

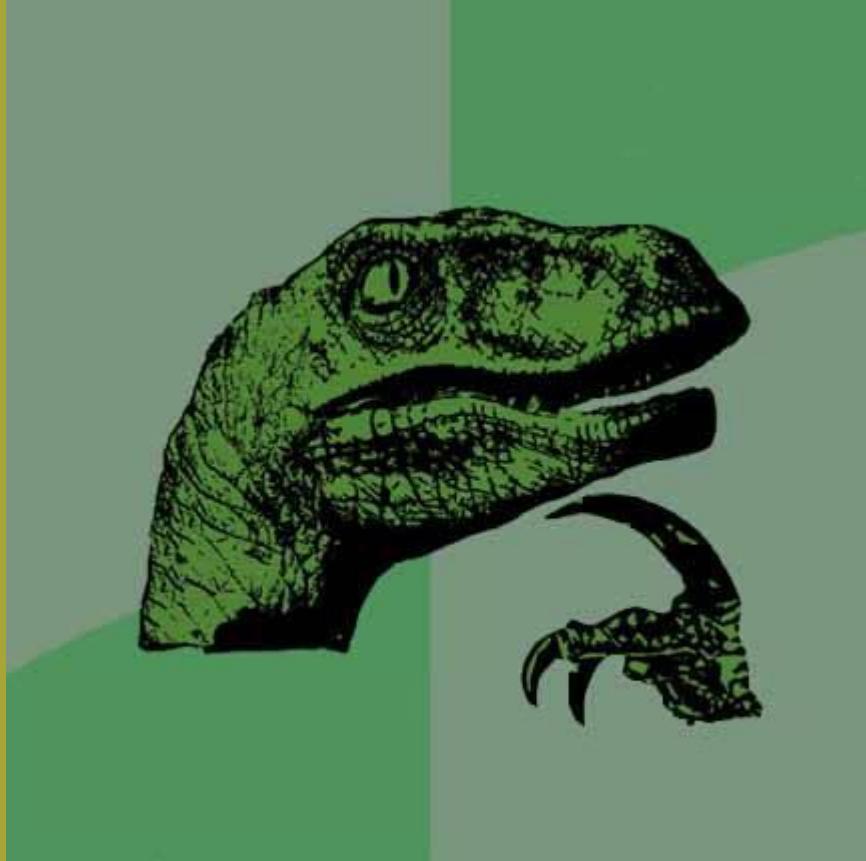


# Animal communication and cognition

Origins and Evolution of  
Language  
Week 3

# RECAP

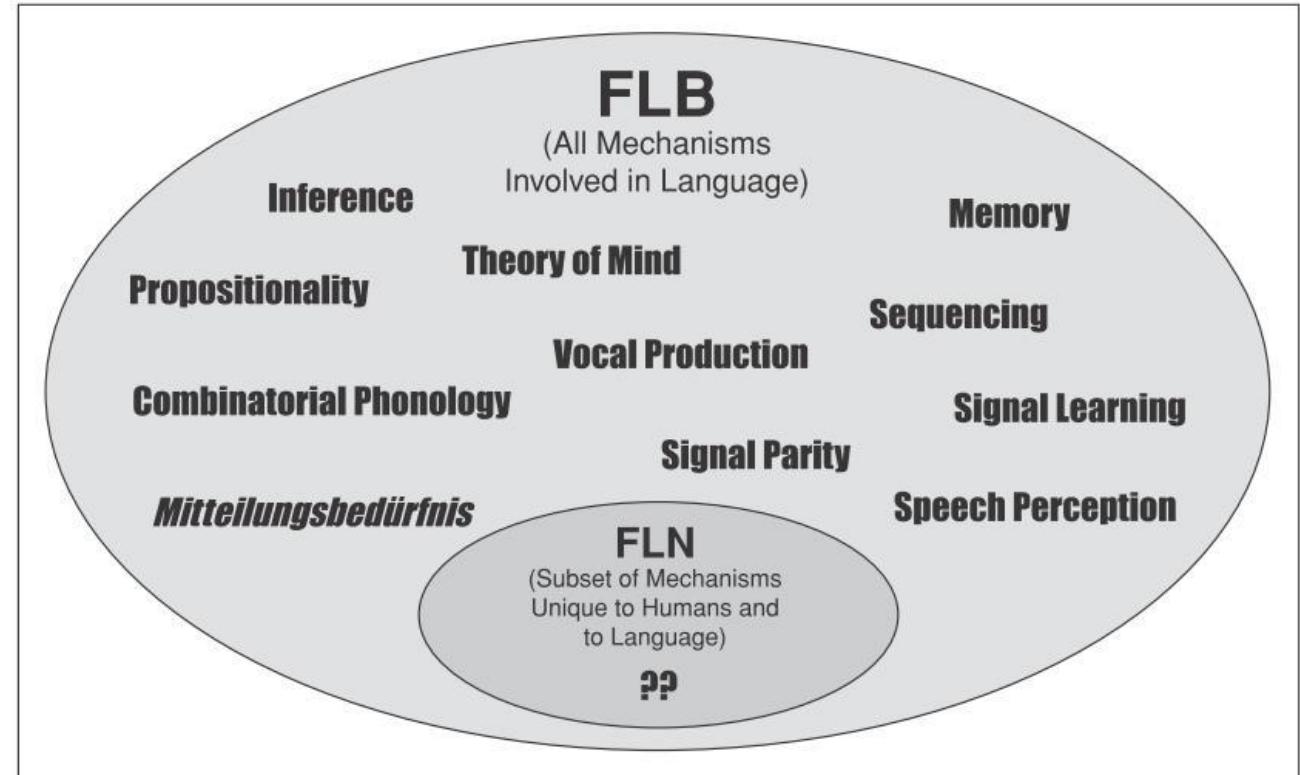
- ❖ Tutorial groups *should* be sorted
  - ❖ (but not on Learn)
  - ❖ You will have a **team** for the readings
- ❖ Reading quiz:
  - ❖ Everyone did well, but any questions?
- ❖ Tutorial recap:
  - ❖ Reflections on Boeckx?
- ❖ Back to Adaptations (Lecture 2) and then on to **the animals**



An obsolete meme

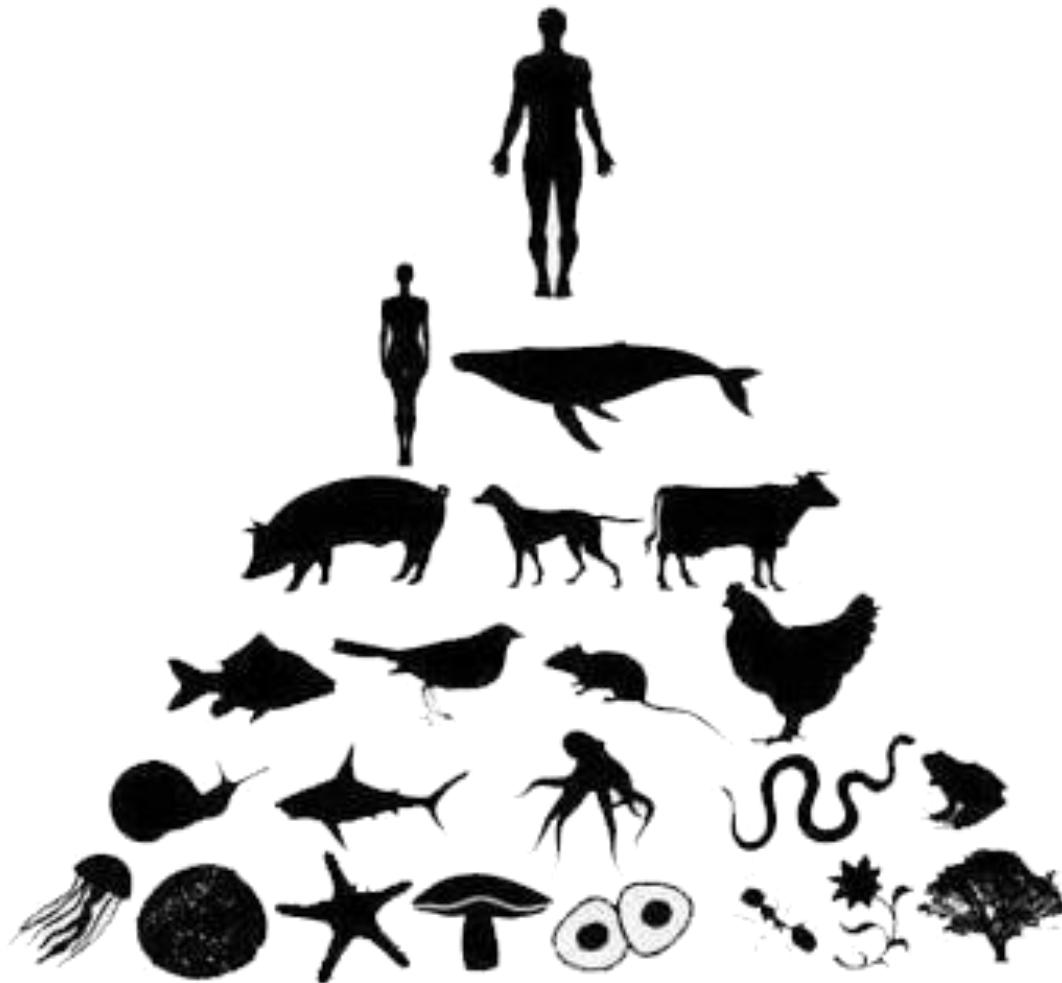
# Faculty of Language

Memory  
Sequencing  
Inference  
Impetus to share  
Theory of Mind  
Signal learning  
Propositionality  
Vocal Production  
Combinatoriality  
Signal parity  
Speech perception



## Human uniqueness

- ❖ The old hypothesis: Humans are unique, we need to seek out explanations for what makes us so
  - ❖ Culture is unique to humans
  - ❖ Tool use is exclusively human
  - ❖ Language is exclusively human



## Human uniqueness

- ◊ The new (null) hypothesis:  
Humans may be unique, but  
much of our cognitive suite is  
not
  - ◊ Culture found in many  
species, from meerkats  
to fish
  - ◊ Tool use from crows to  
chimpanzees
  - ◊ Language...?



# Human uniqueness

“Valid claims of human uniqueness must be based on empirical data showing absence in multiple nonhuman species. If such a claim is intended as a scientific hypothesis, the claimant should specify how the trait in question could plausibly be demonstrated empirically in a non-human animal.”

- Fitch (2010), p.146

# Cognitive Capacities

The comparative method walks a fine line between...



