

Ling 51/Psych 56L:
Acquisition of Language

Lecture 5
Biological bases of language acquisition III

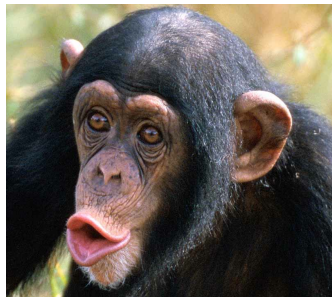
Announcements

Be working on review questions for biological bases of language acquisition

Be working on HW2 (due: 10/13/16)

Learning human language

Are other animals capable of learning human language? How much of a *human* instinct is language?



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

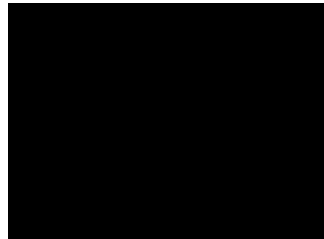
http://www.youtube.com/watch?v=7yGOgs_UIEc

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

Another African Grey Parrot: Einstein



http://www.ted.com/speakers/einstein_the_parrot

Einstein, the African grey parrot, has a vocabulary of more than 200 words and sounds; she can perform nearly half on a cue from her trainer, Stephanie White. She can also impersonate a spaceship, a monkey and even a skunk.

Einstein in action: http://www.ted.com/talks/einstein_the_parrot_talks_and_squawks
[3:25-3:35]

Parrot points



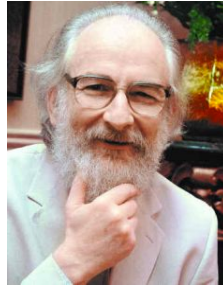
The parrot language acquisition process seems to be very different from a human child's. The output of that process certainly seem to be — much more limited than a human's.

For example, the average adult human knows **tens of thousands of words**, not just a few hundred.

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

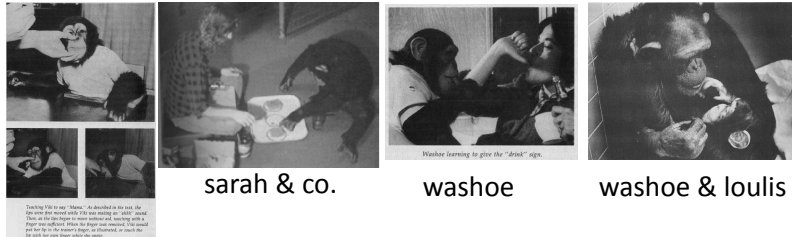
"The words in the mental cupboard"

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 & louis

vicki



Koko

nim chimpsky

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.

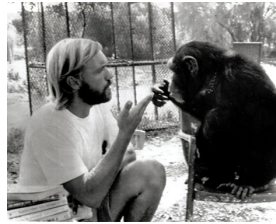
Teaching chimpanzees



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 Loulis (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

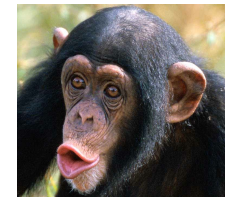
- learned 100 signs and produced some combinations

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

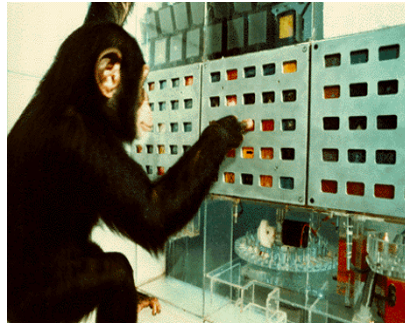
Teaching chimps to sign using ASL

Nim’s longest utterance: “give orange me give eat orange me eat orange give me eat orange give me you”



Lana & friends

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



Teaching bonobos

http://www.ted.com/talks/susan_savage_rumbaugh_on_apes_that_write?language=en
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

Kanzi's spoken English: comparable to a 2-year-old child's performance (**but a 2-year-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.

A linguist's concluding remarks in 2006



I do not believe that there has ever been an example anywhere of a nonhuman expressing an opinion, or asking a question. Not ever...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."

— Geoff Pullum

<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).

