LANGUAGE LEARNABILITY: EXTENSION TO A LANGUAGE-IMPAIRED CHILD

Donna J. Kelly

Instructor
Children's Rehabilitation Unit &
Department of Hearing and Speech
University of Kansas Medical Center
Doctoral Student
Child Language Program
University of Kansas

Steven Pinker (1984) addresses language acquisition in children through the perspective of learnability. Pinker attempts to explain how the child attains the adult grammar. He notes that as children's linguistic productions do not initially approximate the adults' productions, the child's linguistic knowledge should be viewed as an intermediate product. According to Pinker the child's rule system must have been constructed by an innate acquisition mechanism that initially had no specific knowledge about language, yet was able to acquire adult language proficiency through linguistic input, i.e., parental input.

Pinker utilizes child language data to investigate the predictive power of his theory. Corpora from children acquiring language normally, yield one type of information about the ability of his theory to account for the attainment of grammar. Children who acquire language at a slower rate than their peers may pose another sort of "puzzle" for Pinker's theory.

This paper represents one attempt to extend Pinker's theory to the corpora of a language impaired child. Two language samples represent one child's expressive performance at different points in his development, i.e., the initial sample was obtained when the child was 3 years 4 months and produced only single words, the second sample was taken 5 months later (C.A. = 3:9) when both two and three word productive combinations had emerged. Specifically this paper will explore this child's movement from the production of single lexical items to multiword utterances.

General Assumptions

Pinker notes that the child's acquisition of syntax is best explained in terms of rules acting on

representations. The learning mechanisms for language do not change over time, but are assumed to be stationary. His theory attributes developmental progress to increases in the child's lexical knowledge. The learnability theory ignores several "differences" between children and adults which are typically viewed as cognitive, e.g., attention, memory, cognitive sophistication. Pinker defends this position by stating that a theory of language acquisition should be parsimonious, e.g., posit few developmental changes, which results in increased explanatory power. Incorporating parameters such as attention, without an explicit understanding of how such factors operate, could render the theory nonfalsifiable and powerless to make predictions.

Semantic Bootstrapping Hypothesis

Pinker assumes that children have the ability to infer the meaning of utterances they hear from their physical and discourse contexts, and from the individual word meanings in the utterance. The Semantic Bootstrapping Hypothesis (SBH) assumes that the child uses semantic notions as evidence about the occurrence of a particular grammatical category or relation occurring in the input. The child exploits the "rich deductive structure" and from the start uses the semantically transparent members to draw the first "premises" of deductions. The conclusions which children derive about the language are syntactic ones.

The child has access to the linear order of words contained in the input string, their prosodic properties and their meaning. Not all of the utterances (or parts of the utterances) which the child hears are used as input to the acquisition mechanisms, rather the child encodes the parts of the utterances whose words he or she understands. Pinker states that this could be accomplished through several means, e.g., the child attending to single words in isolation, or attending to stressed syllables.

The SBH makes several predictions about the early utterances a child should produce, and Pinker investigates these predictions using child language data. SBH predicts that a child's earliest words will refer to physical objects and action verbs, this prediction is supported by the data. An examination of parental speech is also consistent with the SBH.

whereby parents appear to filter their speech in such a way that the semantic bootstrapping strategy will not lead to "serious" errors by the child.

Distributional Learning & Phrase Structure Rules

Pinker states that the child can only progress so far in the process of language acquisition with semantic bootstrapping, e.g., many nouns do not refer to objects. Therefore once a basic scaffolding of lexical items and semantically induced rules are available, the semantically neutral rules and lexical items may be learned by distributional learning. Distributional learning (DL) refers to the child observing the distribution of words within constituent or inflectional structures; this observation triggers language learning.

Pinker states that, in general, a child's early speech will reflect syntactic-semantic correspondences. As the child learns first rules they will manifest themselves in the child's language productions. He states that the accretion of rules would be slow therefore large amounts of structure-dependent distributional learning would not follow the first acquisitions.

Once the child initiates distributional learning the two grammars begin to converge. Pinker assumes that children will give priority to distributionally based analysis. When the semantics of a sentence are neutral, the child must respond to the syntactic distribution of the words and use the syntactic categories which are already learned to predict the semantic properties of the words.

Although there is nothing in Pinker's theory which specifies when in development distributional learning would begin to operate, he states that there is evidence that children begin to use distributional learning at approximately 18 months of age, e.g., to induce the linguistic properties of a word. This prediction corresponds with the child language data, i.e., children often begin producing word combinations at approximately 18 months.