Rigourous scepticism



Accepting animals might be pretty smart





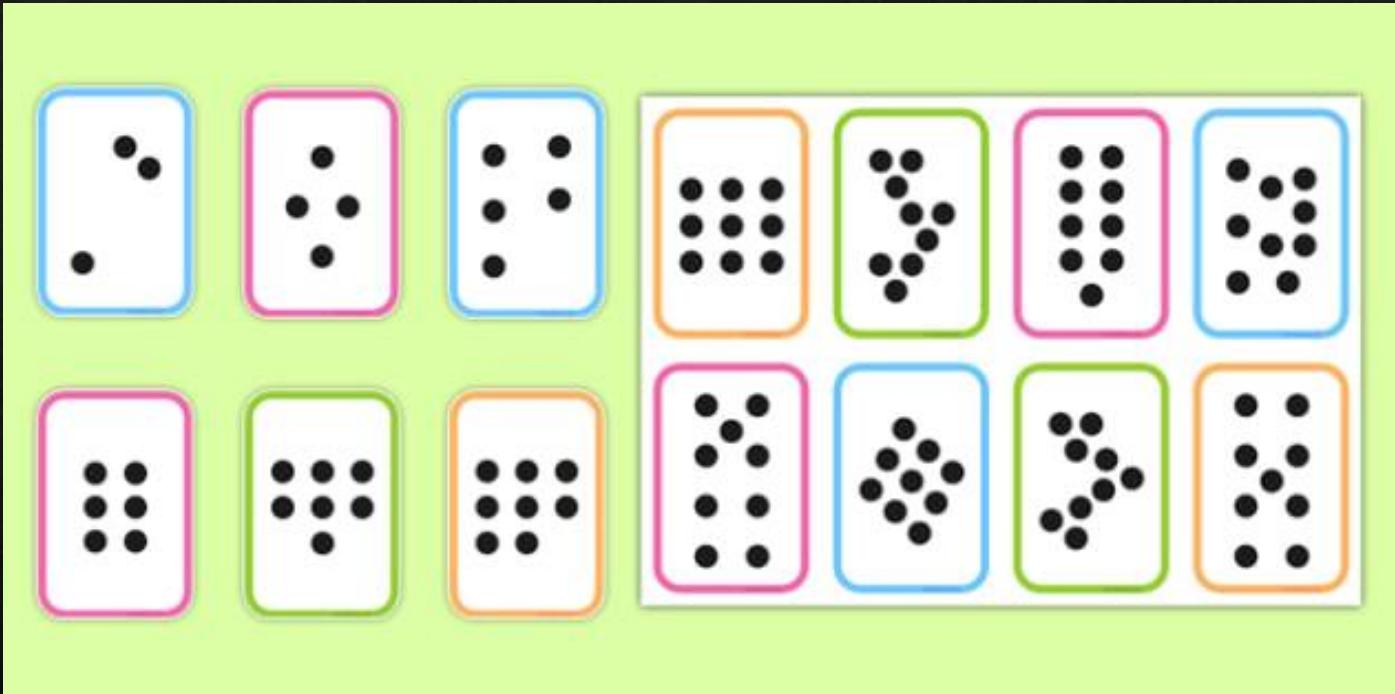
## Temporal planning

- ❖ Many animals **cache** food, which is evidence of temporal planning
- ❖ However – this behaviour seems to be confined to food

# Number sense

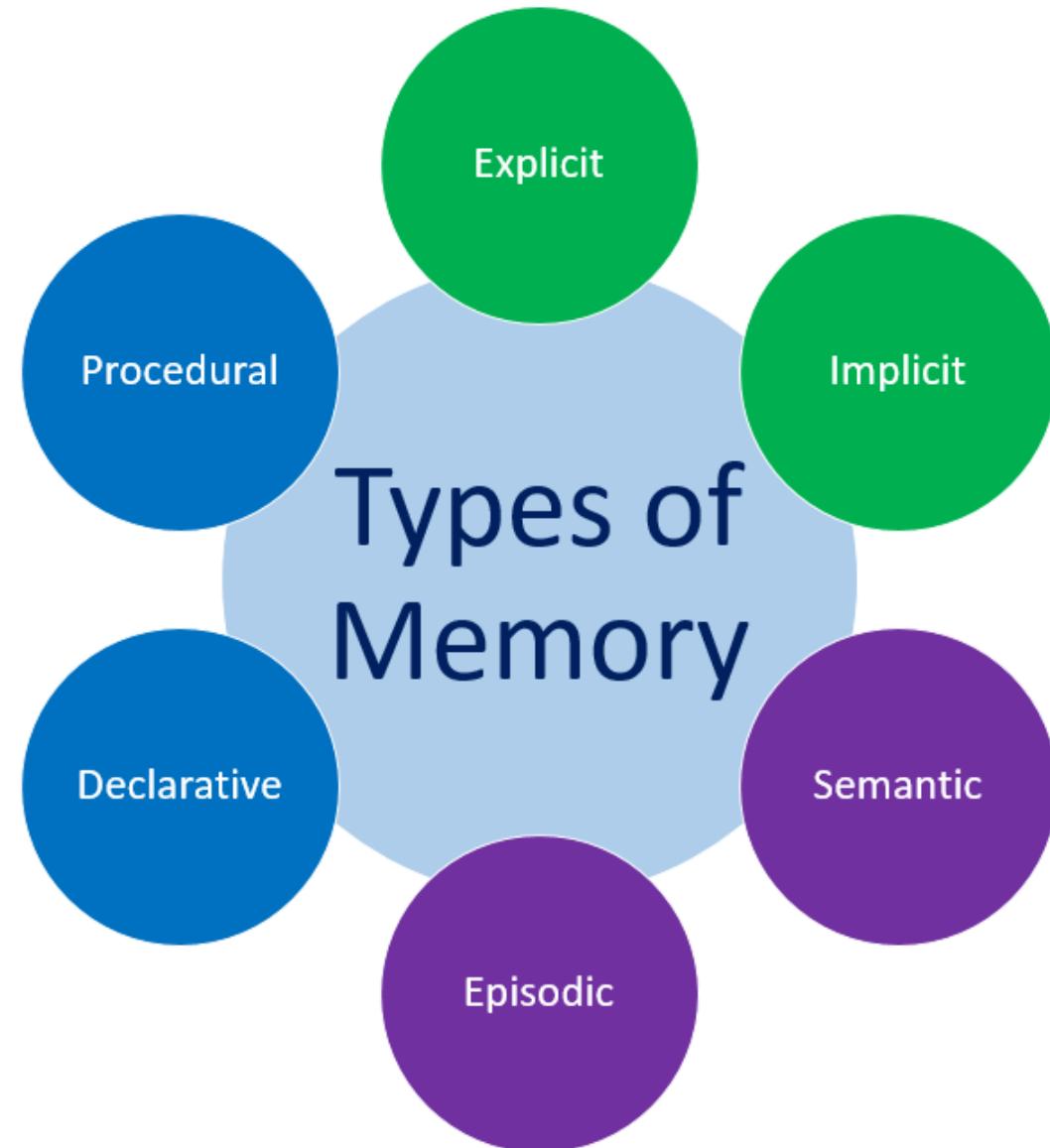
- ❖ *Small exact and large approximate* shared with many animals
- ❖ Subitising
- ❖ Large exact appears to be unique to humans - language enabled?
- ❖ However, still a considerable bit of cross-linguistic and cross-cultural variation

Cross-cultural differences in representations and routines for exact number. M.C. Frank  
<https://scholarspace.manoa.hawaii.edu/bitstream/10125/4566/1/frank.pdf>

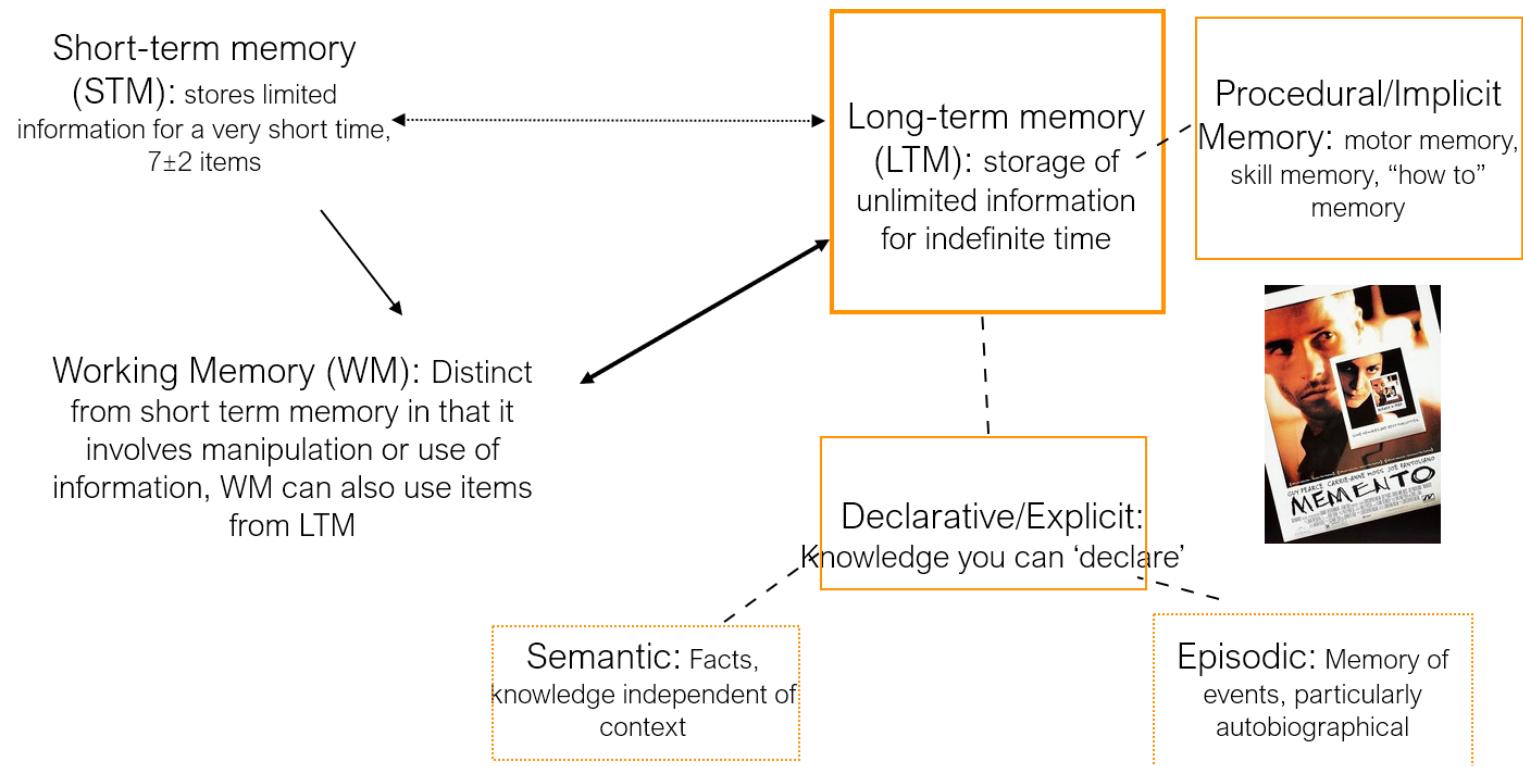


# Memory

- ❖ Memory is an essential component of language
- ❖ The study of memory has primarily focused on humans
- ❖ This has perhaps led to models of memory which are sub-optimal for comparative approaches



# (A) model of human memory



# Semantic vs Episodic Memory

- ❖ Semantic well established in animals: many birds, dogs, all primates tested
- ❖ Episodic: Most rigorous test involves free recall - this is not possible without language
  - ❖ do we abandon it as untestable?
- ❖ Semantic memory is embedded in episodic memory
  - ❖ Ontogenetically, semantic memory develops before episodic
- ❖ Episodic memory requires self-awareness (autobiographical component)

# Memory: a comparative perspective

- ❖ Strong disagreement about whether episodic memory is uniquely human (Fitch takes a v. strong position here)
  - ❖ If language is uniquely human, episodic memory (as defined) must be
- ❖ Problem may be semantic: why apply this model (specifically designed for human memory) to animals?
- ❖ Episodic-like memory: “Stored information acquired through individual experience about temporally dated events and the spatial-temporal relation inherent in the event” (Schwartz, Hoffman & Evans, 2011)

# Scrub jays

- ❖ Recall **where** of food (not unusual)
- ❖ Also recall combination of **what** type of food it is and **when** they stored it
  - ❖ e.g., will not return to food that rots in 2 weeks after 3
- ❖ Can't be tested in free recall; requires finite choices

Clayton, N. S., & Dickinson, A. (1998).  
Episodic-like memory during cache recovery by  
scrub jays. *Nature*, 395(6699), 272.



# Elephants



- ❖ Where water is, when it will be there, who else will want it
- ❖ Follow/socially transmit long, complex paths to water holes
- ❖ Groups seem to know not to arrive at a watering hole at the same time as another large group
- ❖ Not a lot of data...

Moss, C. J. (2012). *Elephant memories: thirteen years in the life of an elephant family*. University of Chicago Press.

# Language trained apes

- ❖ Language trained apes can be tested with free recall (e.g., open ended question about what happened yesterday)
- ❖ Kanzi (trained with lexigrams) can remember who, what, where, and when of events in the past
  - ❖ Highly anecdotal, under very specific conditions, N=1



# Language trained apes

❖ Michael, friend of Koko's



# Theory of mind

- ❖ The impetus to share information requires some notion of theory of mind:
  - ❖ The ability to attribute mental states - beliefs, intents, desired, emotions, knowledge, etc - to oneself, and to others.
  - ❖ More on this in week 5 - but ToM entails self-awareness (as does episodic memory). To what extent is this shared with other animals?

