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INVESTIGATION OF SLI CHILDREN'S SEMANTIC KNOWLEDGE THROUGH INTONATION PATTERNS

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This paper aims to investigate domain-specificity of SLI, by examining SLI children's semantic knowledge through their intonation patterns for contrastive focus and prosodic boundaries. Our results revealed that 1) SLI children's placement of contrastive focus is comparable to that of normally developing children, 2) SLI children has wider pitch range than normally developing children, and 3) SLI children may have problems in their prosody, especially when the prosodic domain becomes longer.

1. INTRODUCTION

The term Specific Language Impairment (SLI) refers to "a significant impairment in spoken language ability when there is no obvious accompanying condition such as mental retardation, neurological damage, or hearing impairment" (Leonard, 1998). Most research on SLI children focus on their syntactic knowledge (e.g., Clahsen, 1989, van der Lely & Stollwerck, 1997), and relatively little is known about their phonological and semantic deficits. Some researchers claim that SLI is a domain specific deficit affecting only syntax, however. For example, van der Lely (1996) tested English speaking children with SLI on their three distinct types of knowledge/ability: Binding Principle A & B (syntactic), use of pronominal reference (semantic/pragmatic), and visual transitive inference (visual/spatial). The results revealed a sharp contrast between SLI and control children on the syntactic task, while their performances on semantic and visual tasks were comparable. She concluded that the findings support a view that the underlying impairment for SLI is a domain specific and modular deficit affecting only grammatical representations (= syntax).

Previous research has revealed the presence of a wide variety of linguistic cues in intonation, including semantic, pragmatic, and syntactic information (Beckman & Pierrehumbert, 1986). Intonational phonology has developed extensively the past decade, deepening our

understanding of the linguistic aspects of prosody. ToBI (Tones and Break Indices) is a system for transcribing the intonation patterns and other aspects of the prosody. For example, according to MAE (Mainstream American English) _ToBI (Beckman & Hirschberg, 1994), contrastive focus is implemented in intonation as *L+H, and after the focused item, no pitch accent is present, that is, a phrase accent follows until the end of the intermediate phrase (= no post-nuclear pitch accent). Also, the end of the intonational phrase in American English, for example the standard `declarative' contour, is often cued by L-L%. Given that signaling the locus of contrastive focus or the end of intonational phrase is semantically driven, these aspects of prosody can be used to assess the speaker's semantic knowledge.

However, if SLI is a domain specific deficit affecting only syntactic representations of our knowledge, children with SLI should have no problem expressing semantic messages such as contrastive focus or the end of an intonational phrase. On the other hand, if SLI is a deficit affecting both syntactic and semantic domain, SLI children might show different intonational patterns than normally developing children. In order to test this hypothesis, a small set of recorded tokens were compared across the two populations.

2. METHOD

2.1. Stimuli

The source of stimuli was tape recordings from the previous study on SLI children (Curtiss et al. 1992) in which children answer questions by the experimenter. The recordings were digitized at 11025Hz using Sciconrd's Pitch Works. Two types of tokens, contrastive focus and repetition[1], were extracted in order to examine the semantically driven prosodic patterns of SLI and normally developing children.

1) **Contrastive Focus** (from Sentence Completion Task):

The task was to complete the sentence spoken by the experimenter. Children were shown a set of pictures describing the scene. The words which are expected to carry contrastive (or narrow) focus are shown in bold.

[1] Repetition itself does not belong to a particular sentence type, and thus its tie to semantic knowledge might be controversial. However, it was used because it was the best controlled data available to examine if SLI children can cue the end of the phrase using the same intonation as the normal group.

Balloon:
Experimenter: "A boy is holding one balloon, and a clown is holding another balloon. This is the balloon….."
Child: "**The clown** is holding."

Running:
Experimenter:"Here the boy is running TO the girl. But here he is running…."
Child: "**With** the girl."

Suitcase:
Experimenter: "Here the boy is carrying the suitcase FOR the man. But here he is carrying the suitcase…"
Child: "**With** the man".

2) **Repetition** (from Rapid Naming task):

The task was to repeat the following words three times.