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)

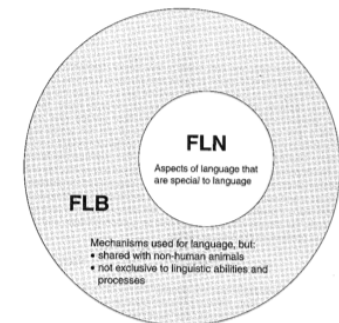
Difference between humans and animals is assumed to be more about "**quantity**" – humans have more power to drive these abilities than other animals, but the fundamental ability is basically the same.

A more detailed look at the nativist idea

Hauser, Chomsky, & Fitch 2002:

Faculty of Language – Narrow (**FLN**): A subset of **Faculty of Language** 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*)

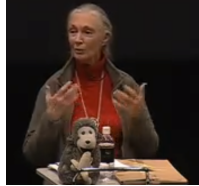


Qualitative differences

Jane Goodall:

[http://www.ted.com/talks/](http://www.ted.com/talks/jane_goodall_on_what_separates_us_from_the_apes)

[jane_goodall_on_what_separates_us_from_the_apes](http://www.ted.com/talks/jane_goodall_on_what_separates_us_from_the_apes)



“The one thing we have, which makes us so different from chimpanzees and other living creatures is this sophisticated spoken language — a language with which we can tell children about things that aren’t here. We can talk about the distant past, plan for the distant future, discuss ideas with each other, so that the ideas can grow from the accumulated wisdom of a group.”

Communication in other species



Communication in other species

Are we special among the animal species?

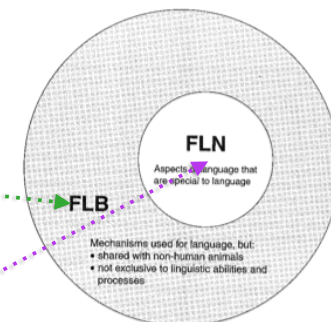
What are other species capable of?

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?



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

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

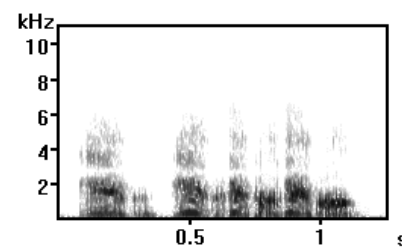
So do chimps — Schel, Townsend, Machanda, Zuberbühler, & Slocombe (2013) have found evidence that chimpanzees produce their alarm calls in a **tactical and goal-directed way**.

<http://www.sciencedaily.com/releases/2013/10/131016212605.htm>

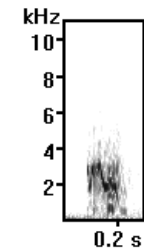


Primate communication

Back to vervet monkeys...



Male (KN)
deep, barking call



Female (LO)
high-pitched chirps

Kaplan 2014

Primate communication

Vervet monkeys



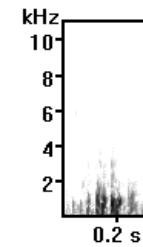
Leopard vervet calls (reacting to pictures of leopards)

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

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

Primate communication

Vervet monkeys



Female (BA)

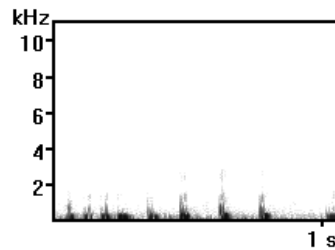
Vervet 'Eagle' Alarm Call

single cough-like call

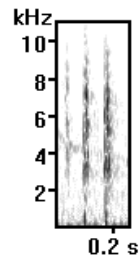
Kaplan 2014

Primate communication

Vervet monkeys



Male (KN)



Female (LB)

Vervet 'Snake' Alarm Call

chutter-like call

Kaplan 2014

Primate communication

Campbell's monkeys, Tiwai Island in Sierra Leone

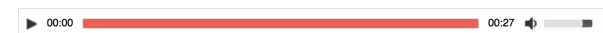


Have dialects when it comes to their alarm calls.

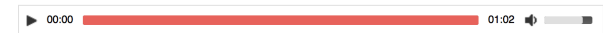
<http://www.scientificamerican.com/article/monkey-see-monkey-speak-video/>



Download Krak WAV



Download Hok WAV



Download Boom WAV

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

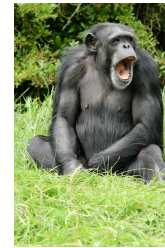


What they can't say:

“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.”