# Self-awareness

- ❖ The Gallup Test or Mirror test: place a mark on the individual, sedate them, show them their reflection when they wake
- ❖ Most apes, though may be captivity dependent?
- ❖ Elephants



# Dolphins



# Magpies



# Dogs

- ❖ Fail the classic mirror test...
- ❖ Might be an issue of modality: dogs are not very visual, far more olfactory
  - ❖ Bekoff (2001) performed an experiment with his dog's urine, moving it to locations where the dog hadn't actually been
  - ❖ Dog reacted markedly different to its own scent, particularly in an expected location



Cats?



# Cats?



@ MIMOTHEKITTE

# Pointing and gaze detection

- ❖ Whites of human eyes allow gaze following
- ❖ Children follow pointing from about ~12-18months
- ❖ Dogs (prosocial, domesticated) will follow pointing, cats will not



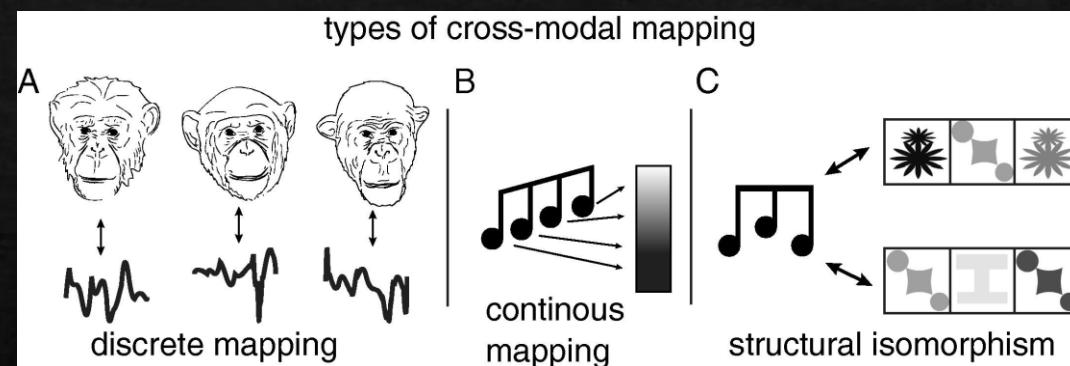
# Cross-modality

The ability to map properties from one modality (e.g., touch) to another (e.g., vision)

Ludwig et al., 2012

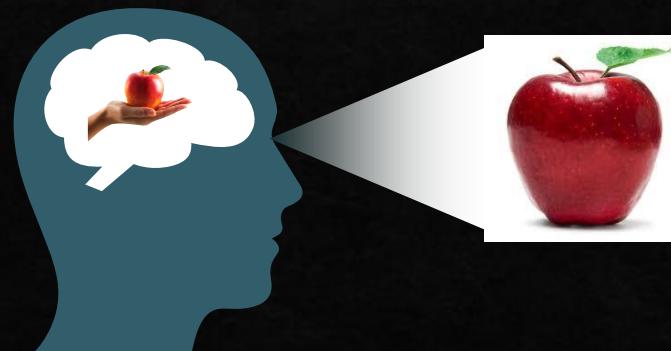


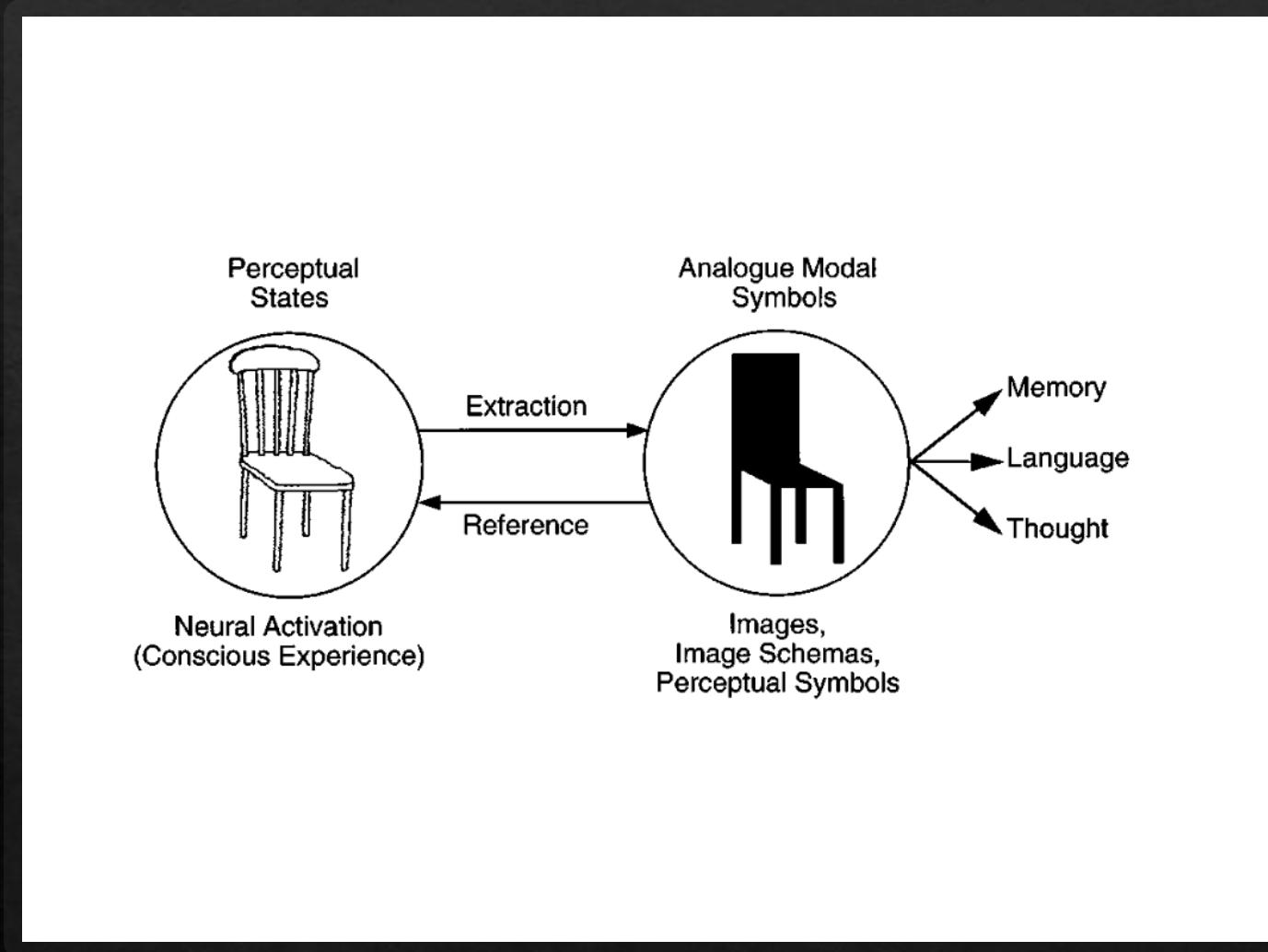
Ravignani & Sonnweber, 2016



Widespread: cross-modal transfer

e.g., Davenport et al., 1973



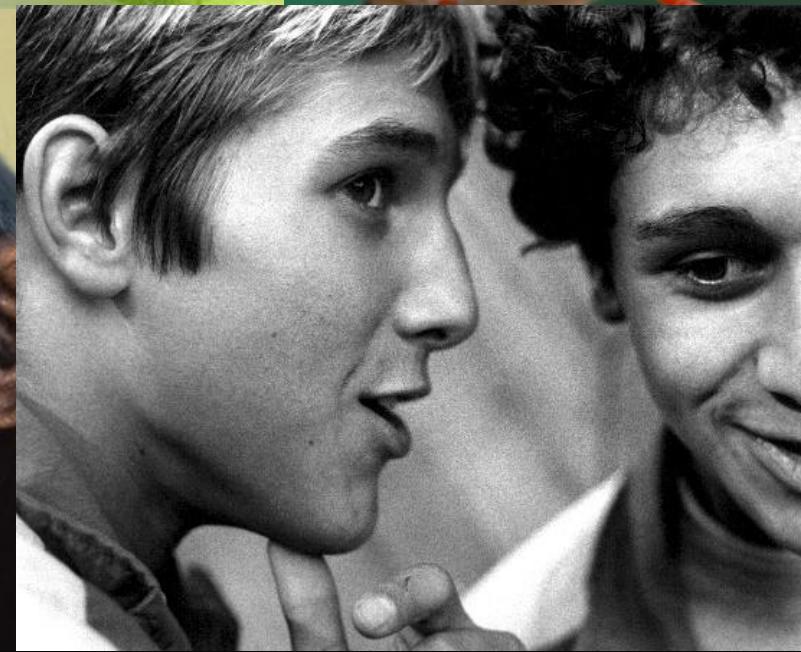


# Cross-modality

Key for symbolic  
reference and cognition

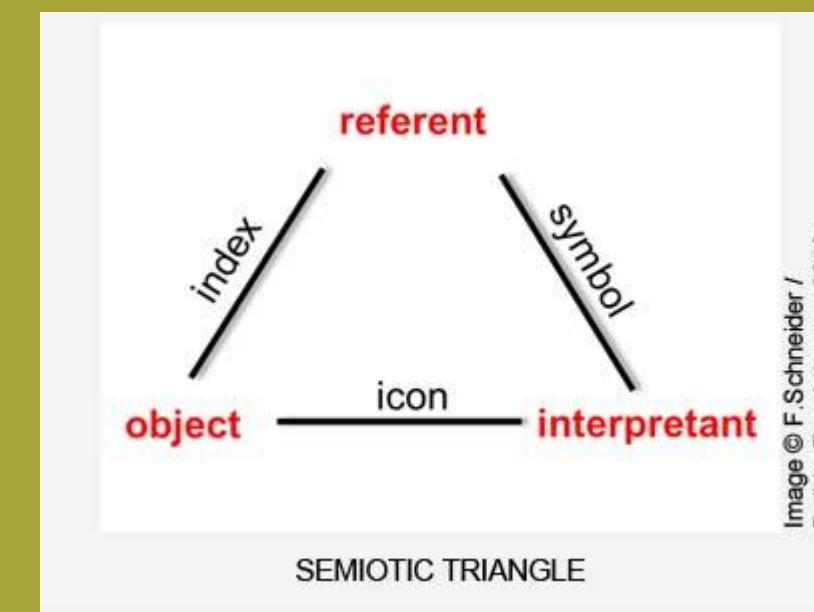
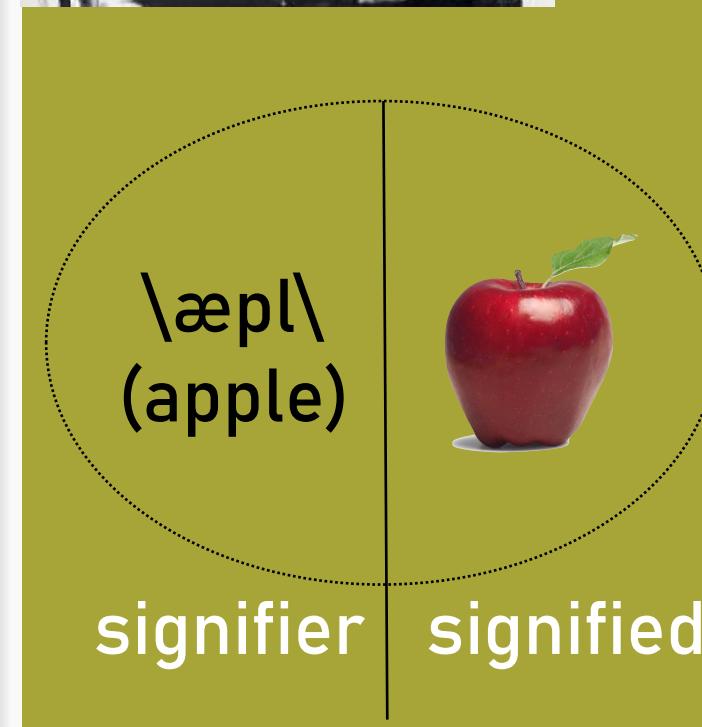
Break

# Communication is ubiquitous, language is unique



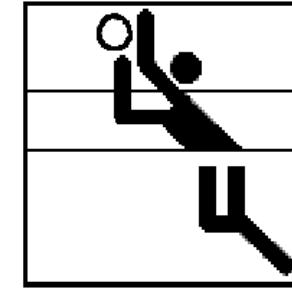
# Semiotics

- ◊ Communication takes place by the sending of signals between communicating parties. A signal involves a **signifier** and the **signified** (Saussure)
- ◊ We can divide these signals into three distinct types, based on the relationship between the signifier and signified (Peirce):
  - ◊ Icons
  - ◊ Indices (an index)
  - ◊ Symbols



# Icons

- ◊ In icons, the relationship between the signifier and the signified is one of resemblance; as such the relationship is obvious, but...
- ◊ Very strong influence of *culture*
- ◊ Perceptual issues
- ◊ Systematic iconicity?



