

Psych 56L/ Ling 51:
Acquisition of Language

Lecture 5
Biological Bases of Language III

Announcements

Be working on review questions for biological bases of language

Be working on HW1 (due: 1/23/14)

- Electronic submission due by the end of class (3:20pm) to receive full credit.
- Remember to include the name of everyone who worked on the assignment, and to submit only a single copy of the assignment per group.

Language and other species



Language and other species

Are we special among the animal species?

What are other species capable of?

Communication systems

Human language does enable communication, but it has several features that separate it from other animal communication systems:

intentionality: speakers use language for the purpose of communicating with others

reference: there are symbols which stand for things (even abstract things) in the world

syntax: productive system for combining symbols to express new meanings

Human language vs. “Animal language”

- Is the difference between an **animal communication system** and **human language** just a matter of degree (a quantitative difference)?

or

- Is there a sense in which human language is qualitatively different from the other communication systems?

Primate communication

Vervet monkeys



Predator alarm calls:

“leopard” = run to the trees

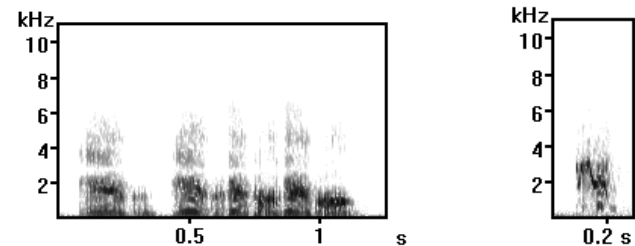
“eagle” = look up, run into the bushes

“snake” = stand up on hind legs & look around

Seem to have **intentionality** – do this to inform other vervet monkeys.

Primate communication

Vervet monkeys



Male (KN)

Female (LO)

Primate communication

Vervet monkeys



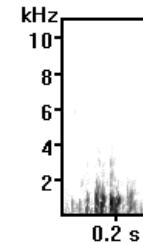
Leopard vervet calls

<http://www.youtube.com/watch?v=hEzT-85gEdA>

http://www.youtube.com/watch?v=sIGvI2y_W2c

Primate communication

Vervet monkeys

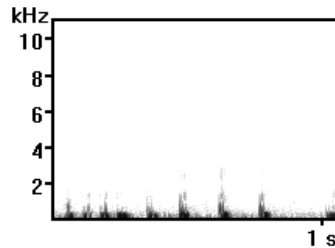


Female (BA)

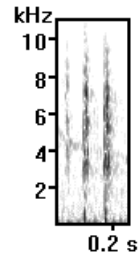
Vervet 'Eagle' Alarm Call

Primate communication

Vervet monkeys



Male (KN)



Female (LB)

Vervet 'Snake' Alarm Call

Primate communication

Vervet monkeys



However...no evidence for **complex combinatorial system**.

Unclear if system has **reference** – are these calls really symbols for “eagle”, “snake”, and “leopard”? Or are they more like “Ack - go low!” and “Ack - look down!” Or something else?

Primate communication

Vervet monkeys



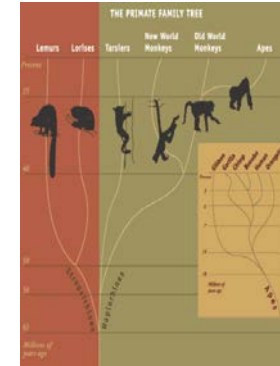
What they can't say:

"What a large eagle up in the sky over there!
We'd better take cover. C'mon!"

"I doubt there are any leopards around here.
The field looks pretty clear."

"Did you see that whopping big snake
yesterday? It was super scary!"

Mollusks vs. Primates



Mollusks vs. Primates

Primates likely have:

- More complex bodies and brains
- Better learning and problem solving skills
- More complex social structures
- More complex and flexible behavior
- Longer lives



Mollusks vs. Primates

After 450 million years...



Cephalopods:
15-35 distinct displays



Non-human primates:
15-35 distinct displays

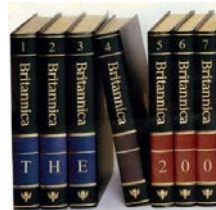
Adapted from Liberman

<http://www.thecephalopodpage.org/cephschool/WhyCephalopodsChangeColor.pdf>

Not just mollusks and non-human primates

“For most relatively social adult fishes, birds and mammals, the range or repertoire size [of communicative displays] for different species varies from 15 to 35 displays.”

