

PRIMATE COGNITION 1: GENERAL ISSUES AND ATTEMPTS AT 'LANGUAGE' TRAINING

Essay (no 8 on the March 15th list)

“Apes cannot be taught language, but there is evidence that they have special abilities in the areas of social learning, imitation, and self-recognition.” Discuss.

A quotation —

“A third hypothesis proposes that *there are, in fact, neither quantitative nor qualitative differences among the intellects of non-human vertebrates*. It is argued that this null hypothesis is currently to be preferred, and that man’s intellectual superiority may be due solely to our possession of a species -specific language-acquisition device” (Macphail, 1985; p.37; see also Macphail, 1996 and Macphail and Bolhuis, 2001).

Notes

- Macphail is an example of those who disagree that primates (other than humans) have more than co-incidental cognitive advantages over other species. He supports a ‘null-hypothesis’ of equal intelligence (assessed in terms of associative learning) across all vertebrate species. Others such as Herman (see Shyan and Herman, 1987; Easter handout) would suggest that there are species differences in cognitive ability, but that certain non-primate species (dolphins, or other large-brained mammals) demonstrate primate levels of performance on complex tasks. Macphail (1985, 1998) and Heyes (1998) take the view that there essentially no differences between the cognitive capacities of different vertebrates species, as the above quotation suggests. Slotnick (2001) has argued that small-brained animals are often as good or better than large-brained animals at solving complex associative problems and Giurfa et al. (2001) have data suggesting that honey bees are able to learn “sameness” and “difference” concepts which had previously thought to be a primate speciality (e.g. Thompson and Oden, 2000).
- A more conventional view is that because primates are biologically more similar to people than other species cognitive processes in primates (especially in our closest living relatives, the great apes) will be noticeably human-like, and distinguishable, quantitatively or qualitatively, from those of non-primate species. It is clearly necessary to assess the behavioural evidence very carefully in order to evaluate the soundness of this assumption.
- An extreme case of the notion of primate cognitive superiority was the expectation that, with a sufficiently favorable training environment, infant apes might develop linguistic competence (e.g. Premack, 1976). Studies which attempted to train apes in language-like skills are reviewed in Walker (1985) and Walker (1987). (See page 3 for a summary). There is now a general consensus that some or other of the cognitive processes necessary for linguistic communication is innately and exclusively human (Hauser et al., 2002; Elman, 2005; Rivas, 2005; Pinker & Jackendoff, 2005). In particular Premack (1986) said he could find no trace of properly linguistic abilities in chimpanzees after many years of attempting to, and concluded that the human species possesses a number of ‘hard-wired’ cognitive specializations, including that for recursive syntax. However Premack (1986) continued to believe that non-human primate cognition is distinctive. In 1983 he proposed that only primates have an ‘abstract code’ for higher-order representations of object properties. In 1986 Premack suggested that primates were distinctive in the understanding of the semantic categories of the agent, recipient and patient of an action. (See page 7 for a definition of

these terms, and Crockford et al., 2004, Pika & Mitani, 2006, Wich et al., 2007 and Hopkins et al., 2007 for other primate abilities with some relation to verbal and gestural communication.).

- Although evidence for language-like communication in apes remains weak (despite Savage-Rumbaugh *et al.*; Greenfield and Savage-Rumbaugh, 1993; Bodamer and Gardner, 2002; Jensvold and Gardner, 2000; see Rivas, 2005), experimental studies of primate cognition have implied that apes, and to a lesser extent, monkeys, are at least quantitatively superior to other species at various kinds of reasoning task (e.g. Gillan *et al.* 1981; Menzel *et al.* 1985; Boysen and Himes, 1999; Call, 2001; Tomassello, 2000; Boesch, 2002; Brauer et al., 2005; Melis et al., 2006: see also week 11).
- Many authors going back to Jolly (1966) and Humpreys (1976) have supposed that primate intelligence is related to the complexity of their social interactions. Recent examples include Tomasello et al. (2005) and Pika and Mitani (2006). “Theory of Mind” hypotheses suppose that only some species have a functional concept of “self” (Gallup, 1970) or that only particular species (usually only the great apes) are able to make inferences or assumptions about the goals and intentions of conspecifics or human experimenters (Premack and Woodruff, 1978; Whiten and Byrne, 1997). This has recently attracted extra interest because of the hypothesis that human autism is characterised by a lack of this capacity (e.g. Leslie, 1987). The social cognitive features of “shared-reference” (or “shared-attention”) and “proto-declarative” communicative acts have been proposed as important pre-conditions both for the development of a “theory of mind” and for the development of human language (Baron-Cohen, 1992; Savage-Rumbaugh *et al.*, 1983; Tomasello, 2000; Suddendorf & Whiten, 2001; Elman, 2005: see Week 11).