# Indices

- ❖ In an index, there is a **causal or mechanical relationship** between the signifier and the signified

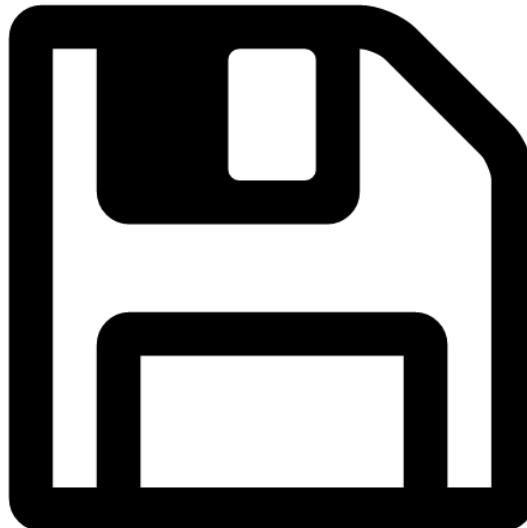


# Symbols

- ❖ In symbols, the relationship between the signifier and the signified is arbitrary, i.e., there isn't one...
- ❖ Or, connection is not obvious.
- ❖ The relationship between the signifier and the signified holds through convention among communicators.
- ❖ Icons can undergo gradual change until they become symbols.



fire  
feugo  
φωτιά

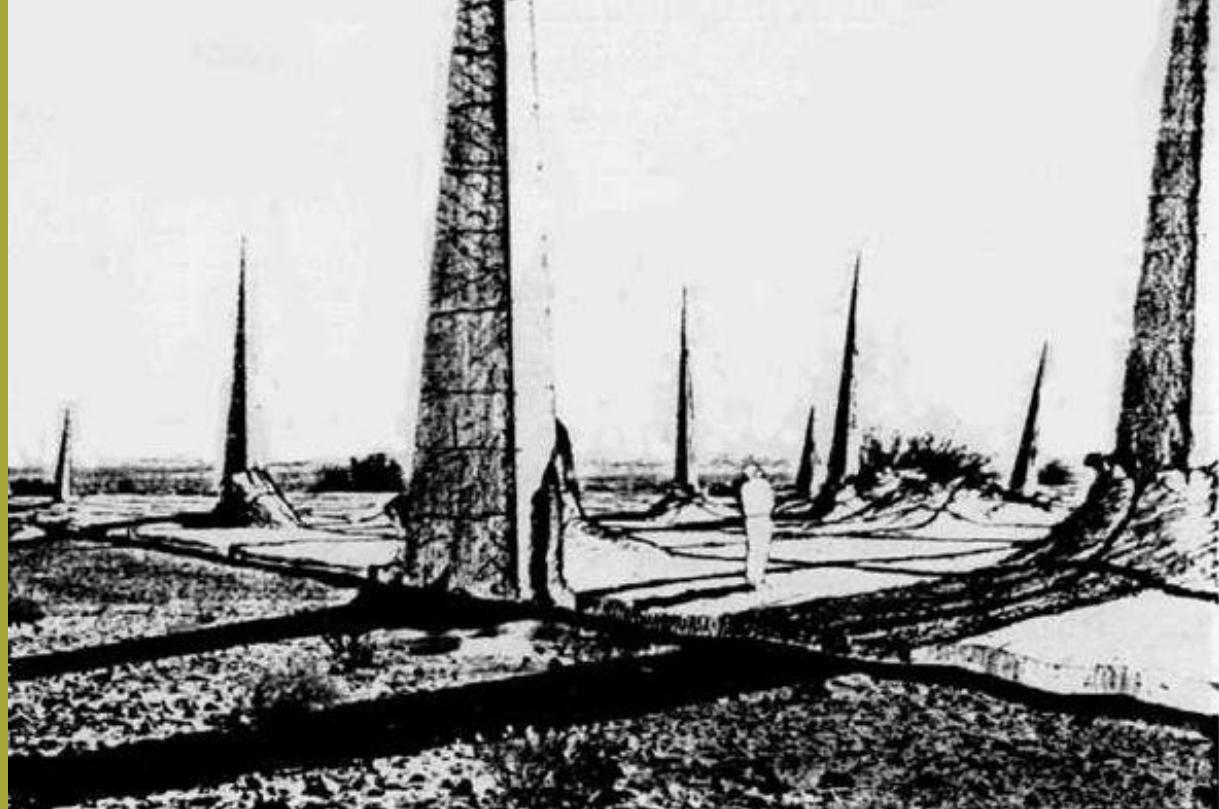


# Icon, index, or symbol?

- ❖ How do you warn people 10,000 years in the future about a radioactive dump?
- ❖ Many signals are quite problematic!
- ❖ Skull & Crossbones? Originally signified *rebirth*, then *momento mori*, then *piracy*...
- ❖ Terrifying 'landscape of thorns' art?
- ❖ Mythical colour-changing radiation cats!

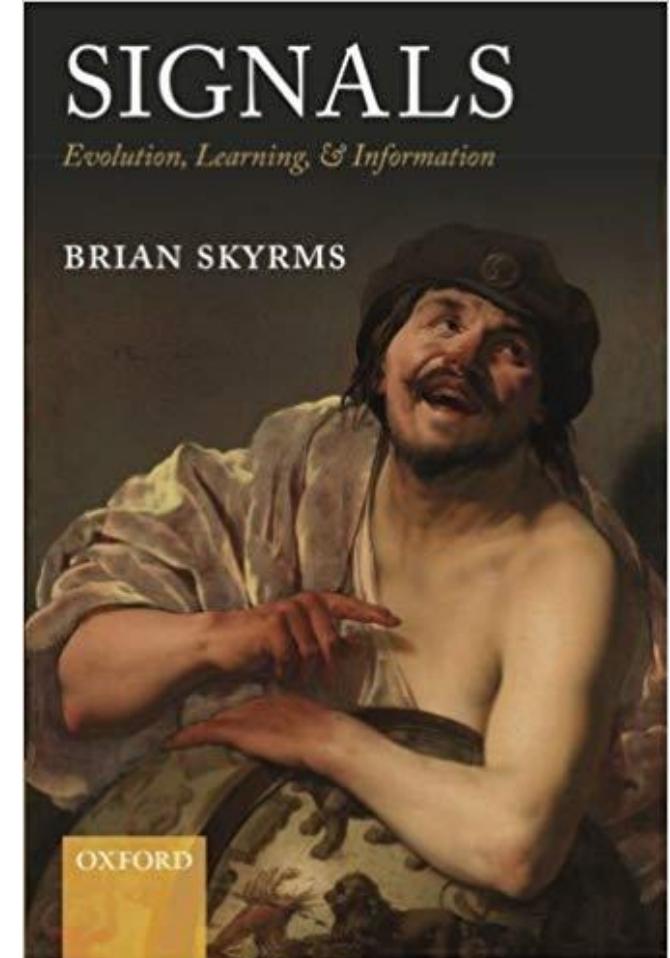
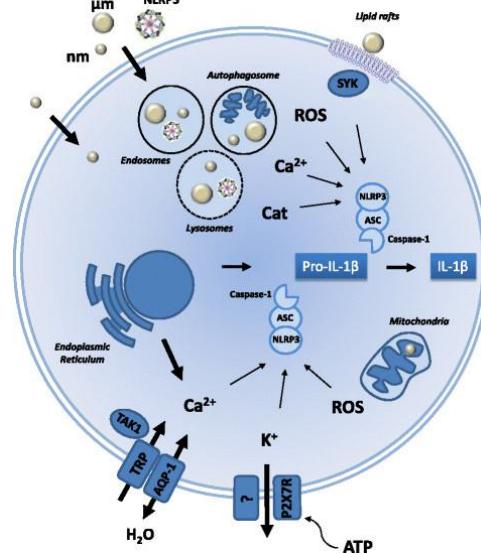
"They proposed that we genetically engineer a species of cat that changes color in the presence of radiation, which would be released into the wild to serve as living Geiger counters. Then, we would create folklore and write songs and tell stories about these "ray cats," the moral being that when you see these cats change colors, run far, far away."

[http://www.slate.com/blogs/the\\_eye/2014/05/14/\\_99\\_percent\\_invisible\\_by\\_roman\\_mars\\_designing\\_warning\\_symbols\\_for\\_the\\_nation.html?via=gdpr-consent](http://www.slate.com/blogs/the_eye/2014/05/14/_99_percent_invisible_by_roman_mars_designing_warning_symbols_for_the_nation.html?via=gdpr-consent)



# Explaining signals in biology

- ◊ For signalling to evolve, it must be mutually beneficial (according to some)
- ◊ Stabilised by:
  - ◊ Genetic relatedness
  - ◊ Physical binding
  - ◊ Strong mutualism
- ◊ BUT:
  - ◊ Deception
  - ◊ Cheating



# Honest Signalling

- ❖ If communication is a form of cooperation, then it has to be resistant to cheaters in order to remain stable (an ESS).
- ❖ Nature has solved this in most communication systems by making signals **honest** - that is, they cannot be faked.
- ❖ Works well with icons and indices - the relationship between the signifier and the signified means you cannot fake the signifier without changing the signified.
- ❖ Thus, most animal signals are inherently honest.