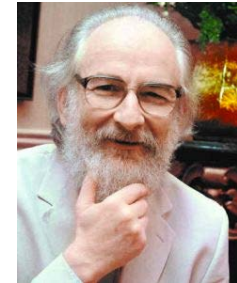
-Encyclopedia Britannica,
“Animal Communication”



Human vocabulary

"Most people know...about 50,000 - easily. A reasonably educated person about 75,000..."

"An ordinary person, one who has not been to university say, would know about 35,000 quite easily."



David Crystal

http://news.bbc.co.uk/2/hi/uk_news/magazine/8013859.stm

“The words in the mental cupboard”

Bee communication

Honey Bees



Dance to communicate the location of food (nectar)

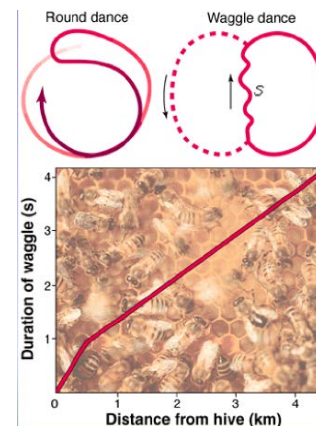
Can indicate: nearby vs. far, direction, richness of the food source (dance harder for the good stuff)

Though bees can create novel messages, they're always about the location of food.

Bee communication

Under 50m away

The angle from the sun indicates direction of food source. The duration of the waggle part of the dance signifies the distance. Approximately 1 second of dance = 1 km distance.



Quantity:

- (1) Ratio of waggle part to round part corresponds to quantity of food.
- (2) More food = more energetic wagging.

Over 50m away:

encodes distance & direction - is encoding of 2D space (a bee's "mental map")

<http://www.youtube.com/watch?v=-7ijl-g4jHg>

'deciphered' by Karl von Frisch, 1919 & onward

Bee communication

Has **intentionality**? Definitely – wagging for other bees.

Has **reference**? Maybe – indicating properties of nectar. (But that's all they ever communicate about with this method – no new symbols are created.)

Has **syntax**? Not really – but has rudimentary combinatorial properties (what direction, how far, how much).

Bee communication

Honey Bees



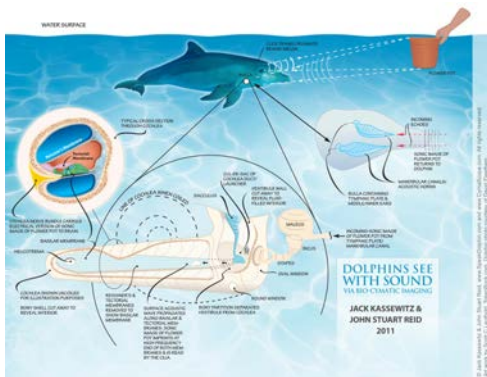
What bees can't communicate:

“Have you seen the flowers in the next field over? They totally rock. I've never seen such brilliant colors.”

“I thought the hive was really crowded yesterday.”

Dolphin communication

Dolphins



Kassewitz & Stuart Reid (2011): Dolphins use “Sono-Pictorial Exo-holographic Language”, (SPEL)

Evidence that dolphins can communicate about novel objects in their environment via the patterns that echolocation makes when pinging off the objects.

Certainly **intentional**, and likely **referential**. Unclear if **syntax** is present.

Dolphin communication

Dolphins Can Call Each Other, Not by Name, But by Whistle

<http://news.sciencemag.org/sciencenow/2013/02/dolphins-can-call-each-other--no.html?ref=hp>

3 samples of dolphin whistles on webpage

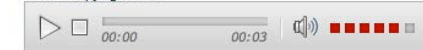
Whistlin' Dolphins

In these recordings, you can hear male dolphin A give his signature whistle. Male dolphin B copies A's call in the second recording; B's own signature whistle sounds very different from A's as you can hear in the third recording.