Further notes on species differences in cognition

1. Global versus local adaptations (Davey, 1989)

Macphail’s “Null hypothesis” corresponds to an emphasis on “global adaptations” (Davey, 1989; p.12). It is certainly the case that behavioural processes such as habituation are very widespread across species, but there is also evidence for species specific specializations such as visual recognition and memory for food locations as discussed in week 8 and week 9.

2. The issue of brain size (page 9 in Pearce, 1997)

There are extremely large differences between species both in absolute size of the brain, and in the size of the brain in relation to body-weight. Although the relation between brain-size and brain function is to some extent indirect, one of the reasons for assuming that primate cognitive abilities may differ from those of the average mammal is that primates in general have above-average brain weights for their body size (see page 8 of handout and Ponting & Jackson, 2005, Evans et al., 2006 and Tang, 2006 for recent studies of the genetic mechanisms behind the increases in brain size in primates and in humans in particular.).

3. Specializations in brain function.

Most primate species share with humans the specialization in foveal colour vision, which is not used by other mammals, and elaborate social interactions exhibited over a long life-span. In terms of both ecological and anatomical specializations therefore, we would expect to find something in common between human cognition and cognition in primates (e.g. Barton, 1998; Regan et al., 2001). There is increasing evidence, in part due to brain-imaging studies in humans, that there is some degree of correspondence between localization of brain function in humans and other primates (e.g. Ungerleider, *et al.*, 1998; Rizzolati *et al.*, 1996; Miller et al., 2002; Semendeferi et al., 2002; Bush and Allman, 2004; Schenker et al., 2005; Sherwood et al., 2006; Tsao et al., 2006).

However, a recently emerging field of research is the genetic and neural aspects of brain development and function which are uniquely human (Enard et al., 2002a and 2002b; Elson et al., 2001; Buxhoeveden et al., 2001; Rilling and Seligman, 2002; Preuss et al., 2004; Pollard et al., 2006).

SUMMARY OF ATTEMPTS AT 'LANGUAGE' TRAINING

References	Name(s) of animals	Mode of Communication	Training
Kellogg and Kellogg (1933)	Gua	Vocal	Home rearing.
Hayes and Hayes (e.g. 1951)	Vicki	Vocal	Home rearing, moulding of lip position
Gardner and Gardner (e.g. 1969). Jensvold & Gardner (2000); Bodamer & Gardner (2002)	Washoe (& others)	American Sign Language (ASL)	Semi Home rearing, no vocalization, imitation and sign moulding, reward.
Terrace <i>et al</i> (1979)	Nim Chimsky	ASL	'Home rearing', many trainers, imitation.
Muncer & Etlinger (1981)	Jane	ASL (limited vocabulary of objects, prepositions and conjunctions.	1 year of lab style reward training, then 'Critical trials' in novel tests.
Premack (1970-1986)	Sarah (& others)	Plastic tokens as symbols for objects, verbs, and abstract categories.	Lab style sessions, examples and initial reward. Attempts to control for experimenter effects.
Savage-Rumbaugh <i>et al</i> (1973-1985)	Austin and Sherman	'Lexigrams' (Arbitrary visual symbols on a keyboard and computer-controlled display.	Examples, and initially specific reward training, (later more general encouragement)
Savage-Rumbaugh <i>et al</i> (1986 and later years) Greenfield and Savage-Rumbaugh (1990, 1993)	Kanzi (& Mulika)	Lexigrams on portable keyboard & ASL & spoken English	Initially imitation of natural mother: very rich environment but no formal training and no food reward; learning during 'informal' daily activities.

