Human language and animal communication

Same or different?

Some characteristics of human linguistic communication

- Innatecritical periodArbitrarycompositionalStructuredrecursiveInfinitedisplaced referenceFlexiblecreative
- Systems with ALL these properties are termed language in the narrow sense (FLN, Hauser, Chomsky and Fitch 2002).

Question:

Do animal communication systems show these properties?

naturally intra-species in the wild?
 when taught inter-species in the lab?

Where should we look?

- Social animals
- Large brains (relative to body size)
- Our close relations
- Visible or audible modalities
- Accessible environments
- Not too aggressive!

Species that qualify on one or more grounds:

- Honeybee
- Various birds
- Some monkeys
- Great apes
- Cetaceans

Some brain facts

- Birds: small cerebral cortex
- Chimps: enlarged plenum temporale in L hemisphere, sometimes assumed to be associated with language
- Whale : 11 lbs
- Human: 14oz at birth to 46oz max.
- BUT: Brain available after managing body: amount, relative to body size, increases in vertebrates and culminates in humans

The path to language?

- Fitch (various);Hauser, Chomsky & Fitch 2002
- Larnyx in nasal cavity in most animals except during vocalizing, when it moves to oral cavity
- Same true for human infants, but around 3 months moves to throat

Macaque monkey: larynx at velum



Size enhancement hypothesis

- Formant structure of vocalizations correlates with vocal tract length and body size
- Signals body size; evolutionarily adaptive
- Lowering the larynx makes one sound larger. All mammals do this during calling
- Happens to facilitate speech production. Humans keep it permanently low
- In humans, larnyx moves even lower when males reach puberty

Other prerequisites

- The ability to imitate: humans, parrots, songbirds, dolphins, but not much at all in non-human primates
- Conceptual-intentional system: rich in primates, parrots
- Theory of mind: controversial for apes
- Ability to compute transitional probabilities: cotton-top tamarins (Hauser, Newport and Aslin 2001)

But they seem to lack...

- Collaborative engagement (including non-verbal, such as pointing) (Tomasello)
- Can learn numbers (Matsuzawa 1985), but do not generalize to the next number. Each new number takes as long to learn as the first.
- Fail to learn long-distance dependencies (Fitch and Hauser 2004) such as AnBn. Finite-state ABn OK.
- Recursion is distinctively human, FLN (Hauser Chomsky and Fitch)But cf Gentner and Hulse 2005

Bee dance 1



Figure 2.3 Pattern of the tail-wagging dance. (Adapted from von Frisch 1967.)

Bee dance 2



Figure 2.4

Relation of solar-oriented flight to force of gravity. Box at center of landscape is the hive: three test feeding stations. A. B. and C. surround it. At bottom: dunces corresponding to the paths to the three feeding stations. (Adapted from 5 on Frisch 1967.)

Summary

- Orientation to vertical: direction w.r.t. sun
- Time spent on tail-wagging: distance
- Level of excitation: richness of source
- Compositional, but inflexible
- Von Frisch 1950



Bird songs

Summary in Doupe and Kuhl 1999

Innate or not?

- European cuckoo: innate, and unaffected by environment
- Bullfinch: learned; can learn canary song if reared with canaries; can transmit it to offspring

Innateness + critical period:

- White-crowned sparrow: dialects. (Marler)
- Requires w-c sparrow input during critical period
- Day 7-60 :perfect
- Day 60-100 basics only
- After day 100: never learns

Innateness continued:

- Botcher: zebra finches fail to learn song if the MAN area is lesioned.
- Gottlieb: Some birds learn from OWN vocalizations. If these are not heard, learn ANY ambient song. Innateness thus in question.

Adult learning

- Nottebohm: canary song areas die and re-grow annually, allowing for new tunes each year.
 Recent work suggests human brains may also regrow neurons. ?Plasticity?
- Whale songs change over time
- Starlings add new motifs throughout life. Also imitate other species.
- Rough analogues to humans ability to change accent, and acquire L2

Eastern white-crowned sparrow (Zonotrichia leucophrys)





south. Each male has a single song type, for the most part. Local dialects are most evident in the second, trilled portion of the song (from Marler, 1970). These dialects have been studied in much greater detail by

Structure in birdsong

- Like music, structure is present
- Like speech, formants can be detected

British starlings: two motifs





Monkeys and apes in the wild

- Fieldwork challenges
- Vervet monkeys (Marler et al):
- Apes: bonobo

mountain gorilla call gorilla chest drumming C C

NE

Vervet monkeys

- Seyfarth, Cheney and Marler 1980
- Different danger calls for leopard, baboon, eagle, python. Involuntary.
- Elicit different actions
- System of grunts: approaching a subordinate, vs a dominant animal vs a group. ?Referential?
- In both cases, tape recordings have same effect
- Non-compositional

Vervet alarm calls:

- Eagles
- Snakes
- Leopards



 Video: C:/animal communication/leopard.mov

Vervet leopard alarm video



Apes in the lab

- Taught, not just exposed
- Over-interpretation problem
- Incomplete documentation
- Limited results: small vocabulary
- Little evidence of grammar
- Little evidence of productive or innovative language
- Little evidence of displaced reference





Ape research

Name	Species	Age	Trained ?	Medium	# of
		at start			words
Washoe	Chimp	~1 yr	Yes	ASL	132
Sarah	Chimp	5	Yes	Chips	
Lana	Chimp	2	Yes	Lexigrams	
Koko	Lowland	1	Yes	Speech	250
	Gorilla			ASL	
Nim	Chimp	2wks	Yes	ASL	125
Kanzi	Pygmy	6mo	No	Speech	149
	Gorilla			Lexigrams	

