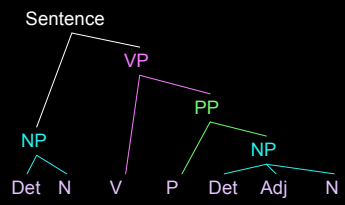
Psych 215L: Language Acquisition

Lecture 13
Learning Phrases II

Learning hierarchical phrase structure



The girl danced with the goblin king.

Distributional Cues for Syntax: Takahashi & Lidz (2009)

"In particular, it has been proposed that 'transitional probabilities', which is a statistic that measures the predictiveness of the following element given a previous element, can be used by learners to successfully learn phrasal groupings of words (Thompson & Newport 2007) in miniature artificial languages."

"However, the artificial grammar in Thompson & Newport (2007) contained phrases with no internal structure and consequently leaves open the question of whether statistical cues to multiply embedded hierarchical structures can be detected by learners."

Artificial Language Phrases from T & N (2007)
AB CD EF

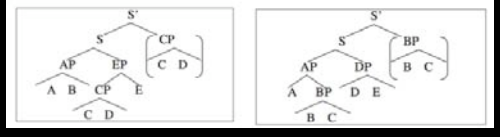
Artificial Languages: Words & Grammars

Classes: same as used for Thompson & Newport (2007)

Word Class	A	B	C	D	E	F
	KOF	HOX	JES	SOT	FAL	KER
	DAZ	NEB	REL	ZOR	TAF	NAV
	MER	LEV	TID	LUM	RUD	SIB

Table 1: Nonsense words assigned to each word class

Grammar 1 Grammar 2



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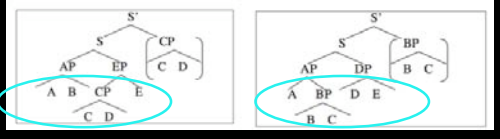

Canonical structure: ABCDE

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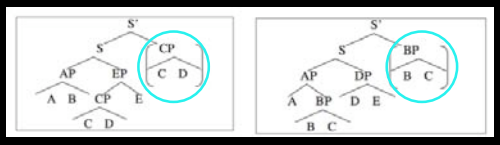
Nested hierarchical structure: EP, AP

Artificial Languages: Language Properties

(a) Certain constituents are optional

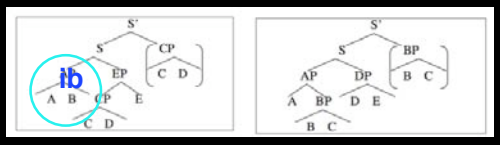
Grammar 1 Grammar 2



Artificial Languages: Language Properties

(a) Certain constituents are optional
(b) Certain constituents can be repeated
(c) Certain constituents can have proforms substituted for them (ex: *ib* can replace AP in grammar 1)

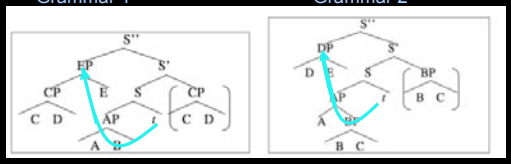
Grammar 1 Grammar 2



Artificial Languages: Language Properties

(d) Movement: the EP can be moved to the front in Grammar 1 and the DP can be moved in Grammar 2.

Grammar 1 Grammar 2



Training Set Probabilities

80 input sentences

Grammar 1

	A-B	B-C	C-D	D-E
Forward TP	1.00	0.24	1.00	0.25
Backward TP	1.00	0.19	1.00	0.34

Grammar 2

	A-B	B-C	C-D	D-E
Forward TP	0.33	1.00	0.15	1.00
Backward TP	0.18	1.00	0.16	1.00

Experiment 1: Identifying Constituents

Training set: 80 sentences randomized and repeated 6 times (36 minutes of listening)

Subjects: 44 native English speakers

3 tests for constituency:
Fragment test, Movement test, Substitution Test

Instructions for forced choice task:
"Pick the one you think belongs in the language"

Fragment Test

Goal: Recognition of phrasal groupings (constituents)

Comparison: Constituent (grammatical) vs. non-constituent that was still a legal sequence

	Grammatical in Grammar 1	Grammatical in Grammar 2
1	AB (e.g. *KOF HOX*)	BC (e.g. *NEB REL*)
2	CD (e.g. *JES SOT*)	DE (e.g. *SOT FAL*)

Grammar 1: compare AB vs. BC

Important: test item sequences were never heard in training set (controls for frequency effects)

Movement Test

Goal: Movement of phrasal groupings (constituents) only?