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3 POSITIONS ON CHIMPANZEE COGNITION

1. Chimpanzees are so close to humans in cognitive ability, that with extra training they will show human-like abilities for linguistic communication (Gardner and Gardner, 1971; Premack, 1971; Greenfield and Savage-Rumbaugh, 1993; Jensvold and Gardner, 2000; Bodamer and Gardner, 2002).
2. All non-human species are equally lacking in linguistic ability, and chimpanzees are not more intellectually able than rats (Macphail, 1985, 1996; Heyes, 1998).
3. Chimpanzees are useless at linguistic communication but they, and other great apes, are more similar to humans than other species in some non-linguistic cognitive abilities, such as those involved in object properties (and other Piagetian tests), social skills, and self recognition (Gallup, 1970; Premack and Woodruff, 1978; Premack, 1983, 1986; Povinelli, 1993; Suddendorf and Whiten, 2001; Boysen and Himes, 1999; Tomasello, 2000)

“Patient” in Roger Brown’s “A First Language” 1973

[Premack (1986) suggested that although chimpanzees have no grammatical ability, they understand the semantic categories of the agent, patient and recipient of an action.]

Patient is in the index,: defined, 27,150, 230; contrast with agent, 191-5. *See also* Object of a predicate, which is 136, 140 ,149,150-55; defined, 143-4

p27.

<i>Role</i>	<i>Definition</i>	<i>Examples</i>
Agent	Someone or something which causes or instigates an action or process Usually animate but not always, an agent must be perceived to have its own motivation force	<i>Harriet sang.</i> <i>The men laughed.</i> <i>The wind ripped the curtains.</i>
Patient	Someone or something either in a given state or suffering a change of state. <undergoes a change>	<i>The wood is dry.</i> He cut the <i>wood</i> .

Source: Adaption from Chafe (1970)

p. 150 just *hit, push pull, kiss, feed*, “For all these verbs the semantic agent becomes the grammatical subject and the semantic object or patient becomes the grammatical object.”

p. 151 *Adam sees Eve, Adam hears Eve*. The Adam role is called an experiencer by Chafe, and Chafe would consider the Eve role a variety of patient <in the state of being seen by Adam, I guess>

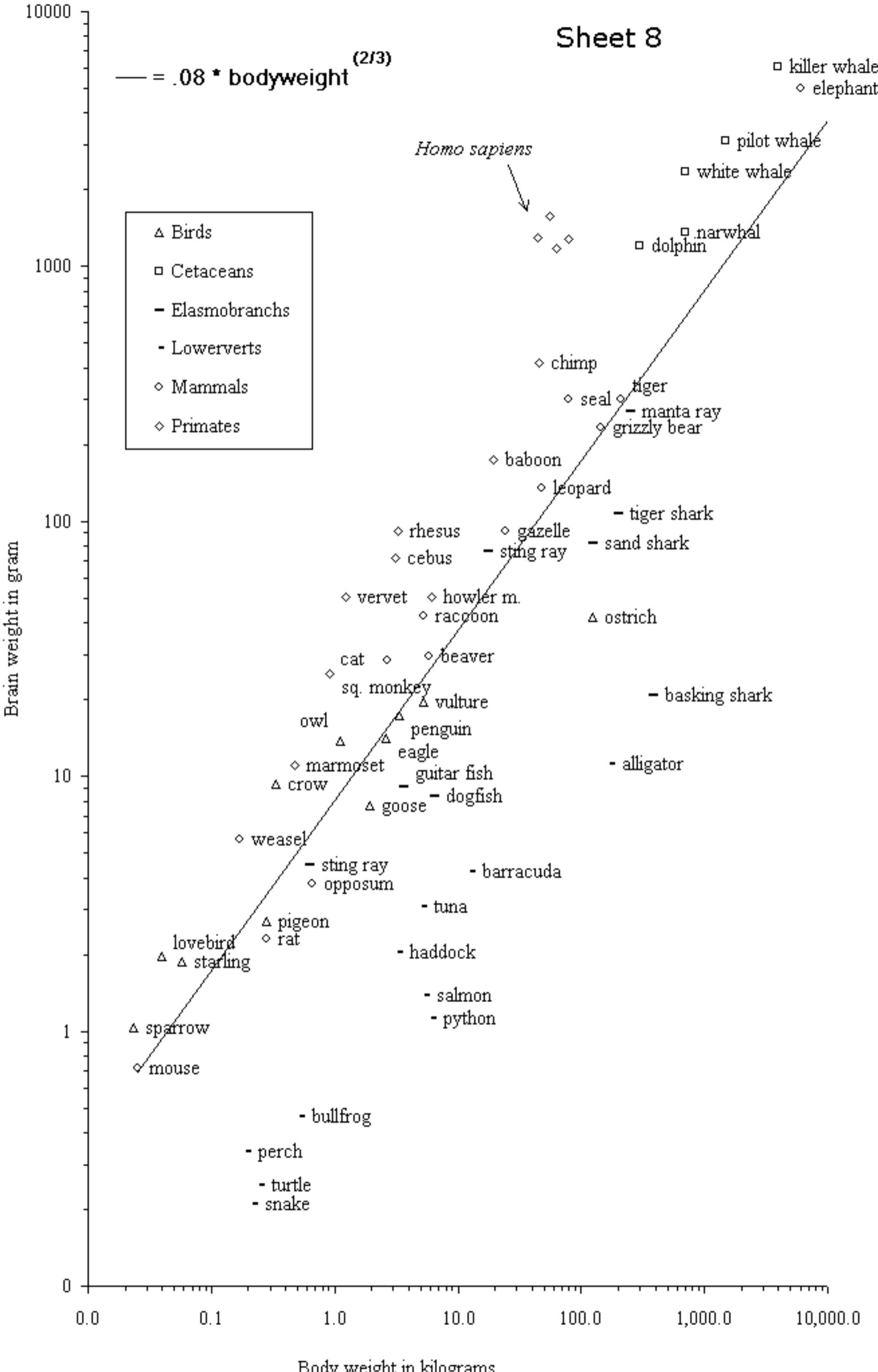
p. 230 Brown does not use “patient” quite so generally as Chafe (1970) does.