Chimpanzees



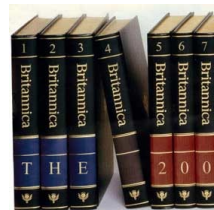
“Did you see that whopping big snake yesterday? It was super scary!”

The quantity of communicative displays

“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”**

Remember: Humans know **tens of thousands** of words on average.



Bee communication

Honey Bees



Dance to **communicate the location of food** (nectar)

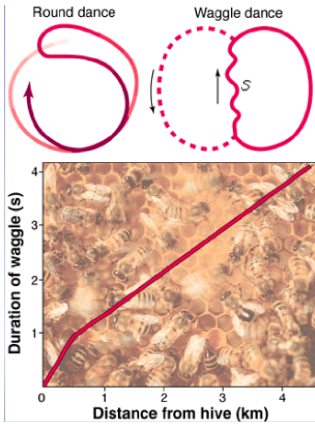
Can indicate: nearby vs. far, direction, richness of the food source (dance harder for the good stuff)

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) for making novel messages about nectar.

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."

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

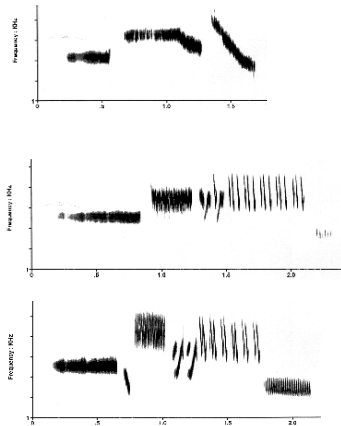


Bird 2

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

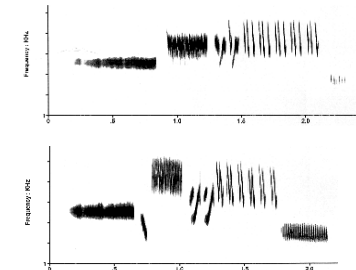


call

student

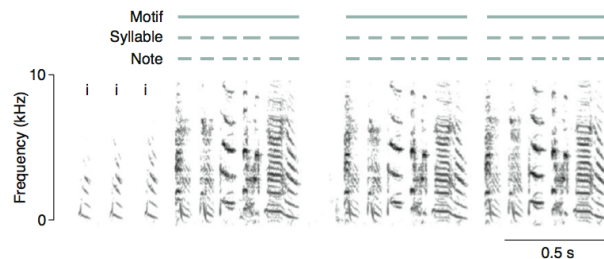
Song is highly structured (combinatorial system) - notes, syllables, phrases

teacher



Bird communication: Hierarchical structure

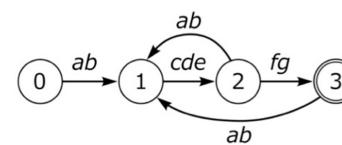
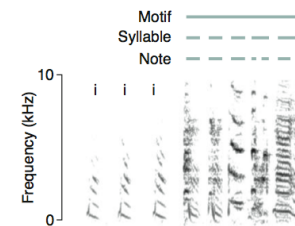
Zebra finch song



“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: Variety of communication

Bengalese finch song



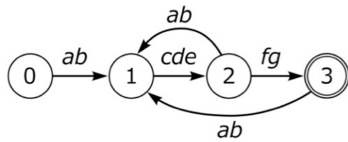
A state diagram of the sequence of motifs that can make up a Bengalese finch song.

Bird communication: Variety of communication

Bengalese finch song

A state diagram is a compact way of representing a collection of outputs. It consists of states (0, 1, 2, 3...) and transitions (the arrows between the states).

state diagram



Here, the starting state is 0, and the ending state (indicated by a double circle) is 3.