The assumption that young children use semantics to induce syntactic categories predicts that children should occasionally make grammatical mistakes; he cites

child language data to support this assumption. Pinker asserts that the child uses distributional learning to alleviate errors acquired through the use of semantic bootstrapping. The child relies on distributional evidence to cement correct syntactic categories or to free incorrect categories until there is enough evidence to fix them. The child's grammar must be both flexible and permanent, i.e., flexible enough to modify errors (through the use of constraining equations), yet able to permanently cement the correct grammar.

According to Pinker, reception and production of the grammar hinge on understanding the phrase structure rules (PSR). PSR are at the "heart" of lexical functional grammar and are among the child's first acquisitions. Knowledge of lexical meaning yields information relative to where the arguments are attached. Therefore early phrase structure rules are dependent on the success of the child's application of semantic bootstrapping. Pinker states that the child's task is simply to add, collapse, or uncollapse rules and to annotate functional equations as needed according to the outlined procedures. However, he notes that the procedures for the acquisition of PSR are initially dependent on semantic bootstrapping, and must be applied sequentially to work.

Developmental Data from a Language-Impaired Child

M.O. presents a history of delayed receptive and expressive language development. By report and observation, he produced 17 words at two years of age; 20 at two years six months; and 75 at three years four months. No word combinations were observed or reported at age 3:4 when an initial language corpus was collected.

Analysis of this sample reveals that M.O. produced 38 utterances in a 30 minute period. All of the utterances were single words, computation of his mean length of utterence for morphemes (MLU) was 1.15. M.O.'s MLU exceeds 1.00 due to the production of three plural markers, i.e., shoe<u>s</u>, bubble<u>s</u>, and block<u>s</u>. However, the plural -s was not judged to be productive, i.e., it was never extended to other nouns and these nouns did not appear without the -s. There was no evidence that the -s was actually emerging as a separate morpheme, e.g., it may be that rather than using -s to mark plurals he assumed the -s was part of

the root phonology and he was mapping stem + s.

Little redundancy was noted across the utterances. M.O. produced 38 utterances but only 8 of 38 were repetitions of previous utterances. His type token ratio (TTR), or the number of different words divided by the total number of words, was .79; the average TTR for his age was .47 (Miller, 1981). According to Miller the average number of different words (for a 50 utterance sample) at age 3:5 is 105 (SD=20) M.O.' s was 30, while the average number of total words was 233 (SD=50) M.O.'s was 35. Although M.O.'s derived data is based on a 38 utterance sample, several aspects of his expressive language are clearly developing more slowly than same age peers, e.g., length of utterance, frequency of utterances produced.

Although it is difficult to reliably infer semantic relations at the single word level, M.O.'s oral language production appeared to markedly lack productivity. The majority of this child's nouns appeared to reflect patient rather than agent status. Of the 16 nouns utilized, all appeared to have been produced as he was labeling objects. No actions were paired with these utterances, and he did not comment on actions initiated by the clinician. Seven verbs were produced, it was noted that four of these verbs were used to label his activity, e.g., done, eat, drink, and cook. Instances of affective verb use were also noted, i.e., want, and go appeared to be used to alert the clinician that he wanted to leave the room. Other relations expressed in the initial sample included negatives, no; demonstratives, e.g., here; adjectives, e.g., big,; and exclamations, hey.

The second sample elicited from M.O. was completed 5 months later; his C.A. was 3:9. During this sample he produced 64 utterences within the 30 minute period. His MLU for morphemes was calculated at 1.94; predicted MLU for age was 4.3 (Miller). It was noted that no plural markers were evidenced in this sample, which supports the lack of M.O.'s acquisition of the plural -s marker as inferred from the initial sample data.

His TTR for this sample was .71 (average TTR for age was .45), his TTR does not appear to have changed markedly from the first sample. This child's mean number of different words and total number of words increased markedly during the five month interval between the two samples. The total words (50

utterances) expressed were 100 (average for age was 233; SD=50), while the total number of different words was 90 (average was 105; SD=20). Although his MLUm and the total number of words expressed remained significantly delayed for his age, the number of different words expressed was now age appropriate.