Sheet 8

— = $.08 * \text{bodyweight}^{(2/3)}$

□ killer whale
 ◊ elephant

- △ Birds
- Cetaceans
- Elasmobranchs
- Lowerverts
- ◊ Mammals
- ◊ Primates



Homo sapiens



□ pilot whale

□ white whale

□ narwhal
 ◊ dolphin

◊ chimp

◊ seal ◊ tiger

◊ grizzly bear

◊ baboon

◊ leopard

- tiger shark

◊ rhesus

◊ gazelle

- sand shark

◊ cebus

- sting ray

◊ vervet

◊ howler m.

◊ raccoon

△ ostrich

cat

◊ beaver

- basking shark

sq. monkey

△ vulture

owl

△ penguin

△ crow

△ eagle

- alligator

◊ marmoset

- guitar fish

△ goose

- dogfish

◊ weasel

- sting ray

◊ opossum

- barracuda

△ pigeon

- tuna

◊ rat

- haddock

△ sparrow

- salmon

- python

- bullfrog

- perch

- turtle

- snake

0 10 100 1000 10000

0.0 0.1 1.0 10.0 100.0 1,000.0 10,000.0

Body weight in kilograms

Two papers claiming “conversations” with chimpanzees

Bodamer, M. D., & Gardner, R. A. (2002). How cross-fostered chimpanzees (*Pan troglodytes*) initiate and maintain conversations. *Journal of Comparative Psychology*, 116(1), 12-26.

This study systematically sampled typical attention-getting sounds and sign language conversations between each of 4 originally cross-fostered chimpanzees (*Pan troglodytes*), still living freely, but now in a laboratory setting, and a familiar human interlocutor. Videotape records showed that when they encountered a human interlocutor sitting alone at his desk with his back turned to them, the cross-fosterlings either left the scene or made attention-getting sounds. The only signs they made to the interlocutor's back were noisy signs. When the human turned and faced them, the chimpanzees promptly signed to him (98% of the time) and rarely made any sounds during the ensuing signed conversations. Under systematic experimental conditions, the signed responses of the chimpanzees were appropriate to the conversational styles of the human interlocutor, confirming daily field observations.

Jensvold, M. L. A., & Gardner, R. A. (2000). Interactive use of sign language by cross-fostered chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, 114(4), 335-346.

Cross-fostered as infants in Reno, Nevada, chimpanzees (*Pan troglodytes*) Washoe, Moja, Tatu, and Dar freely converse in signs of American Sign Language with each other as well as with humans in Ellensburg, Washington. In this experiment, a human interlocutor waited for a chimpanzee to initiate conversations with her and then responded with 1 of 4 types of probes: general requests for more information, on-topic questions, off-topic questions, or negative statements. The responses of the chimpanzees to the probes depended on the type of probe and the particular signs in the probes. They reiterated, adjusted, and shifted the signs in their utterances in conversationally appropriate rejoinders. Their reactions to and interactions with a conversational partner resembled patterns of conversation found in similar studies of human children.