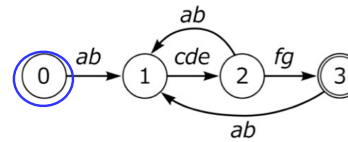
Miyagawa et al. 2014

Bird communication: Variety of communication

Bengalese finch song

To generate an output from a state diagram, begin in the starting state.

state diagram



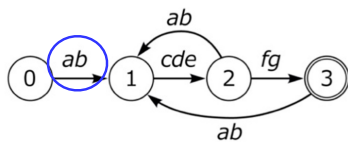
Miyagawa et al. 2014

Bird communication: Variety of communication

Bengalese finch song

Then follow one arrow to the next state, outputting the symbols along the arrow.

state diagram



When going from state 0 to state 1, "ab" is output.

ab

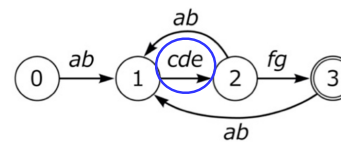
Miyagawa et al. 2014

Bird communication: Variety of communication

Bengalese finch song

Then follow one arrow to the next state, outputting the symbols along the arrow.

state diagram



When going from state 1 to state 2, "cde" is output.

abcde

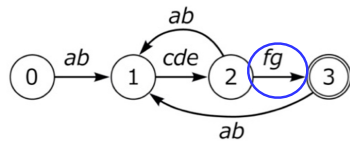
Miyagawa et al. 2014

Bird communication: Variety of communication

Bengalese finch song

If a state has more than one arrow leading out of it, choose any arrow and follow it.

state diagram



If we follow this arrow out of state 2, we go to state 3 and output "fg".
abcdefg

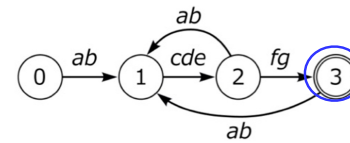
Miyagawa et al. 2014

Bird communication: Variety of communication

Bengalese finch song

When you reach the end state, you are allowed to stop following arrows. The output you have at this point is a valid output captured by the state diagram.

state diagram



If we end here, our output looks like this:
abcdefg

Miyagawa et al. 2014

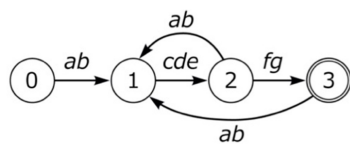
Bird communication: Variety of communication

Bengalese finch song

What are some other output sequences (representing valid Bengalese finch motifs sequences) that this state diagram can generate?

Allowed: abcdefg

state diagram



Miyagawa et al. 2014

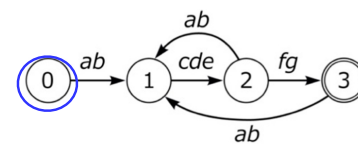
Bird communication: Variety of communication

Bengalese finch song

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Miyagawa et al. 2014

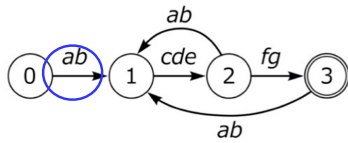
Bird communication: Variety of communication

Bengalese finch song

What are some other output sequences (representing valid Bengalese finch motifs sequences) that this state diagram can generate?

Allowed: *abcdefg*

state diagram



Our current output:

ab

Miyagawa et al. 2014

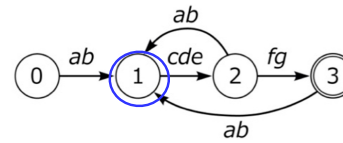
Bird communication: Variety of communication

Bengalese finch song

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Allowed: *abcdefg*

state diagram



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Miyagawa et al. 2014

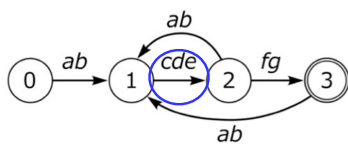
Bird communication: Variety of communication

Bengalese finch song

What are some other output sequences (representing valid Bengalese finch motifs sequences) that this state diagram can generate?

Allowed: *abcdefg*

state diagram



Our current output:

abcde

Miyagawa et al. 2014

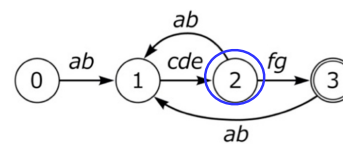
Bird communication: Variety of communication

Bengalese finch song

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Allowed: *abcdefg*

state diagram



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abcde

Miyagawa et al. 2014

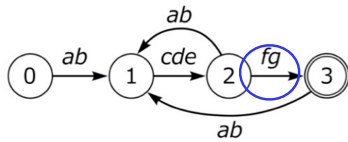
Bird communication: Variety of communication

Bengalese finch song

What are some other output sequences (representing valid Bengalese finch motifs sequences) that this state diagram can generate?