An informal analysis of M.O.'s productivity reveals multiple gains. He moved from no instances of multiword productions to 40 instances of word combinations. An examination of his word order suggests that only 2 of the 40 multiword utterances were incorrectly ordered, i.e., "go plane" and "go truck" (make the plane/truck go). The following phrase structure rules were noted:

S --> (NPsubj) VP

NP --> (Art) (Adj) N
Nposs'v' Nposs'd

VP --> (V) (NPobj) (P)

His most frequently produced syntactic structure was V Nobj; he produced this construction 8 times of 40 possible occurances. Twelve different syntactic constructions were noted at the two-word level, and 10 were noted at the three word level. There was a general absence of morphological markers utilized in this sample, -ing was noted to occur on two occasions with two different verbs. Although M.O.'s phrase structure rules appear limited in frequency and variety relative to his chronological age, an examination of his grammatical structures coupled with his high level of productivity suggest that this child's language development is delayed rather than deviant. (Please refer to appendix 3 for a detailed list of his multiword constructions.)

A much greater variety of semantic relations was also evidenced in the second sample. M.O. continued to emphasize the patient status; however several agents were explicitly produced and several others were omitted but may be inferred from the context. He produced 12 nouns in subject position and 12 in the object position. Nineteen different action verbs were noted in this sample, with four instances of affective verbs. Increases were also noted in his production of adjectives and demonstratives, and the following categories were now evidenced: participles, adverbs,

auxiliaries, and articles. Table 1 contains a breakdown of many of the productive changes noted across the two language samples. (Please refer to appendix 3 for further information.)

TABLE 1. Breakdown of Linguistic Entities

	Sample 1	Sample 2	Norms
Number of utterances	38	64	--
TTR	.79	.71	.45
MLU(m)	1.15	1.94	4.3
Number of word combinations	0	44	--
Number of total words in sample (50 utterances)	35	100	233 (SD=50)
Number of different words in sample (50)	30	90	105 (SD=20)

Categories	Sample 1	Sample 2
Nouns	16	32
Verbs	7	26
Adjectives	2	9
Demonstratives	3	5
Negatives	1	1
Participles	0	5
Adverbs	0	1
Articles	0	2

Analysis of the two language samples suggests that M.O.'s oral language functioning ranged from approximately 20 months in the initial sample, C.A. 3:5, to approximately 27 months in the second sample, C.A. 3:9 (Miller). M.O.'s initial sample markedly lacked productivity for example, restricted noun usage, i.e., labeling of objects, and the absence of multiword utterances. His subsequent sample collected 5 months later was found to be very productive. Multiple syntactic constructions were generated at both the two- and three-word utterance level.

Increases were also evidenced in the categories produced relative to the initial sample, e.g., frequency of adjective productions, and new categories were added, e.g., participles. Grammatical morphemes, e.g., -ing, articles, were also noted to be emerging. Although M.O.'s initial onset of word combinations was markedly protracted, (i.e., although single words were initially produced at 14 months of age no word combinations were observed or reported until approximately 3:5 months of age) his acquisition of productive language appeared to generally adhere to the normal sequence of acquisition. Once M.O. began to utilize word combinations few errors, e.g., word order, were apparent.

A comparison of M.O.'s second sample with the normal data (i.e., Miller) revealed that at 3:9 his expressive language production most closely approximated the 22 to 30 month level (i.e., MLU) and the number of total words produced within a 50 utterance sample remained reduced for age. However, as delineated in Table 1, M.O.'s increasing knowledge of the grammar enabled him to produce functional, productive utterances.

At 3 years and 9 months M.O. was also administered two formal language measures. The Peabody Picture Vocabulary Test - Revised was administered to assess M.O.'s single word receptive vocabulary comprehension. His responses yielded an age equivalent score of 3 years 3 months and a standard score equivalent of 91. These results suggest that his single word receptive vocabulary is within expected age limits. The Test of Auditory Comprehension of Language - Revised was also administered. M.O.'s responses suggested the following pattern of strengths and weaknesses:

Subtest	Age Equivalency	Quotient
Semantics	3 years, 9 months	95
Grammar	3 years, 1 month	89
Elaborated Sentences	3 years, 8 months	101

At 3 years, 9 months, M.O. exhibited average vocabulary comprehension and average to low average receptive language comprehension; however, his expressive language appeared to be markedly lower than his receptive language most closely approximating the 22 to 30 month level (Miller). This data suggests a marked difference between M.O.'s assessed comprehension and expressive language.