One paper claiming “secondary representations” in apes

Suddendorf, T., & Whiten, A. (2001). Mental evolution and development: Evidence for secondary representation in children, great apes, and other animals. *Psychological Bulletin*, 127(5), 629-650.

Recent interest in the development and evolution of theory of mind has provided a wealth of information about representational skills in both children and animals. According to J. Perrier (1991), children begin to entertain secondary representations in the 2nd year of life. This advance manifests in their passing hidden displacement tasks, engaging in pretense and means-ends reasoning, interpreting external representations, displaying mirror self-recognition and empathic behavior, and showing an early understanding of "mind" and imitation. New data show a cluster of mental accomplishments in great apes that is very similar to that observed in 2-year-old humans. It is suggested that it is most parsimonious to assume that this cognitive profile is of homologous origin and that great apes possess secondary representational capacity. Evidence from animals other than apes is scant. This analysis leads to a number of predictions for future research.

3 papers about similarities between the human brain and the brains of other primates

Cantalupo, C., & Hopkins, W. D. (2001). Asymmetric Broca's area in great apes - A region of the ape brain is uncannily similar to one linked with speech in humans. *Nature*, 414(6863), 505-505.

Brodmann's area 44 delineates part of Broca's area within the inferior frontal gyrus of the human brain and is a critical region for speech production, being larger in the left hemisphere than in the right — an asymmetry that has been correlated with language dominance. Here we show that there is a similar asymmetry in this area, also with left-hemisphere dominance, in three great ape species (*Pan troglodytes*, *Pan paniscus* and *Gorilla gorilla*). Our findings suggest that the neuroanatomical substrates for left-hemisphere dominance in speech production were evident at least five million years ago and are not unique to hominid evolution.

Semendeferi, K., Lu, A., Schenker, N., & Damasio, H. (2002). Humans and great apes share a large frontal cortex. *Nature Neuroscience*, 5(3), 272-276.

Some of the outstanding cognitive capabilities of humans are commonly attributed to a disproportionate enlargement of the human frontal lobe during evolution. This claim is based primarily on comparisons between the brains of humans and of other primates, to the exclusion of most great apes. We compared the relative size of the frontal cortices in living specimens of several primate species, including all extant hominoids, using magnetic resonance imaging. Human frontal cortices were not disproportionately large in comparison to those of the great apes. We suggest that the special cognitive abilities attributed to a frontal advantage may be due to differences in individual cortical areas and to a richer interconnectivity, none of which required an increase in the overall relative size of the frontal lobe during hominid evolution.

Courtney, SM, Petit, L, Maisog, JM, Ungerleider, LG, Haxby, JV (1998) An area specialized for spatial working memory in human frontal cortex. *Science*, Vol.279, No.5355, Pp.1347-1351. (see also Courtney, et al.,(1998) *Philosophical Transactions of the Royal Society of London Series B*, Vol.353, No.1377, Pp.1819-1828.

Working memory is the process of maintaining an active representation of information so that it is available for use. In monkeys, a prefrontal cortical region important for spatial working memory lies in and around the principal sulcus, but in humans the location, and even the existence, of a region for spatial working memory is in dispute. By using functional magnetic resonance imaging in humans, an area in the superior frontal sulcus was identified that is specialized for spatial working memory. This area is located more superiorly and posteriorly in the human than in the monkey brain, which may explain why it was not recognized previously.

One paper on special features of the human brain

Preuss, T. M., Caceres, M., Oldham, M. C., & Geschwind, D. H. (2004). Human brain evolution: Insights from microarrays. *Nature Reviews Genetics*, 5(11), 850-860.

Several recent microarray studies have compared gene-expression patterns in humans, chimpanzees and other non-human primates to identify evolutionary changes that contribute to the distinctive cognitive and behavioural characteristics of humans. These studies support the surprising conclusion that the evolution of the human brain involved an upregulation of gene expression relative to non-human primates, a finding that could be relevant to understanding human cerebral physiology and function. These results show how genetic and genomic methods can shed light on the basis of human neural and cognitive specializations, and have important implications for neuroscience, anthropology and medicine.