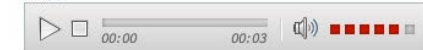
Male A



Male B Copying Male A



Male B



Credit: S. L. King, 2013

Dolphin communication

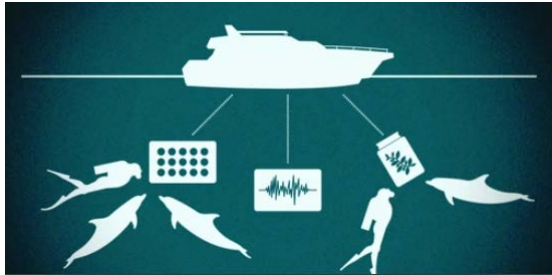
Herzig (2013), TED Talk: Could we speak the language of the dolphins?

http://www.ted.com/talks/denise_herzig_could_we_speak_the_language_of_dolphins.html

Especially 6:07-6:50 (complexity of dolphin whistles)

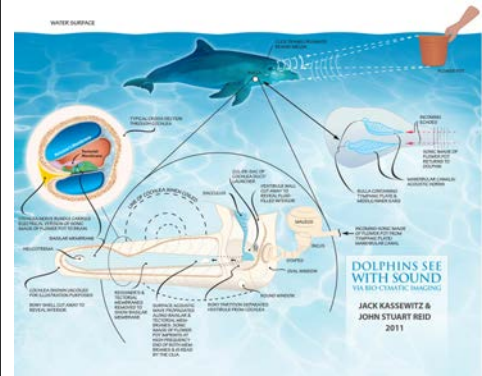
8:36-9:26 (two-way communication & symbolic representation)

10:26-10:52 (dolphin requests)



Dolphin communication

Dolphins



Unclear if they have a complex combinatorial system (syntax)

Can a dolphin communicate this?

“I wish there were some better fish around.”

“Those humans are soooo annoying sometimes.”

Bird communication

Songbirds



Males use songs to attract and acquire mates (fairly clear **intentionality**). In many species, the development of the song requires exposure to adult birds who model the song.

Bird communication

White-crowned sparrows: Stages of learning



0-35 days: no singing (but probably lots of learning)

25-40 days: subsong (like babies babbling)

35-80 days: “plastic” singing -- closer and closer approximations of the full song

> 90 days: crystallization of the song

Bird communication

Songbirds



Note: even though there is a learned part and a genetic part, we still classify birdsong as an instinct.

Bird communication



- Songs are learned
 - Regional dialects
- Learning, however, is innately guided (Marler, 1990)
 - Many species of sparrows prefer to learn the songs of their own species
 - And if they are only exposed to other species' songs, they follow species-specific structure
 - Learning is subjected to a sensitive period (must be learned within a time period)

Bird communication

Variation in song

Bird 1

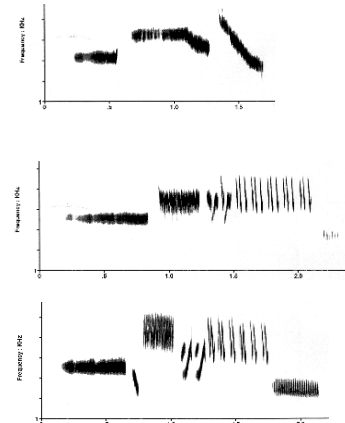


Bird 2

White-crown sparrow song



- White-crown sparrow #1 in isolation
- White-crown sparrow #2 w/ tutor
- White-crown sparrow's tutor



Bird communication

Sparrow song

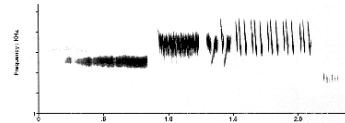


song

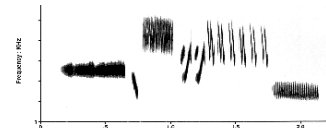


call

student



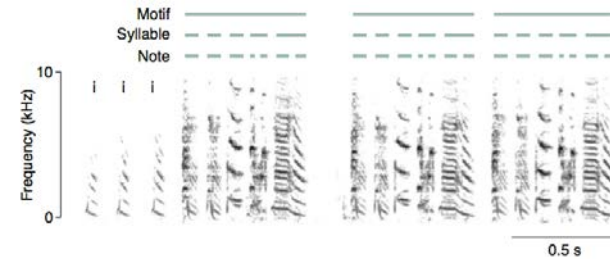
teacher



Song is highly structured
(combinatorial system) -
notes, syllables, phrases

Bird communication: Hierarchical structure

Zebra finch song



“Sound spectrogram of a typical zebra finch song depicting a hierarchical structure. Songs often start with ‘introductory notes’ (denoted by ‘i’) that are followed by one or more ‘motifs’, which are repeated sequences of syllables. A ‘syllable’ is an uninterrupted sound, which consists of one or more coherent time-frequency traces, which are called ‘notes’. A continuous rendition of several motifs is referred to as a ‘song bout.’” – Berwick et al. 2012