Extension of Pinker's Model

M.O. presents as a language-impaired child. He exhibited a pattern of markedly delayed onset of word combinations, (i.e., the language acquistion literature predicts two word combinations at 18 to 24 months and M.O. did not produce two word combinations until he was over 41 months of age). His rate of acquisition is atypical; the growth pattern which M.O. exhibited during this 5 month period is markedly different from his earlier pattern of linguistic acquisition. M.O.'s language functioning was characterized by a marked difference between his comprehension of language which apppears to approximate his age level of 45 months, and his productive language which was estimated at the 21 to 30 month level relative to his MLU. Finally, assymmetry was notably present in both samples relative to his production of more patients than agents.

It appears that Pinker's learnability theory would posit the same explanation for both the slowed rate of linguistic acquisition and the measured differences between his comprehension and production abilities. Pinker could argue that both of these deviations from the norm were secondary to causes outside the grammar. Specifically, Pinker could utilize a competence versus performance distinction, i.e., the child possessed a working kowledge of both the semantic and syntactic aspects of the language, but influences outside the grammar interfered with his expressive production. Evidence for this position would include M.O.'s

adequate performance on the formal language comprehension measures, and data to suggest that M.O.'s expressive language acquisition was following a predictable developmental sequence.

Pinker notes that asymmetries in children's productions are difficult to account for through the learning mechanism, and suggests these patterns may also be caused by factors which are external to the grammar. This explanation is consistent with evidence in the child language literature which suggests that many language-impaired children exhibit a "listener dependent" strategy. The listener dependent strategy may allow the child to assume common knowledge of the subject or agent thereby excusing him from making the form explicit in the discourse. This explanation is also consistent with Pinker's explanation of why gaps occur in children's speech, i.e., communication did not require the use of a particular form (the receiver inferred it).

In summary, Pinker's theory of language learnability carefully blends linguistic theory with empirical and naturalistic evidence from the child language literature. The application of theoretical predictions to available data records yields information which may serve to stimulate futher theoretical and empirical research. An extension of the learability theory to data from a language-impaired child suggested that Pinker's theory appears to be applicable to language learning which is consistent with the normal rate of acquisition, as well as with protracted periods of expressive language acquisition.

REFERENCES

Miller, J.F. (1981). Assessing language production in children. Baltimore: University Park Press.

Pinker, S. (1984). Language learnability and language development. Cambridge: Harvard University Press.

Appendix 1: Sample 1
December, 1985
C.A.: 3 years, 4 months
MLU: 1.15
/: denotes a repeated utterance

Nouns	Verbs	Other
juice	done	no //
wagen	eat	here //
baby	drink	hey
car ///	cook	rightthere //
Adam	want	righthere
Bert	go //	big
ball	look	little
choochoo		
bear		
plate		
truck		
book		
stove		
blocks //		
bubbles		
shoes		

According to observation and parent report (M.O.) had not yet produced any two-word combinations.

Appendix 2: Sample 2
May, 1985
C.A. 3 years, 9 months
MLU: 1.94

Single Words	2-Word Utterances	3-Word Utterances
stove	open door	the block in
flower	walk down	doggie sit down
table	go plane	I like that
juice	go up	me do it
milk	go down	my ear hurt
gum	go truck	big truck coming
eye	move plane	look, a cow
baby	move block	pull it away
hair	get it	don't like that
head	want it	a big ball
crawl	pop bubble	time to go
jump	hit ball	
kick	get this	
push	egg in	
wet	it hot	
good	it break	
cold	me too	
under	horsie run	
little	baby crying	
big	hi, honey	
rightthere	big one	
rightnow	green pea	
alldone	hard egg	
allgone	hey, move	
	red block	
	big ball	
	that ball	
	let go	
	turn on	

Appendix 3

Type and Frequency of Syntactic Constructions Produced: Sample 2

Construction	Examples	Frequency
V Nobj	open door	8
Art N P	the block in	1
V P	walk down	4
Nsubj V P	doggie sit down	1
V Nsubj	go plane	2
Nsubj V Nobj	me do it	2
Nsubj P	egg in	1
Nposs Nsubj V	my ear hurt	1
Nsubj V	it break	3
Adj Nsubj V	big truck coming	1
Nsubj Adj	it hot	1
Art Adj N	a big ball	1
N Adv	me too	1
V Art N	look, a cow	1
Ex N	hi, honey	1
V Nobj P	pull it away	1
Adj N	red block	5
Aux Neg V Nobj	don't like that	1
Ex V	hey, move	1
N infinitive	time to go	1
Dem N	that ball	1
V [V]s	let go	1