One paper on possible genetic changes during recent human evolution

Enard, W., Przeworski, M., Fisher, S. E., Lai, C. S. L., Wiebe, V., Kitano, T., Monaco, A. P., & Paabo, S. (2002). Molecular evolution of FOXP2, a gene involved in speech and language. *Nature*, 418(6900), 869-872.

Language is a uniquely human trait likely to have been a prerequisite for the development of human culture. The ability to develop articulate speech relies on capabilities, such as fine control of the larynx and mouth(1), that are absent in chimpanzees and other great apes. FOXP2 is the first gene relevant to the human ability to develop language(2). A point mutation in FOXP2 co-segregates with a disorder in a family in which half of the members have severe articulation difficulties accompanied by linguistic and grammatical impairment(3). This gene is disrupted by translocation in an unrelated individual who has a similar disorder. Thus, two functional copies of FOXP2 seem to be required for acquisition of normal spoken language. We sequenced the complementary DNAs that encode the FOXP2 protein in the chimpanzee, gorilla, orang-utan, rhesus macaque and mouse, and compared them with the human cDNA. We also investigated intraspecific variation of the human FOXP2 gene. Here we show that human FOXP2 contains changes in amino- acid coding and a pattern of nucleotide polymorphism, which strongly suggest that this gene has been the target of selection during recent human evolution.

Two papers suggesting that domestic dogs are good at reading human social cues

Hare, B., Brown, M., Williamson, C., & Tomasello, M. (2002). The domestication of social cognition in dogs. *Science*, 298(5598), 1634-1636.

Dogs are more skillful than great apes at a number of tasks in which they must read human communicative signals indicating the location of hidden food. In this study, we found that wolves who were raised by humans do not show these same skills, whereas domestic dog puppies only a few weeks old, even those that have had little human contact, do show these skills. These findings suggest that during the process of domestication, dogs have been selected for a set of social-cognitive abilities that enable them to communicate with humans in unique ways.

Hare, B., & Tomasello, M. (2005). Human-like social skills in dogs? *Trends in Cognitive Sciences*, 9(9), 439-444.

Domestic dogs are unusually skilled at reading human social and communicative behavior-even more so than our nearest primate relatives. For example, they use human social and communicative behavior (e.g. a pointing gesture) to find hidden food, and they know what the human can and cannot see in various situations. Recent comparisons between canid species suggest that these unusual social skills have a heritable component and initially evolved during domestication as a result of selection on systems mediating fear and aggression towards humans.

Differences in chimpanzee and human temperament suggest that a similar process may have been an important catalyst leading to the evolution of unusual social skills in our own species. The study of convergent evolution provides an exciting opportunity to gain further insights into the evolutionary processes leading to human-like forms of cooperation and communication.

SOME EXAMPLES OF "ICONIC" SIGNS

*hug**pray**think*

SOME EXAMPLES OF "NONICONIC" SIGNS

*girl**boy**airplane*

All signs, iconic or otherwise, are made by holding the hand(s) in a particular configuration, and by moving the hand(s) so they touch a particular location on the body with a particular orientation. A major step toward providing an objective and systematic description of signs was the development of a system that identified the basic elements of sign language. William Stokoe, a linguist at Gallaudet College, in Washington, D.C. (the only liberal arts college for deaf people in the world), has shown that every sign can be described as a unique combination of nineteen hand configurations, twenty-four types of movement, and twelve body locations. This system is analogous to the phonemic system for specifying the words of spoken language. A simple illustration of Stokoe's system of cheremes (the manual equivalent of spoken phonemes) can be seen below and on the next page.

*flower**kiss*

Terrace, H.S. (1979/1980) *Nim*. London: Eyre Methuen.

Terrace, H.S., Pettito, L.A., Sanders, R.J. and Bever, T.G. (1979) Can an ape create a sentence? *Science*, 206, 891-902.

- The project lasted 4 years and involved 60 teachers, mostly volunteers. Another group of about 40 volunteers tabulated and analyzed data from daily records and videotapes.
- In the *Science* paper more than 19,000 “multi-sign utterances” were analyzed for syntactic and semantic regularities.
- There were some regularities, but videotape analyses showed that most of Nim’s utterances were prompted by his teacher’s prior utterances (signs in American Sign Language).
- Nim interrupted his teachers to a much larger extent than a child interrupts an adult’s speech.