1. buttercup
2. cafeteria
3. kitty
4. refrigerator
5. television

2.2. *Subjects*

Studies have suggested that acquisition of prosodic comprehension actually takes place earlier than segmental comprehension (e.g., Lewis, 1951, Crystal, 1979). According to Jusczyk (1997), infants attuned to the prosody of their native language at the age of 9 months. However, relatively little is known about how/when children master production of prosody. Jannedy (1997) investigated acquisition of narrow focus intonation by testing children from 3 to 10 years of age. Her production and perception data show clear developmental changes between 3 and 4. After that, their scores on narrow focus perception increase rather

gradually until 7 (and it seems to stabilize). Taking her result, as well as the availability of data[2], the subjects' age was decided to be seven.

Recordings of four seven-year-old children with SLI were chosen from the corpus by controlling the following factors: MLU (Mean Length of Utterance), IQ, and language age. Thus, all the subjects in the SLI group were 7 years old, with 4 MLU, normal IQ (85-120), and 5 to 6 language age. Subjects in the control group were also 7 years old, with normal IQ and age appropriate language development. New recordings of the rapid naming task were made from 2 normally developing 6.5-year-old children who are native speakers of American English, because the corpus did not include the rapid naming task for normal children.

3. RESULTS

The data was analyzed in terms of overall pitch range and ToBI.

3.1. *Pitch Range*

Table 1: The means of pitch range (in Hz) and standard deviation for the two groups

		SLI	Control	*p* (t-test/2tails)
Pitch Range (Hz)	Contrastive Focus	152.5	119.5	0.436
	Repetition	137.9	106.3	0.453
	Overall	143.5	115.1	0.343
Standard Deviation	Contrastive Focus	30.9	12.2	0.134
	Repetition	27.6	28.8	0.802
	Overall	34.6	17.7	*0.039

As can be seen in Table 1, the pitch ranges of SLI children were always greater than that of the control group, although the differences never reached statistical significance. However, the difference in the overall (the two tasks combined) standard deviations between the two groups was statistically significant (p= 0.039).

[2] The data in this study was taken from the tape recordings made for a previous study on SLI children (Curtiss et al. 1992), which included three- to seven-year-old children.

3.2. *ToBI Analysis*

3.2.1. *Contrastive Focus*

According to ToBI (Beckman & Hirschberg, 1994), the expected intonation pattern for this narrow focus statement is L+H* L-L% (H* only when the focused syllable is the sentence initial syllable). The focused word is realized as the most prominent accent (= nuclear pitch accent) within an intermediate phrase, and no pitch accent is realized after the focused item. In the following sentence (A), "clown" is expected to get H*, and "is" and "holding" should be de-accented, realized as L-L%. In the sentences (B) and (C), "with" should be realized as H*, and the rest should be realized as L-L% as in (A). (The words in bold face are the expected loci of narrow focus.)

Balloon:
Experimenter: "A boy is holding one balloon, and a clown is holding another balloon. This is the balloon….."
Child: "The **clown** is holding." (A)

Running:
Experimentor: "Here the boy is running TO the girl. But here he is running…."
Child: "**With** the girl." (B)

Suitcase:
Experimenter: "Here the boy is carrying the suitcase FOR the man. But here he is carrying the suitcase…"
Child: "**With** the man". (C)

<u>SLI group</u>

Among four children in the SLI group, only two produced the correct answer "the clown is holding" (A). Among them, one child produced a pitch contour [H* H* L-L%], placing an extra pitch accent (H*) on "holding" in addition to "clown". Another child also placed a pitch accent on "holding", yet in his case, the type of accent was !H* (down-step high). That is, no SLI children showed the expected pitch contour for this sentence.

Three out of four SLI children produced the expected intonation contour for (B). One of the three produced the word “girl” (which should be de-accented) with a higher intensity, although she did not put a pitch accent there. The one who did not produce [H* L-L%] pattern placed an extra pitch accent !H* on “girl” ([H* !H* L-L%]).

All SLI children produced the expected intonation contour for (C). Among them, one child produced an unexpected answer: "Not for him" (instead of "with the man"). However, his utterance was not semantically incorrect, and his pitch contour was still [H* L-L%]. Also, the de-accentuations of three children's utterances were not quite perfect, leaving a slight prominence on "man".