Allowed: *abcdefg*

state diagram



Our current output:

abcdefg

Miyagawa et al. 2014

Bird communication: Variety of communication

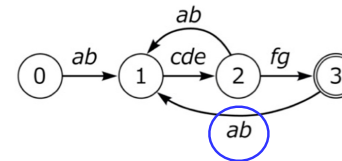
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state diagram

But we don't *have* to stop there...



Our current output:

abcdefgab

Miyagawa et al. 2014

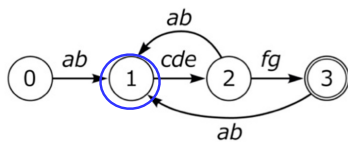
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abcdefgab

Miyagawa et al. 2014

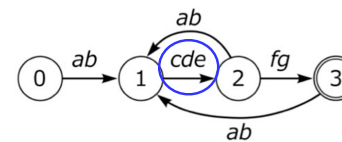
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abcdefgabcde

Miyagawa et al. 2014

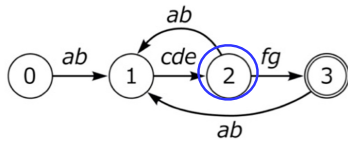
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Miyagawa et al. 2014

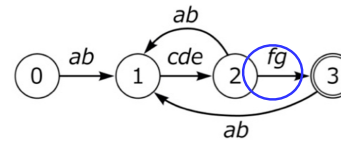
Bird communication: Variety of communication

Bengalese finch song

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Miyagawa et al. 2014

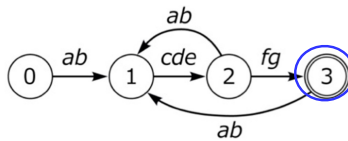
Bird communication: Variety of communication

Bengalese finch song

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state diagram



Our current output:

abcdefgabcdefg

Miyagawa et al. 2014

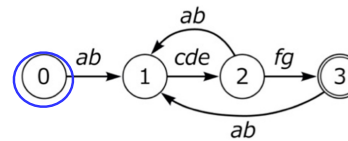
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Miyagawa et al. 2014

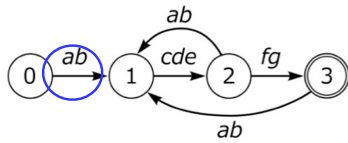
Bird communication: Variety of communication

Bengalese finch song

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state diagram



Our current output:

ab

Miyagawa et al. 2014

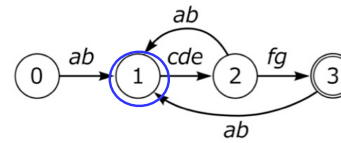
Bird communication: Variety of communication

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state diagram



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ab

Miyagawa et al. 2014

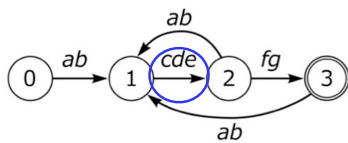
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abcde

Miyagawa et al. 2014

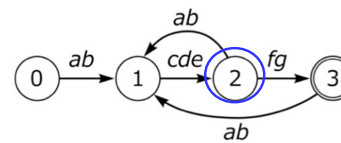
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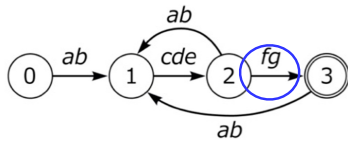
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Miyagawa et al. 2014

Bird communication: Variety of communication

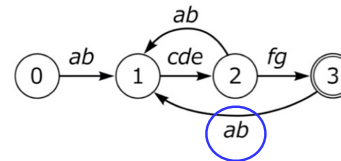
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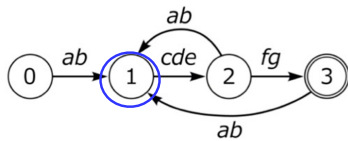
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Miyagawa et al. 2014