Bird communication vs. Human language



There are several similarities between language acquisition in humans and song acquisition in songbirds (Okanoya 2013). Both human language and birdsong:

- (1) have early stages prior to the appearance of the adult form (babbling vs. subsong)
- (2) require the babies to be able to hear their own productions

Bird communication vs. Human language



There are several similarities between language acquisition in humans and song acquisition in songbirds (Okanoya 2013). Both human language and birdsong:

- (3) have sensitive periods (between 7 and 60 days old for birds)
- (4) are lateralized in the left hemisphere

Bird communication vs. Human language



However, there are also some crucial differences (see Berwick et al. 2012 for a more thorough discussion of this):

- (1) Birdsong seems to lack flexible semantics. (Like the bee dance, birdsong is only ever about one thing. No novel meanings.)
- (2) Birdsong seems to lack individual words. (Is a particular note sequence a **symbol** for something? What does it **refer** to? It's unclear.)

Bird communication vs. Human language



However, there are also some crucial differences (see Berwick et al. 2012 for a more thorough discussion of this):

- (3) The **combinatorial system seems less complex** in birdsong. While human language has phonemes that make syllables that make words that make phrases that make sentences, birdsong seems to stop at the “word” level (~motif).

Bird communication vs. Human language



However, there are also some crucial differences (see Berwick et al. 2012 for a more thorough discussion of this):

- (4) Also, while birds can reorder elements within their song, this never changes the meaning of the entire song. Thus, their **combinatorial system** does not connect with meaning in the same way that human syntax does. (For example, “Penguins eat fish” does not mean the same thing as “Fish eat penguins”, but a song made of motif order A-B-C conveys the same meaning as a song made of motif order C-B-A.)

Learning human language

Just because other animals’ communication systems aren’t as complex as human language, does that mean that they’re incapable of learning human language (**intentional** communication, **reference**, **syntax**)?



Non-primates



Donning his new canine decoder, Professor Schwartzman becomes the first human being on Earth to hear what barking dogs are actually saying.

Alex the parrot



Grey parrot, born 1976, died 2007

Trained by Dr Irene Pepperberg (U. Arizona) since 1977

Impressive ability to speak/understand
...for a parrot

http://www.youtube.com/watch?v=7yGOgs_UIEc

Alex's language



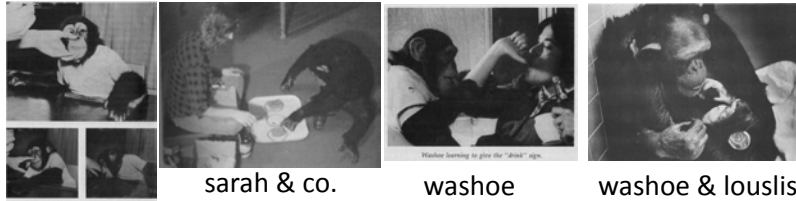
- Speech sounded remarkably accurate
...produced *very* differently from humans
- Knew names of about 150 objects plus some fixed expressions
- Answered simple questions about objects (e.g. about size, color, material)
- Required *immense* amounts of training

Non-human primates



"He's pretty good at rote categorization and single-object relational tasks, but he's not so hot at differentiating between representational and associational signs, and he's very weak on syntax."

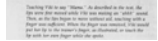
Non-human primates



sarah & co.

washoe

washoe & louslis



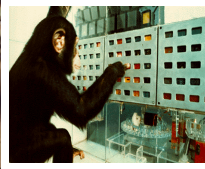
vicki



Koko



nim chimsky

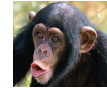


lana & co.



kanzi & co.

Teaching chimpanzees



Teaching chimpanzees to speak didn't work out very well

1930s: Gua, raised in a human home and treated like human infant along with the couple's son

- motor skills surpassed child's, but never learned to speak (while the child did)

1940s and 50s: Viki, raised in a human home and actively taught to produce words

- by 6, Viki could say "mama", "papa", "cup", and "up"

Problem: Chimpanzees have a vocal tract that makes speech production essentially impossible.