Comparison: Moved constituent (grammatical) vs. moved non-constituent

	Grammatical in Grammar 1	Grammatical in Grammar 2
1	CDEAB (e.g. *JES SOT FAL KOF HOX*)	DEABC (e.g. *SOT FAL KOF HOX JES*)
2	FAB (e.g. *KER KOF HOX*)	DEF (e.g. *SOT FAL KER*)
3	CDEABCD (e.g. *JES SOT FAL KOF HOX JES SOT*)	DEABCBC (e.g. *SOT FAL KOF HOX JES HOX JES*)
4	FABCD (e.g. *KER KOF HOX JES SOT*)	DEFBC (e.g. *SOT FAL KER HOX JES*)

Grammar 1: compare CDEAB vs. DEABC

Important: test item sequences were never heard in training set (controls for frequency effects)

Substitution Test

Goal: Substitution of phrasal groupings (constituents) only?

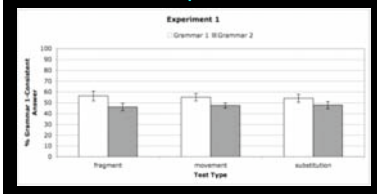
Comparison: Pronoun substitued for constituent (grammatical) vs. pronoun substituted for non-constituent

	Grammatical in Grammar 1	Grammatical in Grammar 2
1	ib CDE (e.g. *ib JES SOT FAL*)	ABC ib (e.g. *KOF HOX JES ib*)
2	AB et E (e.g. *KOF HOX et FAL*)	A et DE (e.g. *KOF et SOT FAL*)
3	ib et E (e.g. *ib et FAL*)	A et ib (e.g. *KOF et ib*)

Grammar 1: compare ib CDE vs. ABC ib

Important: test item sequences were never heard in training set (controls for frequency effects)

Experiment 1: Results



Grammar-1-trained subjects prefer constituents over non-constituents for the fragment and movement tests (though overall performance is generally at chance). However, they did not significantly prefer constituents over non-constituents for the substitution test.

T&L Implications: Subjects can pick out a constituent (ex: CD from fragment test), and a hierarchical constituent (ex: CDE from movement test) from distributional information alone.

Experiment 2: distinguishing between two hypotheses

H1: Phrase structure invention

Each child has to discover the existence of phrase structure and its characteristics on the basis of distributional information alone

Output of learning determined solely by experience

H2: Phrase structure identification

Each child uses the input distribution to determine how the particular language maps words to structural descriptions of a highly restricted character

Output of learning derives from an interaction between the input and an experience-independent representational system.

Experiment 2: Altered Training

The Issue: Training for experiment 1 included lots of examples of movement and substitution for constituents - maybe this is what subjects were using to make decisions.

Training for experiment 2: no movement or substitution examples in the training set.

Grammar 1

	A-B	B-C	C-D	D-E
Forward TP	1.00	0.28	1.00	0.24
Backward TP	1.00	0.24	1.00	1.00

Grammar 2

	A-B	B-C	C-D	D-E
Forward TP	1.00	1.00	0.22	1.00
Backward TP	0.22	1.00	0.24	1.00

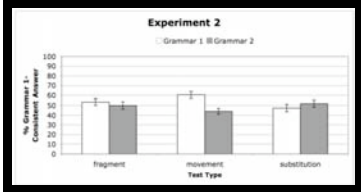
Experiment 2: Altered Training

The point about no movement or substitution during training:

Phrase structure invention: If subjects are just using distributional information to make abstractions without prior guidance, they should think movement and substitution sentences at test are bad - whether a constituent or non-constituent is moved/substituted for.

Phrase structure identification: If subjects are mapping structures to a system they know beforehand, they should think movement and substitution sentences at test are fine for constituents but not for non-constituents.

Experiment 2: Results



44 native English speakers

T&L Implications: The fact that subjects preferred movement of constituents when they had no input showing this indicates they didn't just get this from the input. They must be mapping the input to pre-existing knowledge. As for substitution, maybe other cues are required to signal it. (What about the fragment test?)

Grammar-1-trained subjects prefer constituents over non-constituents for the movement test only (though overall performance is generally at chance). However, they did not significantly prefer constituents over non-constituents for the substitution test or the fragment test.

Discussion

Suppose we accept that subjects could map information contained in the transitional probabilities to pre-existing ideas about movement rules. How well does an artificial language experiment on adults shed light about how kids do this? Could it be that adults have pre-existing knowledge because they know their native language, but children do not have this pre-existing knowledge because they don't know their native language yet? If so, what would that mean?