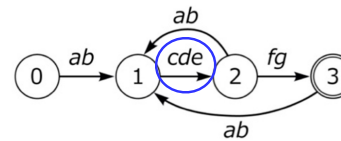
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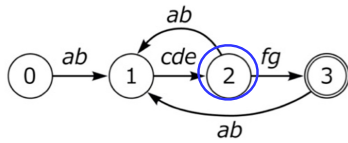
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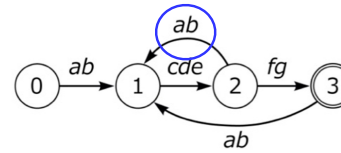
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state diagram



Our current output:

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Miyagawa et al. 2014

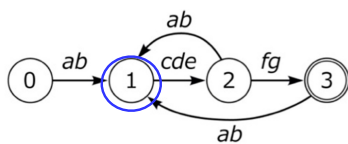
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Our current output:

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Miyagawa et al. 2014

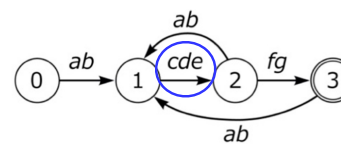
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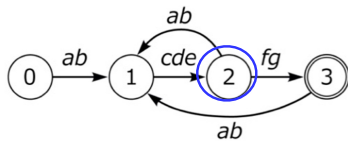
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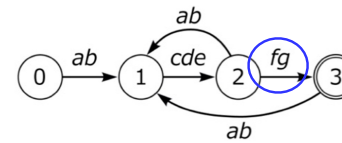
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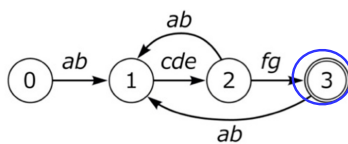
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Allowed: *abcdefg*, *abcdefgabcdefg*, *abcdefgabcdeabcdefg*

state diagram



Our current output:

abcdefgabcdeabcdefg

Miyagawa et al. 2014

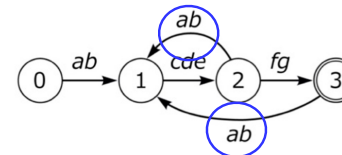
Bird communication: Variety of communication

Bengalese finch song

Important: An *infinite* number of valid sequences can be generated because we have these backward arrows. This aspect of bird song is similar to human language (which has *infinite* sentences).

Allowed: *abcdefg*, *abcdefgabcdefg*, *abcdefgabcdeabcdefg*, ...

state diagram



Miyagawa et al. 2014

Bird communication vs. Human language



There are several similarities between language in humans and birdsong. Both human language and birdsong:

- (1) Alarm calls in birdsong and words in human language are referential and stable signals. These signals can incorporate spontaneous gestures like pointing (by either finger or beak) [Kaplan 2014]
- (2) Birdsong and human language both have a way to combine units (birdsong: notes make syllables which make motifs; human language: phonemes make syllables which make words) [Kaplan 2014]

Bird communication vs. Human language



There are several similarities between language in humans and birdsong. Both human language and birdsong:

- (3) How the units that make up syllables (human language: phonemes, birdsong: notes) are perceived depends on the surrounding context (Lachlan & Nowicki 2015, <http://www.sciencedaily.com/releases/2015/01/150105170024.htm>)

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) and can reconstitute itself from impoverished input (human language: pidgin to creole; birdsong (zebra finches): from song produced by isolates to full song over several generations)
- (4) are lateralized in the left hemisphere

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:

(5) rely on similar genes for vocalization (Pfenning et al. 2014, Zhang et al. 2014, <http://www.sciencedaily.com/releases/2014/12/141211142429.htm>)

(6) have smaller and larger units learned simultaneously (human language: sounds and words; birdsong: motifs and song bouts) (Comins & Gentler 2015, <http://www.sciencedaily.com/releases/2015/06/150625130900.htm>)

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:

(7) involve adults modifying their input when it's directed at babies (humans: motherese; zebra finches: a slower and more repetitious version of their normal song) (Chen et al. 2016, <https://www.sciencedaily.com/releases/2016/05/160531165239.htm>)

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 a few things. Not clear there's an infinite range of 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 often 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 doesn't seem to change 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.)

Bird communication vs. Human language



Or are there?

(4) ...*except* chestnut-crowned babblers produce song "AB" when flying and song "BAB" when feeding chicks (Engesser, Savage, & Townsend 2015). Co-author Townsend suggests this is "the first time that the capacity to generate **new meaning from rearranging meaningless elements** has been shown to exist outside of humans".