# Honest Signal Systems

- ❖ The classic example is the peacock's tail
- ❖ Also holds for predation



Behav Ecol Sociobiol (2005) 58: 552–557  
DOI 10.1007/s00265-005-0958-y

ORIGINAL ARTICLE

Adeline Loyau · Michel Saint Jalme ·  
Cécile Cagniant · Gabriele Sorci

**Multiple sexual advertisements honestly reflect health status  
in peacocks (*Pavo cristatus*)**

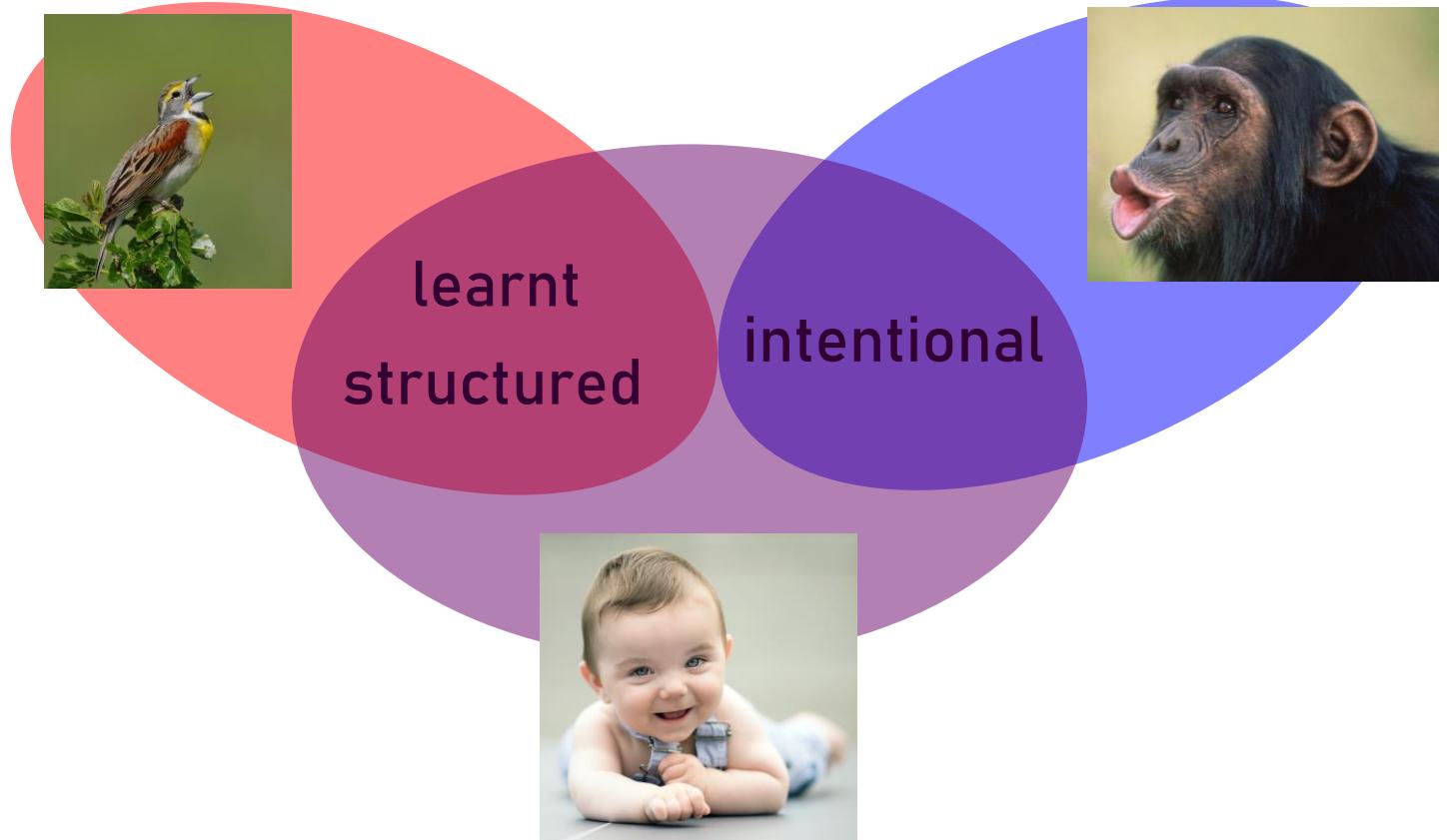
# What about language?

- ❖ Honest signalling is a (huge) problem for human language.
- ❖ Because we use symbols, and symbols are arbitrary, there is no connection between the sign and the signifier to prevent faking. We can and do lie.
- ❖ Some aspects of language that are somewhat honest, e.g., accent
  - ❖ function for the critical period of lang acquisition?
- ❖ If we think of culture generally as an honest system of which language is only one component, this *might* make it slightly less problematic



# Animal communication

- ❖ Communication is widespread: any transfer of information between individuals or groups
- ❖ Focus on the intersection of intentionality and structure



# Animals have rich mental lives

Episodic(-like) memory

Number sense

Self-awareness

Temporal sense

(some elements of) Theory  
of Mind (maybe)



# Alex the parrot (1976-2007)

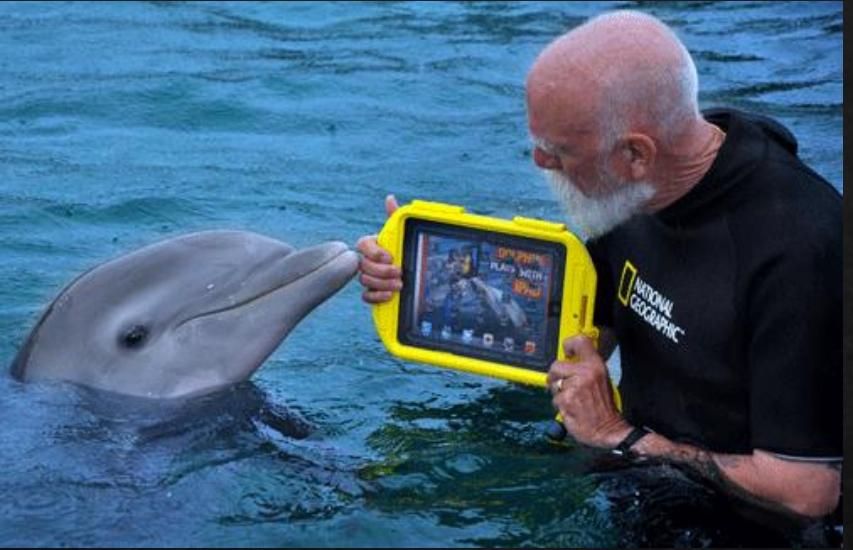
30 year experiment by Irene Pepperberg

Avian Language EXperiment

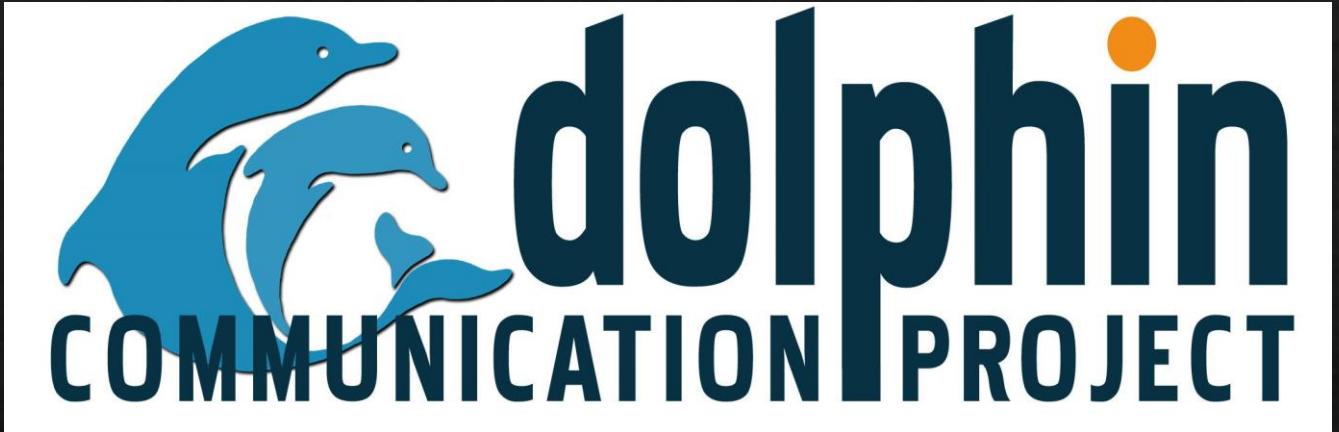
Alex was a definitely a smart bird

BUT interpretation is disputed:  
imitation or language?





# Communicating with dolphins?



## DOLPHIN PHRASEBOOK

### The Side-Flop

**What it is:** Dolphin jumps clear out of the water before landing on its side with a large splash

**When it's seen:** More experienced dolphins execute side-flops just before the group swim into fresh waters

**What it means:** 'Let's go' or 'I want to go now'

### The Upside-down Lobtail

**What it is:** Dolphin rolls on its back with its belly in the air and slaps its tail on the water

**When it's seen:** The upside-down lobtail is spotted just before a group of dolphins come to a halt

**What it means:** 'Let's stop' or 'I want to stop now'



# Dogs

- ❖ Lack dexterity for speech (unlike parrot), signs, or lexigrams
- ❖ Bred to be social - impressive receptive language
- ❖ Rico (~200 distinct objects) and Chaser (>1000)
- ❖ Display mutual expressivity

Kaminski, J., Call, J., & Fischer, J. (2004). Word learning in a domestic dog: evidence for "fast mapping". *Science*, 304(5677), 1682-1683.  
Pilley, J. W., & Hinzmann, H. (2013). Chaser: Unlocking the genius of the dog who knows a thousand words. Houghton Mifflin Harcourt.

# Communicating with animals



- ❖ See also, Kanzi, Koko, Washoe
- ❖ However, keep in mind that this is a **strange thing to do**
  - ❖ Animals are usually in captivity (dolphins the exception)
  - ❖ Intentional interspecies communication is very rare (though in case of dogs, it is evolved)
  - ❖ Usually effort for them to come to us (dolphins the exception)

# ...but natural communication *relatively* restricted



(as far as we know)