Washoe's progress

- June 1965
- June 1966
- Dec 1966
- July 1967
- Apr 1968
- June 1969 training)
 June 1970
)

Born Begins training 4 signs 13 signs 34 signs

85 (Age 4; 3 yrs of

130 (Age 5; 4 yrs of training

Compare to a typical child

- Age 3
- Age 4
- Age 6

1000 words

3000 words

10,000 words

Interpretive problems

• Incomplete reporting:

Me banana you banana me you give reported as me banana you give

 Fixed sequence training: may not attach meanings to sub-parts Test by checking for FIRST trial in transfer tests: Teach 'cherry' see if they get 'me cherry you give' right FIRST time

More problems

- Cognitive skills clear, linguistic less so
- Sarah banana pail apple dish insert Sarah/insert constant, containers empty, so 50:50 chance of being right
- Experimenter often not native speaker of ASL, huge over-reporting of signs.

But they probably can:

- Use displaced reference
- Imitate (40% of Nim's utterances; whistlematching in dolphins in wild and lab)
- Sort objects into categories

Cetaceans

Killer whale (Orcinus Orca)





Dolphin whistles





Cetaceans in wild

- Humpbacks: only males, in mating season Same song all year, by whole ocean. Changes over time. Highly structured, possible rhyming.
- Fin whales: 20Hz pure tone blips, 2sec apart.
 155dB (louder than rock band). Travels 4000 miles! Function not known
- Dolphins: signature whistles(but see McCowan and Reis 2001), and echo location. Bursts of sound to stun prey (cephalopods)
- Extreme difficulty of study in wild

SONGS OF THE NUMPBACKED WHALE FEATURING · Why'd I Eat That Instamatic? . Tired of Swimmin' Blues . The Ballad of Jacques Cousteau · Dolphins in My Face · Gimme Some Plankton and lots more!

Dolphins in the lab

- Entirely passive
- Word-order effects not much above chance
- Replicated with sea-lions
- Hoover bthe talking seal (Fitch)

A sound-based set of commands



The experiment (Herman)



Dolphin object 'words

TABLE 10.1.

Comprehension Vocabulary of Phoenix (Pho) and Akeakamai (Ake); If Only One Dolphin Understands a Listed Word it is Followed by the Name of that Dolphin.

Objects

Tank Fixtures GATE (divides portion of tank; can be opened or shut) (Pho) WINDOW (any of four underwater windows) PANEL (metal panel attached underwater to side of tank) (Pho) CHANNEL (channels connecting two tanks)

Relocatable Objects^a SPEAKER (underwater) WATER (jetted from hose) PHOENIX (dolphin as object) (Ake) AKEAKAMAI (dolphin as object) (Pho)

Transferable Objects^b BALL HOOP PIPE (length of rigid plastic pipe) FISH (used as object or as reward) PERSON (any body part or whole person in or out of water) FRISBEE SURFBOARD BASKET

Dolphin action 'words'

Actions Take Direct Object Only TAIL-TOUCH (touch with flukes) PECTORAL-TOUCH (touch with pectoral fin) MOUTH (grasp with mouth) (G0) OVER (G0) UNDER (G0) UNDER (G0) THROUGH TOSS (throw object using rostrum movement) SPIT (squirt water from mouth at object)	Take Direct and Indirect Object FETCH (take one named object to another named object) IN (place one named object in or on another named object)

Agents

PHOENIX or AKEAKAMAI (prefix for each sentence; calls dolphin named to her station; indicates to dolphin which is to receive fish reward)

Akeakamai

- DO + A
- M + DO + A
- IO + DO + R
- IO + M + DO + R

Basket Toss

- **Right Fish Pec-touch**
- Pipe Hoop Fetch
- Ball Right Net In
- M + IO + DO + R Right Basket Pipe Fetch
- M + IO + M + DO + R
 - >>
- Right Hoop Left Pipe Fetch

Typical signs



Typical instructions

- a. Akeakamai over
- c. person tail-touch
 - e. water mouth

b. pipe tossd. ball pec-touchf. surfboard spit



Results

- Semantically reversible sentences: 77% correct (Phoenix) 59% Akeakamai . Drops to 14% using new 'words'
- Replicated with sealions (Schusterman and Gisiner 1988)
- No evidence for reference, despite Herman's claims
- Response precedes full command

Alex, the African grey parrot



Cognitive experiments, not linguistic ones

(Russian)

- Other than apes, only two-way experimental work
- Only spoken work
- Careful double-blind studies
- Tasks intermingled, making stimulusresponse strategies unlikely
- Pepperberg 1999

Alex's vocabulary

Shapes: 2-cornered, 3-cornered, ..6-corner Materials: cork, wood, paper, chalk, wool, rock, (raw)hide

- Colours: green, red, blue, yellow, gray, purple, orange
- Labels: key, chain, grate, tray, toy car, clothes pin, block, cup, box

Comprehension task:

- Objects: purple key, yellow wood, green hide, blue paper, orange peg wood, gray box, red truck
- Question: What object is gray?
- Answer: box [correct] (100% right)



Results

		Correct	%	Error type
What object is red?		10/12	83.3 %	Wrong object
What color is wood?		8/12	66.7 %	Wrong color
What object is 4-corner?		12/12	100 %	
What shape is red?		9/12	75%	Wrong shape (2) wrong colour (1).

How do they do?

Innate: YES critical period: YES Arbitrary:YES compositional:NO Structured:YES recursive:NO Infinite:NO displaced reference:? Flexible:? creative:NO

 In our present state of knowledge, no species other than our own has a system with all these properties.

The End