(<http://www.sciencedaily.com/releases/2015/06/150629152230.htm>)

But is it really **meaning** (if so, **what does each song mean**)?
Under debate...

Bird communication vs. Human language



Or are there?

(5) Japanese great tits use "ABC" calls to mean "watch out!" (in the presence of sparrow hawks), "D" calls to mean "come over here", and "ABC-D" calls to indicate that they should all flock together and be alarmed. (This is something like "watch out" + "come over here".) Notably, "D-ABC" doesn't cause them to do this — so **order matters**. (Suzuki, Wheatcroft, & Griesser 2016).

(<https://www.sciencedaily.com/releases/2016/03/160308134748.htm>)

Recap: Animal communication

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.

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

However, birdsong seems to share a number of properties with human language. It's currently unclear whether the difference is quantitative (and so part of the FLB) or qualitative (and so part of the FLN).

Questions?



Remember: HW2 is due 10/13/16, 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 acquisition.

Extra Material

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 ...”

Teaching bonobos

Did Kanzi have [reference](#)? Unclear.

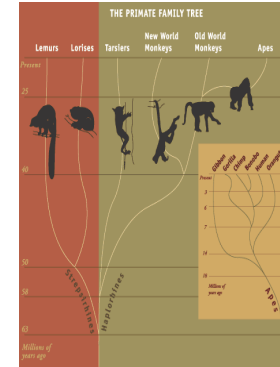


“strawberry” = “I want to go to the place where strawberries are found”, “I want a strawberry to eat”, “There’s a picture of strawberries”, ...

Kanzi’s spoken English: comparable to a 2-year-old child’s performance (but a 2-year-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.

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



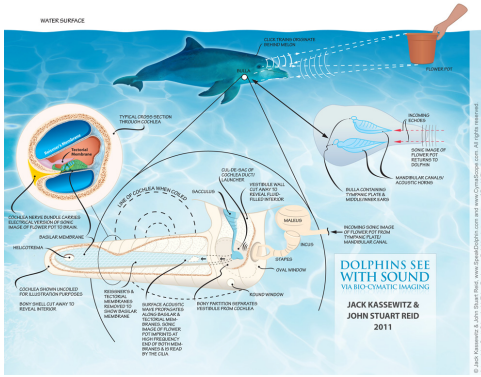
Non-human primates:
15-35 distinct displays

Adapted from Liberman

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

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.

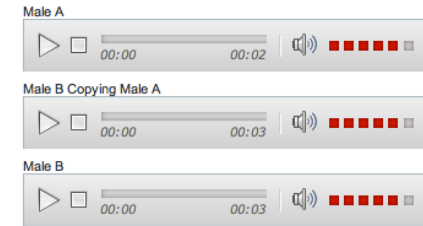
Dolphin communication

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.



Credit: S. L. King, 2013

Dolphin communication

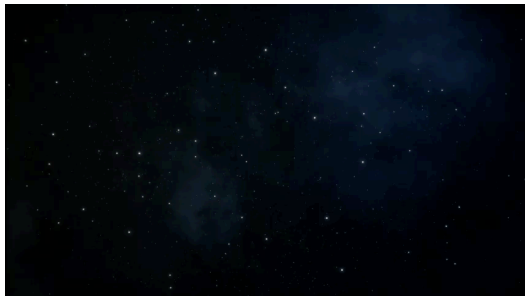
Herzig (2013), TED Talk: Could we speak the language of the dolphins?

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

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

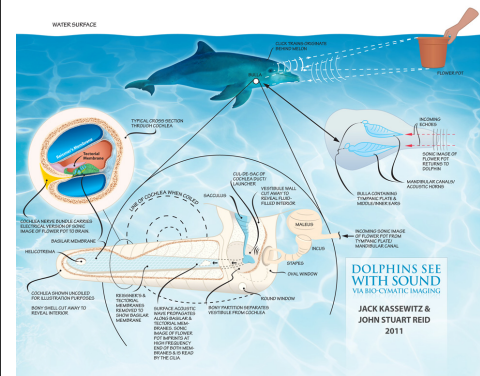
8:36-9:26 (two-way communication & symbolic representation)

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.”