Control group

Three out of four children in the control group produced the expected H* L-L% pattern for (A). The child who did not produce the pattern also showed a normal (or, expected) pitch contour, only that she answered the question with a question intonation (i.e., "The clown is holding?"). She placed L* on "clown" (which is what ToBI predicts for a focused item in a yes-no question), and the rest of the sentence was realized as H-H%. In other words, four children in the control group produced the intonation patterns predicted in the ToBI frame-work. (4/4)

As for sentence (B), three out of four control children produced the expected pattern [H* L-L%]. One child (different child from the one who produced a question contour for A) produced [H* L-H%], showing some uncertainty at the end of the sentence. His answer was "against the girl" (which is both syntactically and semantically correct), and he did place H* on "against" and de-accented the rest, and thus his intonation pattern is normal.

As for sentence (C), all four children produced the expected pitch contour (three produced [H* L-L%], and one produced [L+H* L-L%] which is also normal for contrastive focus). One child did not pronounce the words clearly and thus it was difficult to understand what he said. Nonetheless his intonation was clearly [H* L-L%].

3.2.2. *Repetition*

SLI group

1. Buttercup (# of syllables 3)

Child 1 L*+H L*+!H !H* L-L% (Listing)
Child 2 L*+H H- L*+H H- L*+H H- H* L-L%
(Listing. Four repetitions.)
Child 3 H* H* H- H* H* H- H* L* L-L% (Declarative)
Child 4 H* H* H- H* H* H- H* L-L% (Declarative)

Four SLI children showed different intonation patterns when they repeated the word "buttercup". Children 1 and 2 produced a so-called "listing" contour, in which the end of each item goes up. However, child 1 produced all the words in intermediate phrase with down steps, while child 2 produced rather long pauses between each word. Children 3 and 4 produced a declarative (or "hat") pattern, keeping everything high until right before the end of the utterance (= H* H* L-L%). Although the two children's utterances sound very similar in terms of their intonation, child 3 placed a pitch accent (L*) on the last syllable while child 4 did not.

2. Cafeteria (# of syllables 4)

Child 1 L*+H L*+!H H* L-L% (Listing)
Child 2 H* H* H- H+!H* H* H- H+!H* H* H-L%
Child 3 H* H* L-L% H* H* L-L% H* H* L-L% (Declarative)
Child 4 H* H* H- H* H- H* L-L% (Declarative)

3. Kitty (# of syllables 2)

Child 1 L*+H L*+H H* L-L% (Listing)
Child 2 H* H* H* L-L% (Declarative)
Child 3 H* H+!H* H+!H* L-L% (Non-clear final falling & poor articulation)
Child 4 H* H* H- H* H- H* L-L% (Declarative)

4. Refrigerator (# of syllables 5)

Child 1 L*+H L*+!H H* L-L% (Listing)

Child 2 H* L- H* H* L- H* H* L-L% (Singing contour & non-clear final falling)
Child 3 H* L- H* L- H* L-L%
Child 4 H* H- H* H- H* L-L% ("fregerator", Declarative)

5. Television (# of syllables 4)

Child 1 L*+H L*+!H !H* L-L% (Listing)
Child 2 H* H- H+!H* H- H+!H* L-L%
Child 3 H* L- H* L- H* L-L% (Non-clear final falling & poor articulation)
Child 4 H* H- H* H- H* L-L% (Declarative)

Each child seems to have his/her own strategy for repeating words, and they are consistent with their strategies regardless of the item. Child 1 always used the rising "listing" contour, and produced three words within an intermediate phrase. Child 2, on the other hand, produced one intermediate phrase per word. She also showed some listing contours, as well as a singing contour. Child 3 produced "hat" (or declarative) patterns when the word was short (2 to 3 syllables), while when the word was longer, he placed L- (low pitch intermediate phrase marker) after each word. Child 4 always produced the declarative pattern regardless of the word length. Note that two children (#2 and #3) produced more intermediate phrase boundaries for longer words.