Teaching chimpanzees



Teaching chimps to sign using ASL

1960s: Washoe, lived in trailer in backyard, people always communicated via ASL, taught by molding hands into the appropriate signs

- June 1965: born
- 1-yr-old: Begins training
- 2-yrs-old: 13 signs
- 3-yrs-old: 34 signs
- 4-yrs-old: 85 signs
- 5-yrs-old: 132 signs
- 27-yrs-old: 240 signs



Findings (though controversial)

New extensions

e.g., "dirty", "red"

New word combination & syntax

e.g., "water bird", "baby in my drink."

Transmitted 50 signs to Louslis (adopted son).

Teaching chimpanzees



Teaching chimps to sign using ASL

1979: Nim Chimpsky, raised in private home, taught signs by having hands molded into them

- learned 100 signs and produced some combinations

But combinations produced are very different from those of a human child - very repetitive, no additional complexity:

2-sign

"eat drink"

"tickle me"

3-sign

"eat me Nim"

"me Nim eat"

4-sign

"eat drink eat drink"

"play me Nim play"

Teaching chimpanzees



Teaching chimps to sign using ASL

1979: Nim Chimpsky, raised in private home, taught signs by having hands molded into them
- learned 100 signs and produced some combinations

A quantitative analysis of combinatorial ability (called *productivity*) from Yang (2013) also demonstrates that Nim's productions are *not compatible with a combinatorial system*. Instead, they are much more likely to be imitations of whole chunks from the surrounding input. This is corroborated by reports of how Nim's sign combinations originated: All of them were imitations of his teachers - *no novel combinations, unlike human children*.

Teaching chimpanzees

Teaching chimps to sign using ASL

Nim's longest utterance: "give orange me give eat orange me eat orange give me eat orange give me you"



Teaching chimpanzees



Teaching chimps to sign using ASL

No symbolic reference:

"For Nim, meaning seemed to have no role outside of the specific association between a form and its referent that had been explicitly taught to him....for Nim, signs did not refer; he did not have words - signs, or names - for things." - Laura Petitto, one of Nim's teachers, 1988

Conversations with Koko



- *Moderator:* Koko are you going to have a baby in the future?
- *Koko:* Pink.
- *Dr. Patterson:* We've had earlier discussion about colors today.
- *Koko:* Listen! Koko loves eat.

....

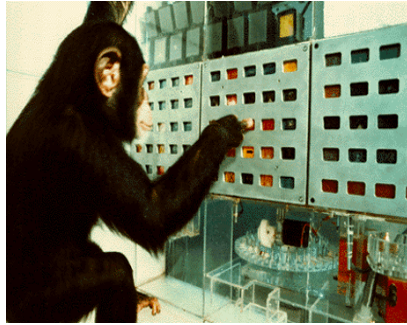
- *Moderator:* What are the names of your kittens? (and dogs?)
- *Koko:* foot
- *Dr. Patterson:* Foot isn't the name of your kitty.
- *Moderator:* Koko, what's the name of your cat?
- *Koko:* no

....

- *Moderator:* Do you like to chat with other people?
- *Koko:* fine nipple
- *Dr. Patterson:* Nipple rhymes with people, she doesn't sign people per se, she was trying to do a "sounds like ..."

Lana & friends

- The Lana Project (or LANguage Analog) established in 1971.
- Yerkish: Artificial language



Teaching bonobos

http://video.ted.com/talks/podcast/SusanSavageRumbaugh_2004.mp4

Total length = 17:25, look at 2:32 - 7:32 especially



Teaching bonobos

Bonobos (pygmy chimpanzees) vocalize in communication more frequently than common chimps do.



1981: adult bonobo Matata instructed with an artificial language and utterly failed

However, her **infant bonobo Kanzi** - who **wasn't explicitly instructed** in anything, but accompanied his mother when she was instructed - learned the artificial language and was also able to understand some spoken English (presumably because he was within the critical/sensitive period).

<http://www.youtube.com/watch?v=wRM7vTrIiis> (Lexigrams)

<http://www.youtube.com/watch?v=2Dhc2zePJFE> (Novel Sentences)

Teaching bonobos

Did Kanzi have **reference**? Unclear.



“strawberry” = “I want to go to the place where strawberries are found”, “I want a strawberry to eat”, “There’s a picture of strawberries”, ...