Innate signal repertoires, particularly among primates



Functionally referential, but not intentional

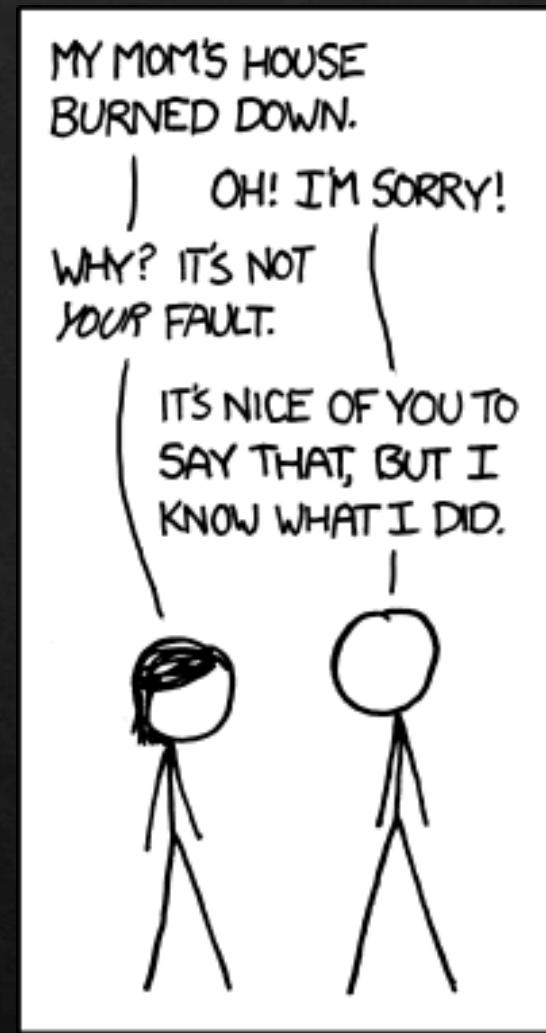


Complex vocalisations, but

Rarer in primates (more common in birds)  
Not (obviously) propositional

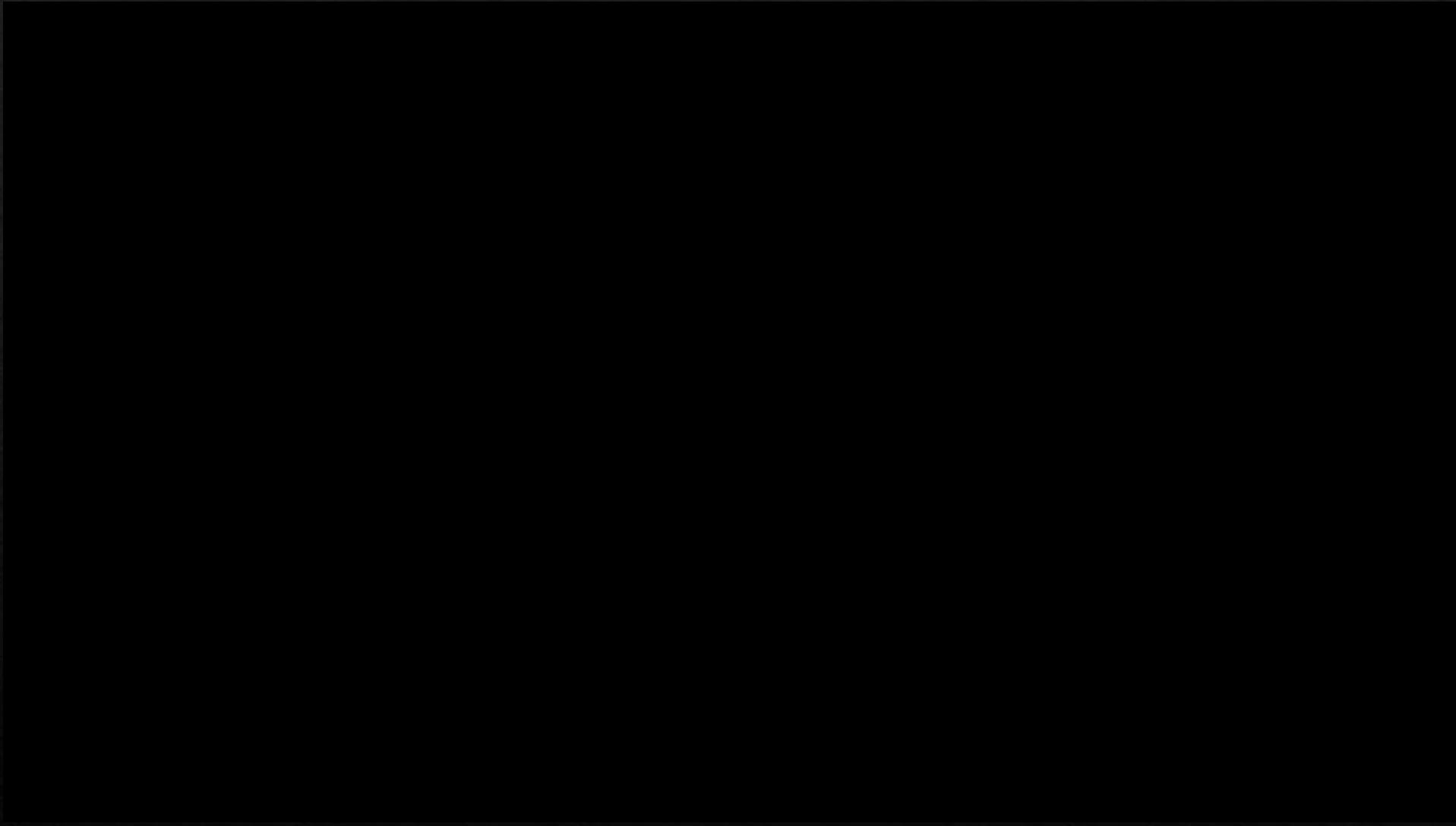
# Intentional communication

- ❖ Grice (1957): the meaning of an utterance is defined in terms of the speakers' intention, and recognition of that intention by the hearer
  - ❖ Grice (1975): Maxims - be cooperative, be informative
- ❖ When engaged in communication, keep each other's mental states in mind
- ❖ Functional reference vs intention to inform



IT ANNOYS ME WHEN PEOPLE  
INTERPRET AN OBVIOUSLY  
SYMPATHETIC "I'M SORRY" AS  
AN APOLOGY, SO I'VE STARTED  
RESPONDING BY MAKING IT ONE.

# Functional reference



# Functional reference in macaques

- ❖ Studied mothers and infants
- ❖ Ignorance condition: mother knows something infant doesn't (e.g., presence of food, predator)
- ❖ Knowledge condition: They both know
- ❖ Mothers vocalisations don't differ between conditions.

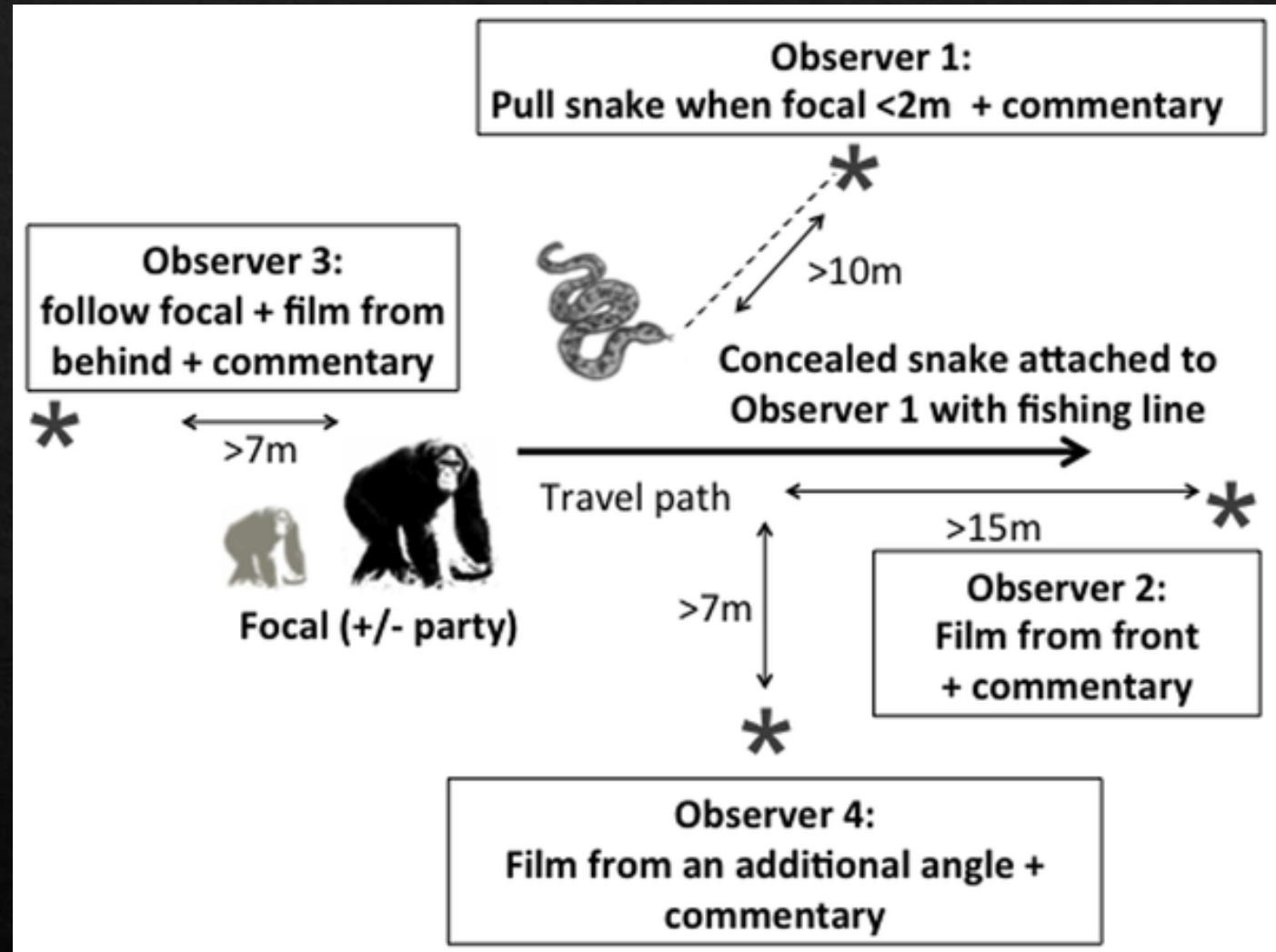
Cheney, D., & Seyfarth, R. (1990). Attending to behaviour versus attending to knowledge: examining monkeys' attribution of mental states. *Animal Behavior*, 40, 742-753.



# Intentional communication in chimpanzees

- ❖ Wild chimpanzees, surprised with a fake snake, either
  - ❖ alone
  - ❖ as part of a group
- ❖ Does the presence of others matter? Do they persist until others are safe?

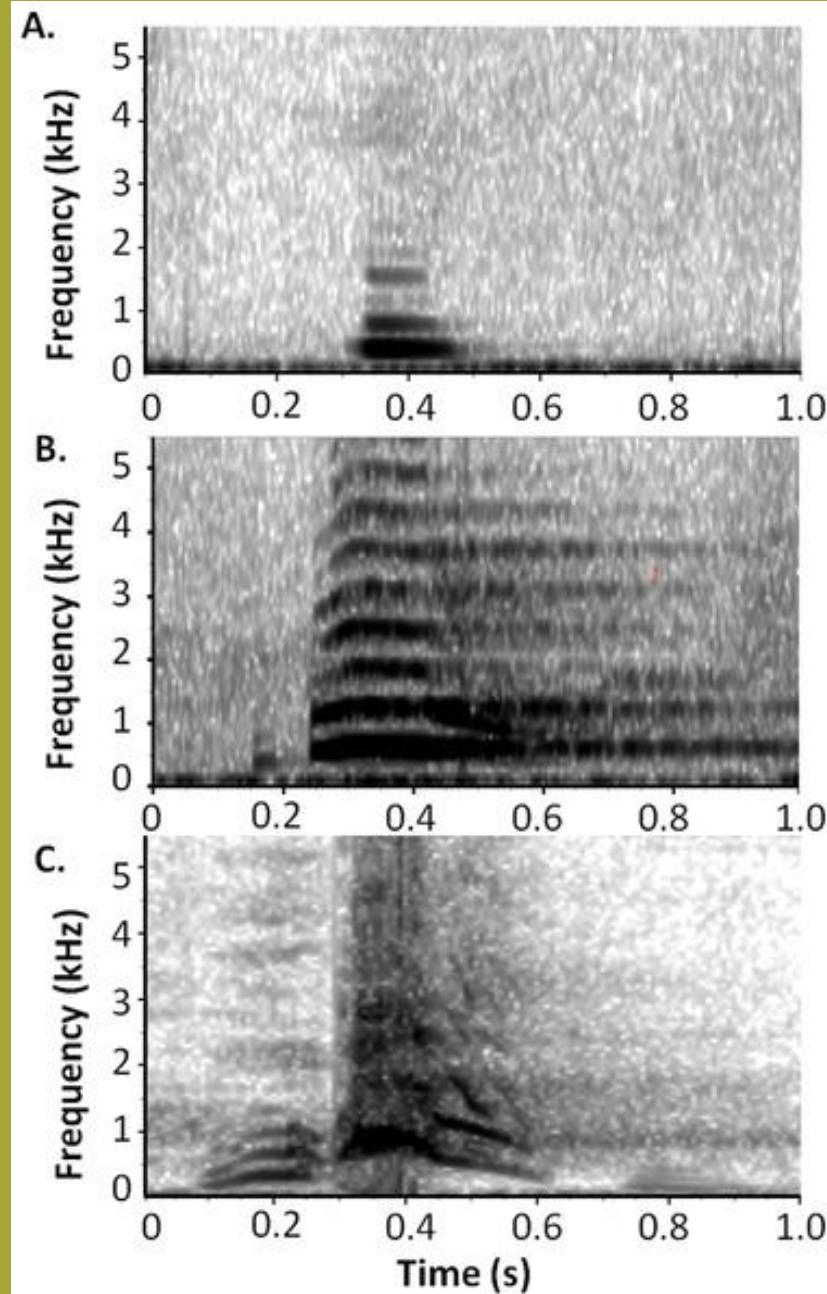
Schel, A. M., Townsend, S. W., Machanda, Z., Zuberbühler, K., & Slocombe, K. E. (2013) Chimpanzee Alarm Call Production Meets Key Criteria for Intentionality. *PLoS ONE*, 8, e76674



