Unit III: Language Acquisition
Part 1: Acquiring Words and Grammatical Categories

Introduction
What does a child learn, when a child learns a language? At a minimum, she/he needs to learn the following:

1) The words in her/his language
2) Which grammatical categories these words belong to (e.g., learning that "house" is a noun, "kick" is a verb, etc.)
3) Syntactic rules governing how sentences can be composed out of these grammatical categories (e.g., learning that "The woman swam in the ocean" is a well-formed sentence in English, but "The woman ocean swam swam" is not).

Learning each of these is no small feat – it is a very striking fact that all normal children acquire this knowledge at a very early age! The big question is:

> **Big Question:** How is this possible? How do children manage to learn – usually in the absence of any explicit instruction – at a relatively early age?

This question has attracted a good deal of attention from linguists, psychologists, and philosophers. At least part of the discussions have fallen against a backdrop of a long-standing debate between *nativists* and *empiricists*.

- *Nativism* about language claim that some – much/all – of our knowledge of language is innate.
- *Empiricists* about language claim that our knowledge of language comes from experience; it is not innate.

Almost no one would claim that all knowledge of language is innate. Clearly, no one is born knowing specific English words such as "dog" or "epistemology". Rather, the debate has usually unfolded as a debate over how much of language learning is driven by *domain-specific factors* and how much is driven by *domain-general factors*. In the case of language learning, this amounts to the question as to whether language-learning is made possib

Acquiring Words
One major task facing the infant language learner is carving the speech stream into words.

- It takes a bit of work for adults to appreciate the magnitude of this task. We often think there are "spaces" or "gaps" between words in a sentence. But as a matter of fact the gaps that we "hear" are largely an illusion: in everyday space, acoustic breaks do not reliably signal word boundaries. To get a sense for this, try listening to a conversation in a language with which you are totally unfamiliar and try to identify what the different words in the sentence are.

How do infants manage to do this? Here we will look at three different clues that infants seem to track: (i) phonotactic constraints, (ii) stress patterns, (iii) transitional probabilities.

Phonotactic Constraints

- **Phonotactic constraints** are language-specific constraints that determine how sounds of the language may be combined to form words or syllables.

For example, consider the following nonsense string:

Banriptangbowpkesternladfloop.

Exercise: Try to segment this sentence in an "English-like" way.

You may find some discrepancies with your classmates. But chances are, you did not propose a segmentation like this:

Ba-nri-ptangbow-pkester-nladfl-oop.

This shows that some ways of segmenting a wordstream don't result in what we would consider "possible" words of English. But which segmentations are considered "possible" vary across languages. For example, try segmenting the following stream of Swahili into three words:

nipemkatenzuri

You probably wouldn't guess the correct segmentation, which is:

nipe-mkate-nzuri

While a number of segmentations are "impossible" in English, English is actually relatively loose/permissive when it comes to its phonotactic template. For example, letting "C" represent a consonant and "V" represent a verb, here are some phonotactic templates one finds in other languages:

Hebrew	Hawaiian	Indonesian
CV	V	V
CVC	CV	VC
CVCC		CV
		CVC

Based on head-turn paradigm experiments, it appears that by 9 months of age babies have some knowledge of the templates for proper words in their language. For example, Jusczyk et al. (1993) found that American babies orient longer towards strings of sounds that are legal words in English (e.g., *cubeb, dudgeon*) than they do to sequences that are legal words in Dutch but not in English (e.g., *zampljes, vlatke*). This suggests an important tool that babies use to identify the words in their language: they are sensitive to which words are possible or impossible according to their language's phonotactic template.

Stress Patterns

In addition to phonotactic differences, languages also differ from one another in their characteristic stress patterns. For example, English words stress tends to alternate, giving rise to one of two stress patterns:

- Trochaic stress pattern: the first syllable is stressed, the second is not (e.g., *BLACKmail*)
- Iambic stress pattern: First syllable is unstressed, second is stress (e.g., *reTURN*)

(In some languages, such as French, syllables are stressed more or less evenly.)

But as a matter of fact, English contains far more trochaic words than iambic words (on the order of 9:1 by some estimates). There is evidence that babies are sensitive to this fact: by 7.5 months, babies in an English-speaking environment have no trouble carving up words with a trochaic stress pattern, but they don't recognize iambic words. This suggests another clue that babies may use to identify words: they make educated guesses about which segments of the speech stream constitute words by recognizing the most common stress patterns in their language.

> **Important Question:** It seems that in order to apply either of these techniques – using phonotactic constraints, or exploiting stress patterns – children would need to have some antecedent conception of words in their language. But how do they get this initial conception in the first place?

Transitional Probabilities

In recent years, a number of researchers have tried to answer this residual question by appealing to the idea that babies are capable of tracking *transitional probabilities* between syllables. To illustrate this idea, consider the following syllables:

ti – pre – bay

Which of these would you most likely hear following the other?

One thing to notice here is that in English, pre – ti makes a word ("pretty"), whereas ti – pre, pre – bay, bay – pre, and ti – bay do not. Now, you might still hear some of these combinations within the speech stream, but it would only be at the boundaries between words. As a result, the probability of hearing ti followed by bay is pretty low – it would only happen if you heard two words in succession (e.g., "pretty bay"). By contrast, the probability of hearing pre followed by ti is much higher.

To make this a bit more precise, we can talk about the transitional probability of a syllable Y given a syllable X (written: "T(Y|X)") – that is, the probability that syllable Y will occur given that syllable X has just occurred. We can calculate this by dividing the frequency of the string XY (that is, X followed immediately by Y) by the frequency of X:

$$T(Y|X) = \text{frequency (XY)} / \text{frequency (X)}$$

Exercise: using this formula, calculate T(ti|pre) and T(ti|bay) for the following sentence:

"We went to a bakery and watched the pretty boats on the pretty bay."

- *Hypothesis:* babies pick up on these transitional probabilities, and use them to break up the speech stream into word-size chunks.

An important study by Saffran et al. (1996) seems to bear out this hypothesis:

- In the familiarization phase, eight month old infants were exposed to a two-minute speech stream made up of three syllable nonsense "words" – e.g., *bidaku, golabu, padoti, dutaba.* The only cues to word boundaries were the transitional probabilities between syllables, which were higher within words than at word boundaries.

- In the test phase, researchers looked at how much babies pay attention to the "words" they heard in the familiarization phase, and compared this to the extent to which they paid attention to three-syllable nonsense "words" that straddled the word boundaries (e.g., *dakupa*). Babies paid more attention to the latter, arguably because they were bored by the frequent repetition of the word units.

There is a further question whether the statistical learning mechanisms that babies use to segment words are unique to humans or not. Some evidence that it is not:

- Hauser and colleagues replicated Saffran et al.'s experiments on tamarin monkeys. In the familiarization phase, the monkeys heard 20 minutes of a speech stream in a language of made up words. In the test phase, they heard some words from the familiarization phase, as well as some "words" that straddled word boundaries. The monkeys seemed to distinguish between them, staring at the researchers more when they heard one of the unfamiliar "words".
- Toro and Trobalón (2005) also reproduced the results on rats, using the same artificial language used on human infants and monkeys. They found the rats were also able to distinguish between the words in the original speech stream and the unfamiliar "words" straddling word boundaries.

There is a further question as to whether non-human animals are capable of tracking the exact same types of statistical regularities that human infants are capable of tracking.