Kanzi’s spoken English: comparable to a 2-yr-old child’s performance (**but a 2-yr-old’s syntactic knowledge is fairly limited**)

Also, Kanzi was 8 years old when he was tested, and was unlikely to improve his performance any further with age....unlike human children.

Some interim conclusions about animal communication

- Small vocabularies
- Little evidence of syntax
- Little evidence of productive or innovative language
- Maybe some evidence of displaced reference (referring to something that's not there right now)
- Maybe some transmission of language to next generation



A linguist's concluding remarks



- I do not believe that there has ever been an example anywhere of a nonhuman expressing an opinion, or asking a question. Not ever," says Geoffrey Pullum, a linguist at the University of California at Santa Cruz. "It would be wonderful if animals could say things about the world, as opposed to just signaling a direct emotional state or need. But they just don't."
- Source: <http://www.smithsonianmagazine.com/issues/2006/november/speakingbonobo.php>

So what's the problem?



Not a lack of intelligence - chimpanzees are highly intelligent.

One answer: language is an expression of a domain-specific mental faculty that humans have and other primates do not (nativist: generativist).

Specific abilities: syntax & referential semantics

Another answer: language must be learned through social interaction with others, and chimpanzees' ability to learn from others is limited - they can't seem to collaborate

A more detailed look at the nativist idea

Hauser, Chomsky, & Fitch 2002:

Faculty of Language – Broad (FLB): biological capacity for acquiring language that humans have and other animals don't. However, much of the biological capacity is assumed to derive from **shared origins with animal communication**.

Ex: Parts of the human conceptual system such as causal, spatial, and social reasoning are shared with other primates (Buttelman et al. 2007)

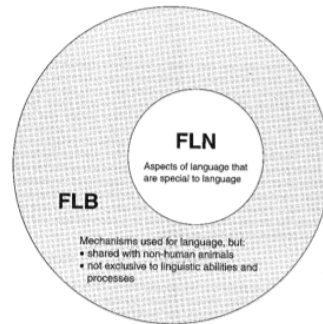
Difference between humans and animals is assumed to be more about "quantity" – humans have more power to drive these abilities than other animals, but the fundamental ability is basically the same.

A more detailed look at the nativist idea

Hauser, Chomsky, & Fitch 2002:

Faculty of Language – Narrow (FLN): A subset of FLB abilities that only humans have. Biological underpinnings not shared with other animals. A difference of “quality” not just “quantity”.

Pinker & Jackendoff (2005) suggest these might be in the FLN: properties of **speech perception**, **speech production**, **words** (as referential), **grammar**, **complex conceptual understanding that requires words** (ex: *week, 10 feet from the blue wall, half past five next Tuesday*)



The evolution of human language: One idea

How Human Language Could Have Evolved from Birdsong: Researchers Propose New Theory On Deep Roots of Human Speech

<http://www.sciencedaily.com/releases/2013/02/130221141608.htm>

Describing findings in Miyagawa, Berwick, & Okanoya 2013

Human language = combination of two communication forms found elsewhere in the animal kingdom

- elaborate songs of birds
- more utilitarian, information-bearing expressions seen in other animals

"When something new evolves, it is often built out of old parts"
- Robert Berwick

The evolution of human language: One idea

Sample utterance: “When did Sarah trick Hoggle?”



Two layers of human language

Lexical layer

= invariant core elements (Sarah, trick, Hoggle)

[animal equivalents: bee dance components, primate calls]

Expression layer

= rearrangement of core pieces to convey different meanings

Sarah tricked Hoggle. Did Sarah trick Hoggle?

How did Sarah trick Hoggle?

[animal sort-of equivalent: bird song melodies, which rearrange pieces, but don't change the overall meaning of the song]

Linking nativist ideas and language evolution

Faculty of the Language Broad (FLB):

Humans and some animals have the **lexical layer** in their communication systems.

Humans and some animals have the **expression layer** in their communication systems.

Faculty of the Language Narrow (FLN):

Only humans have the ability to **combine both layers** in their communication systems.

Recap: Animal Communication

While animal communication systems may share some properties of human language, none currently seem to be as complex as human language.

When other animals try to learn human language, they are much slower and do not achieve a level of competency that a human child does.

This suggests that there is something special about human language. Some ideas about why suggest that there are aspects that are unique to human biology which make this possible.

Questions?



Remember: HW1 is due Thursday, and you should be able to do all of it now.

You should also be able to do all of the review questions for biological bases of language.