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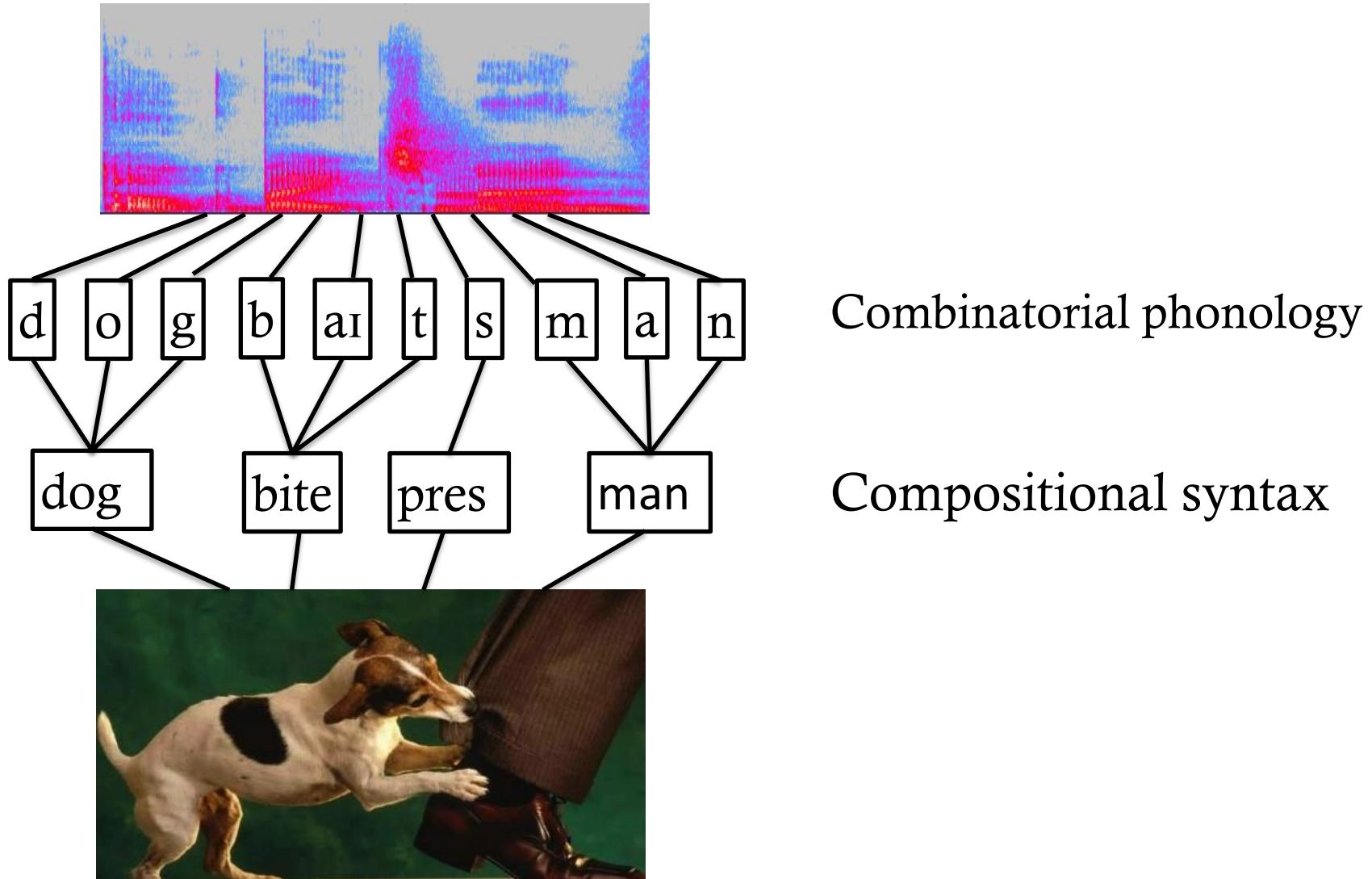




Structure in  
communication



# Language structure



# Putty nosed monkey: combinatoriality compositionality?

- ❖ Pyow: Leopard
- ❖ Hack: Eagle
- ❖ Pyow-hack: move



Arnold, K. & Zuberbuhler, K. (2006). Language evolution: semantic combinations in primate calls. *Nature*, 441, 303

Zuberbühler, K. (2018). Combinatorial capacities in primates. *Current opinion in behavioral sciences*, 21, 161-169.





Zuberbühler K (2002) A syntactic rule in forest monkey communication.  
*Animal Behaviour*, 63, 293–299.

## Campbell's monkey and Diana monkey

- ❖ Campbell's has leopard alarm and eagle alarm
- ❖ Dianas use these
- ❖ Sometimes, alarm is modified with a 'boom'
  - ❖ For Campbell's, reads "not urgent"
  - ❖ For Dianas, no difference in reaction

# Gibbon song

- ❖ Primarily used for
  - ❖ Pair bonding
  - ❖ Mating
  - ❖ Territorial defence/warning predators
- ❖ In other words, not propositional



# Gibbon song



0:40 / 0:40

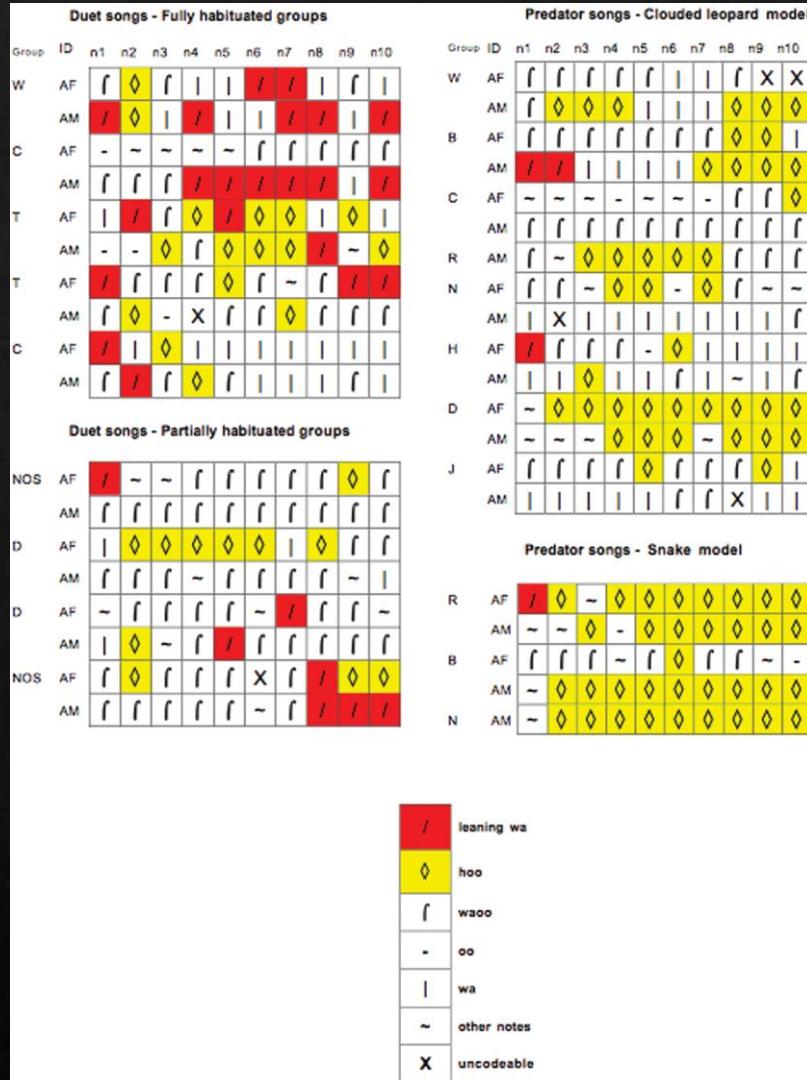
360p



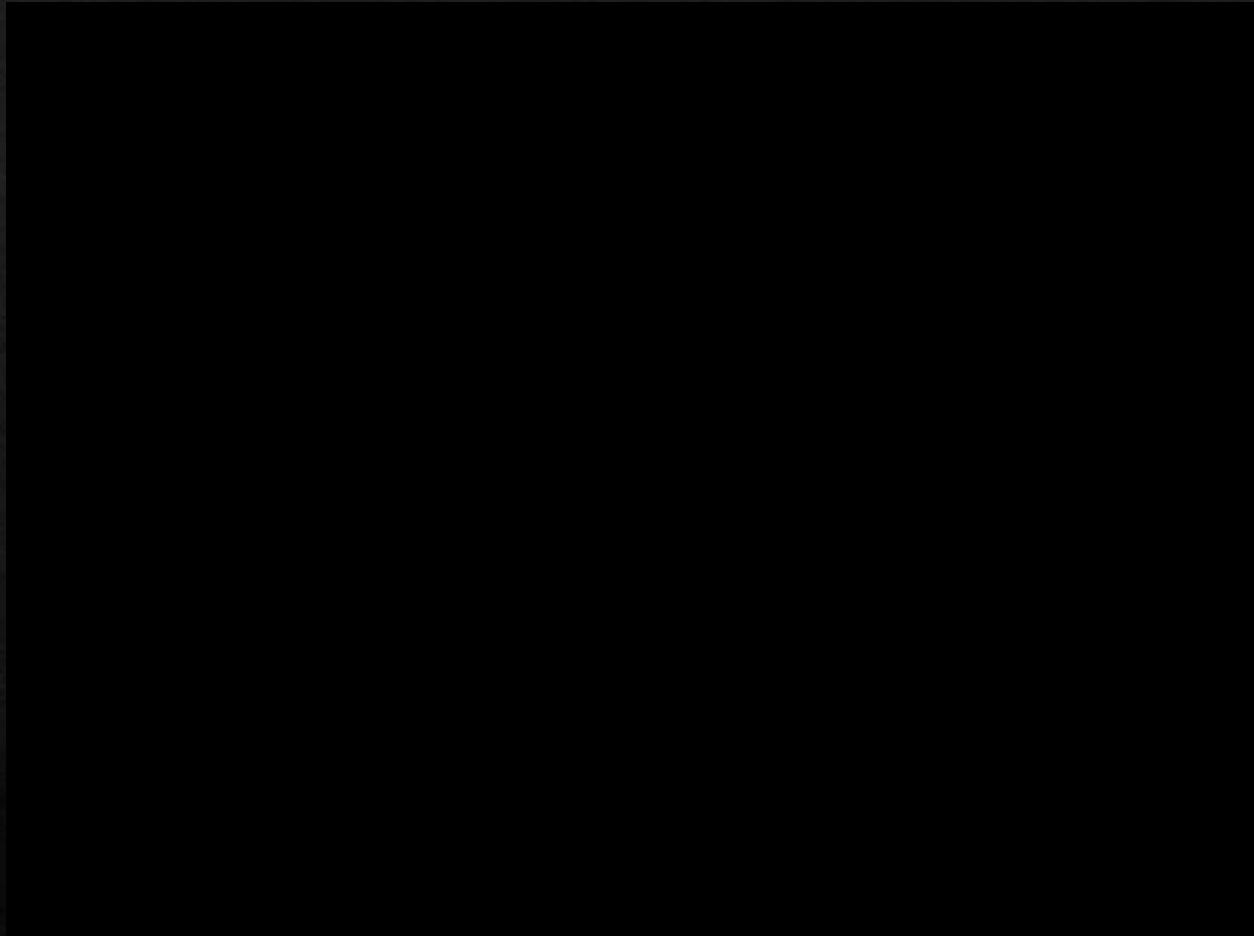
# Structure in Gibbon Song

- ❖ Same elements contained in predation defence and mating/pair bonding
- ❖ Seem to be recombined in different ways for different situations

Clarke, E., Reichard, U. H., & Zuberbühler, K. (2006). The syntax and meaning of wild gibbon songs. *PLoS one*, 1(1), e73.



# Latent capacity for syntax in apes?



Savage-Rumbaugh, E. S., Murphy, J., Sevcik, R., Brakke, K., Williams, S., Rumbaugh, D., & Bates, E. (1993).  
Language comprehension in ape and child. *Monographs of the Society for Research in Child Development*, 58, 1–252.

