prelock (1982).

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## Appendix B

### *Hesitation Phenomena\**

1. Interjections/parenthetical remarks: These included noises such as "uh," "er," and "um" and parenthetical remarks such as "I mean" and "you know."
2. Sentence changes:
  - a. Phonemic changes—changes in sounds within a word (e.g., "the gog, uh, the dog").
  - b. Lexical changes—changes in word selection (e.g., "They went—they ran down the street.").
  - c. Phrase changes—changes in phrase use (e.g., "He's going, I mean the boy and his dog are going.").
3. Sentence incompleteness: Incompleteness that occurred after a

phrase, word, or in the middle of a sentence (e.g., "Susan fell asleep when—and it was dark in there.").

4. Repetitions: Repetitions of whole phrases, words, and parts of words (e.g., "She is the g-g-girl you're looking for.").
5. Prolongations: The prolongation of any continuous phoneme (e.g., "Sssssusie is going to town.").
6. Unfilled pauses: Short pauses referred to as pauses less than 2 sec in length and long pauses referred to as those greater than 2 sec.

\*Taken from Levin and Silverman (1965).