Control group

1. Buttercup (# of syllables 3)

Child 5 H* H* H- H* H* H- H* L-L% ("cup" is realized higher than "butter".)
Child 6 H* L- H* L- H* L-L% (The pitch track looks like down steps, but I do not hear it.)

2. Cafeteria (# of syllables 4)

Child 5 H* H+!H* H* L-L%
Child 6 H* L- H* L- H* L-L% (High intensity on 'teria', but not pitch.)

3. Kitty (# of syllables 2)

Child 5 H* !H* H* L-L% (Longer pause between words.)
Child 6 H* H* L-L% (No pitch accent on the second token.)

4. Refrigerator (# of syllables 5)

Child 5 H* H+!H* H+!H* L-L%
Child 6 H* L- H* L- H* L-L%

5. Television (# of syllables 4)

Child 5 L+H* !H* !H* H-L% (No final falling.)
Child 6 H* H* !H* L-L%

Similar to the SLI group, each child in the control group also seems to have his/her own strategy for repeating words, and they were fairly consistent. Child 5 often used the "listing" contour, raising the pitch at the end of each word. On the other hand, Child 6 produced either sequences of H* or repetitions of H* L- (which are different from declarative). Unlike the SLI group, which showed more intermediate phrases for words with more syllables, the numbers of intermediate phrases and syllables do not seem to correlate for the control group.

4. Discussion and Conclusion

Results from the contrastive focus task revealed notably higher occurrences of expected contours among the control group compared to the SLI group. The SLI group and control group produced 7 and 12 correct answers respectively (out of 12 sentences). The difference is mainly due to their performance for the "balloon" question, which was syntactically most challenging, and it required the longest answer (they had to say the entire sub-clause) among the three questions. Besides, unlike the other two questions in which the experimenter would produce the contrastive focus contour in her utterances, children could not simply repeat the intonation pattern in the question. That is, they had to produce a structure which was not in the question. In addition, one time the experimenter gave a wrong intonation (high plateau). In fact, SLI children often produced the correct intonation contour when the answers were shorter and syntactically simpler. Taken together, it is difficult to conclude that SLI children have poorer semantic knowledge

from the results in this contrastive focus task. Although the performance level of the SLI group was lower than that of the control group, the difference could have been caused by non-semantic factors.

As mentioned earlier, the results from the repetition task revealed a general tendency of greater pitch-ranges for the SLI group than for the control group, although the differences never reached statistical significance. However, the overall standard deviation for the SLI group was proven to be greater than for the control group, and the difference reached statistical significance (p=0.039, paired t-test 2 tails). There was no clear difference between the two groups in terms of their intonation patterns for the repetition task. Each child in both groups showed different patterns which were roughly consistent throughout the five test-words. Some produced a listing contour, while some produced a declarative contour. Unlike the contrastive focus, there is no "correct" answer for the repetition task and thus it is difficult to determine which contour is more standard. One trend I observed was that SLI children are more likely to place more phrase boundaries than the control group. This pattern was particularly noticeable among longer words, and three SLI children (2, 3, 4) always placed an intermediate phrase boundary between each word except "kitty".

The purpose of the current study was to test the hypothesis that "SLI is a domain specific deficit affecting only syntactic representations of our knowledge, and children with SLI have no problem expressing semantic messages such as contrastive focus or the end of an intonational phrase by using prosody". Our results did not reveal a clear difference in terms of semantic knowledge between SLI and control children, supporting our hypothesis. However, the results indicated that the intonation patterns of SLI children tend to be more atypical when the string of utterance becomes longer, suggesting that SLI children may have problems other than syntax (rejecting our hypothesis). This is consistent with the findings from Wells and Peppe (2003), in which LI (language impaired) children seem to have shown some difficulties in retaining information over the longer prosodic domains. Wells and Peppe claimed that this result ties in with the suggestion by Weinert (2000), that the short-term memory deficits repeatedly found in children with SLI may be attributable to problems in long-domain prosodic processing.

Although domain-specificity of SLI was not determined in this study, our results revealed that 1) SLI children's placement of contrastive focus is comparable to that of normally developing children, 2) SLI children has wider pitch range than normally developing children, and 3) SLI children may have problems in their prosody, especially when the prosodic domain becomes longer.

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