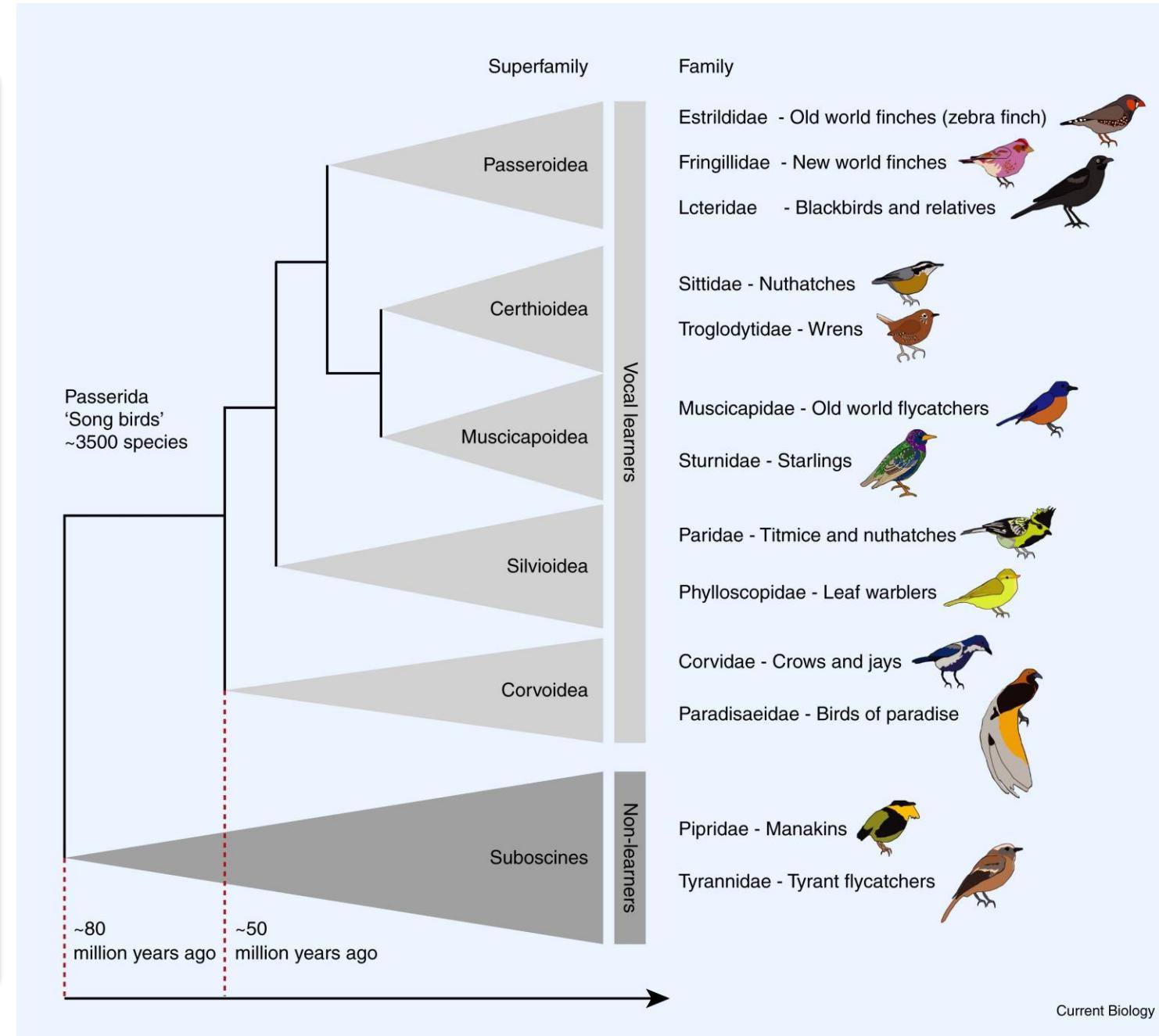
# Latent capacity for syntax in apes?

- ❖ Could just be 'semantic soup' plus smart interpretation?
- ❖ Cut the onions with your knife
- ❖ Put the pine needles in the refrigerator
- ❖ But he can handle reversible events
- ❖ Put the tomato in the oil
- ❖ Put some oil in the tomato [Kanzi pours oil in a bowl with the tomato]
- ❖ But no strong evidence for hierarchy
- ❖ Give the water and the doggie to Rose. [Gives dog only]
- ❖ Give the lighter and the shoe to Rose. [Gives lighter only]
- ❖ Give me the milk and the lighter [Responds correctly]

Truswell, R. (2017). Dendrophobia in bonobo comprehension of spoken English. *Mind & Language*, 32(4), 395-415.

# Structure in avian communication

- ❖ Songs consist of sequences of notes, including sub-parts
- ❖ Constraints on the ordering of parts
  - ❖ but, structure in the signal does not convey structured (or any) meaning
- ❖ Socially learned, rather than innate
  - ❖ most primate vocal behaviour is innate
- ❖ Ultimate functions
  - ❖ Territorial defence
  - ❖ Courtship
  - ❖ Pair/group bonding and duetting
  - ❖ ...just like gibbons



# Chaffinch

Each bird has 1-6 song types

- Mean 2-3

Order of notes in each song fixed

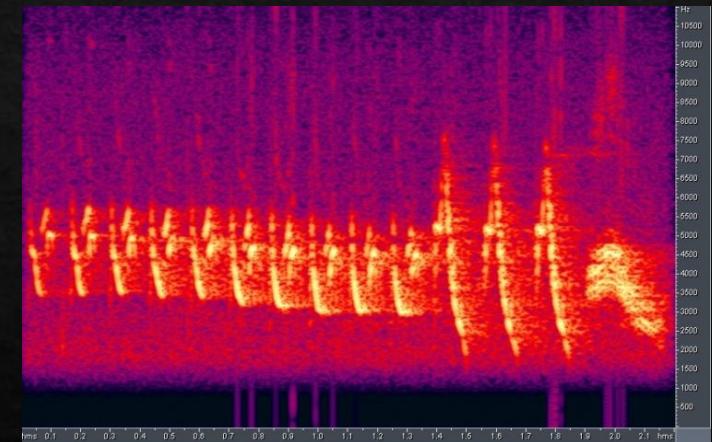
2-5 trill phrases, followed by a flourish

- Trill: sequence of 2 or more near-identical units
  - Number of repetitions can vary
- Flourish: no repetition
- Transitional notes: single notes between trill phrases
- Re-use of notes
  - Different songs may share, e.g., a flourish

Slater, P. J. B., & Sellar, P. J. (1986). Contrasts in the Songs of Two Sympatric Chaffinch Species. *Behaviour*, 99, 46-64.

Slater, P. J. B., Clements, F. A., & Goodfellow, D. J. (1984). Local and regional variations in chaffinch song and the question of dialects.

*Behaviour*, 88, 76-97.



Trill 1

Trill 2

Flourish

# Sedge warbler

Large repertoire of syllables

- 40-60 (?)

Highly variable

- No two songs are the same (probably)

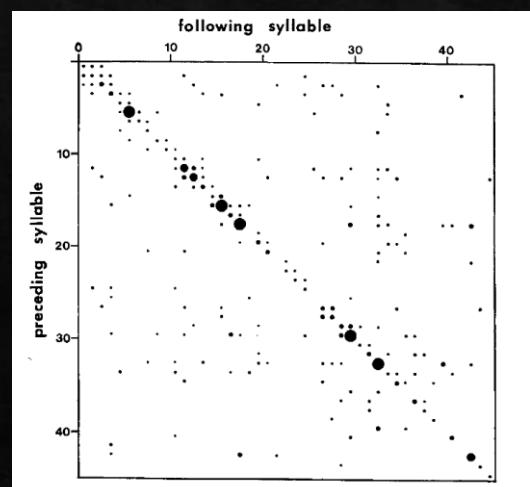
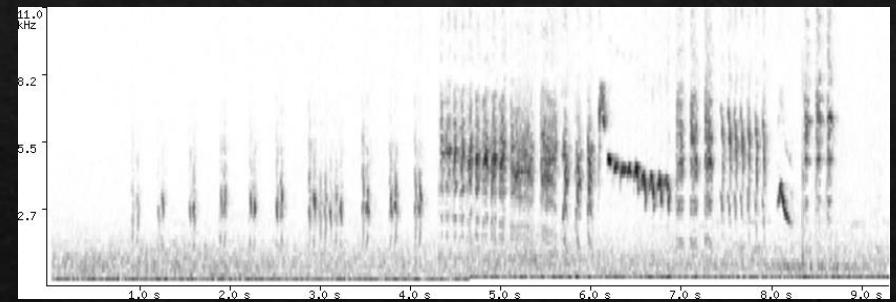
General organising principles

- Song start: long complex sequence of repetitions of 2 syllable types
- Middle: Multiple new syllable types introduced in quick succession
- End: similar to start, but using 2 syllables selected from middle

Catchpole, C. K. (1976). Temporal and sequential organisation of song in the sedge warbler (*Acrocephalus schoenobaenus*). *Behaviour*, 59, 226-245.



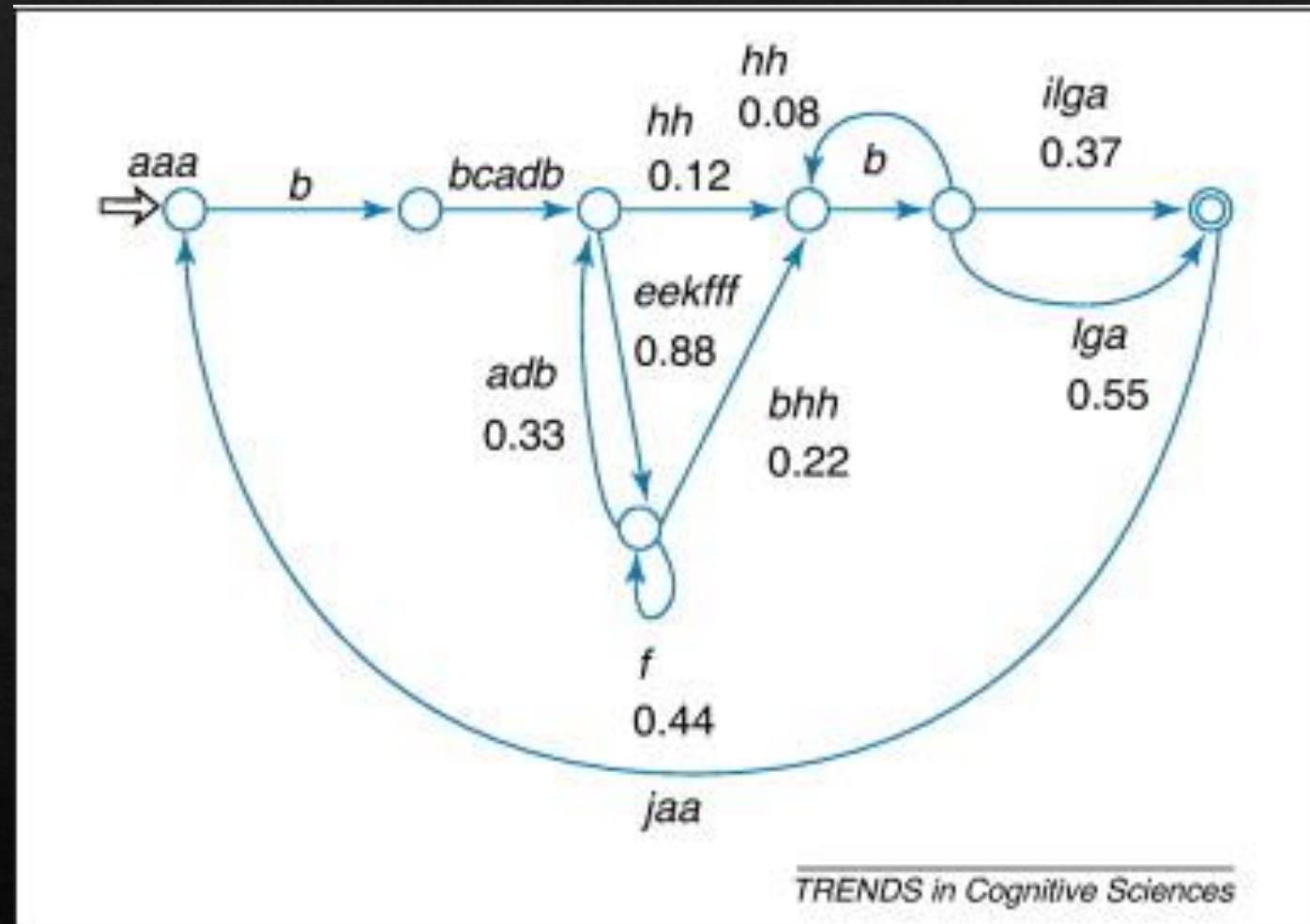
© P. H. Harvey



# Avian song structure: Overview

- ❖ Beyond bigram dependencies
- ❖ No nested dependencies
- ❖ Crucially: no compositional semantics

Berwick, R. C., Okanoya, K., Beckers, G. J., & Bolhuis, J. J. (2011). Songs to syntax: the linguistics of birdsong. *Trends in cognitive sciences*, 15(3), 113–121.



*TRENDS in Cognitive Sciences*

# Vocal communication in bats

- ❖ Complex vocalisations for navigation (e.g., echolocation)
- ❖ Also used for social bonding and interaction
- ❖ In some species , learned and open-ended
- ❖ Exhibits turn-taking

Vernes, S. C. (2017). What bats have to say about speech and language. *Psychonomic bulletin & review*, 24(1), 111-117.



# Summary

- ❖ Animals exhibit many aspects of complex cognition:
  - ❖ memory, including episodic and episodic-like
  - ❖ self-awareness (may be more widespread than we think?)
- ❖ Where they don't, if they don't, burden of proof has shifted – uniqueness cannot be assumed
- ❖ Communication is widespread – but analogues to language are rare
- ❖ Systems where intentionality, learning, and structure **intersect** are rare