Typical two-sign combinations were —

“play me” (375)
“tickle me” (316)
“hug Nim” (106)
“tickle Nim” (107)

“more eat” (287)

“banana Nim” (73)
“in pants” (70)

The most frequent three-sign combinations were —

“play me Nim” (81)
“eat me Nim” (48)
“eat Nim eat” (46)
“tickle me Nim” (44)
“grape eat Nim” (37)
“banana Nim eat” (33)
“Nim me eat” (27)
“banana eat Nim” (26)
“eat me eat” (22)

The most frequent four-sign combinations were —

“eat drink eat drink” (15)
“eat Nim eat Nim” (7)
“banana Nim banana Nim” (5)
“drink Nim drink Nim” (5)
“banana eat me Nim” (4)
“banana me eat banana” (4)
“banana me Nim me” (4)
“grape eat Nim eat” (4)
“Nim eat Nim eat”
“play me Nim play”
“drink eat drink eat” (3)
“drink eat me Nim” (3)

Greenfield, P.M. and Savage-Rumbaugh, E.S. (1990) Grammatical combination in *Pan paniscus*: Processes of learning and invention in the evolution and development of language. In S.T. Parker and K.R. Gibson (eds) "*Language*" and *Intelligence in Monkeys and Apes: Comparative Developmental Perspectives*. Cambridge University Press, 540-578.

The authors note that in 1979, Terrace *et al* asked "Can an ape create a sentence?" and gave the answer no, and say that their goal is to show that under different conditions the answer can be "Yes". (p.540)

Drawing on several previous suggestions, they suggest that all five of the following criteria are necessary for something to count as a grammatical rule.

1. Each component of a combination must have independent symbolic status.
2. The relationship between the symbols must be reliable and meaningful.
3. A rule must specify relations between *categories* of symbols across combinations, not merely a relation between individual symbols.
4. Some formal device, such as statistically reliable word-order, must be used to relate symbol categories across combination.
5. The rule must be productive: a wide variety of spontaneous combinations must be generated.

The claim is that the pigmy chimpanzee Kanzi not only learned but invented simple grammatical rules which conform to these criteria.

METHOD

Although trained with a computer controlled keyboard, when outdoors Kanzi used a laminated board showing an array of lexigram symbols, which could be pointed to by him or by researchers. (p.547), who logged such symbol usage by hand and entered it into the computer at the end of the day. Checks were done using videotapes on the reliability of this data. Normally, Kanzi had someone with him recording data 9 hours per day, 7 days per week.

DATA AND ANALYSIS

The data consisted of all of Kanzi's two-element combinations (either two lexigrams or a lexigram plus a gesture) produced over a 5-month period when he was 5½ years old. (A less extensive analysis was conducted on 3-element combinations). There were 1,422 "utterances" of two or more elements out of a total of 13,691 (i.e 90% of utterances were single elements). However, combinations were only analysed when there was sufficient situational context "to make the basic meaning relations clear". Also, for the purpose of the analysis all partial or complete imitations were excluded, as were utterances that were in anyway solicited such as responses to questions, or responses to a caregiver who withheld something contingent on lexigram production. This left 723 two-element combinations produced by the chimpanzee. 80% of the lexigrams in this corpus met the criteria used to check on symbolic function. For example if the symbol "BANANA" was used as a putative request for a banana, several different preferred foods would be offered: only if the animal chose the banana 9/10 time after using the lexigram was it assumed that the lexigram was being used in a meaningful way.

Video transcripts were used to analyse the communicative input from the six major caregivers.

RESULTS

1. A rule corresponding to environmental input: **Action precedes object**

During the last 4 months of the study, 31/39 action/object two-lexigram combinations had the action first, which is statistically significant. Examples are BITE BALL, BITE TOMATO, SLAP BALL, HIDE PEANUT.

2. An invented rule: **Gesture follows lexigram**

Human caregivers always used the order agent-action. Kanzi however had a strong preference for pointing to a lexigram first in lexigram-gesture combinations, even when the lexigram was the action (116/123 examples: e.g. CHASE (then point to a particular person.). The majority of examples of this rule arose from pointing to a lexigram followed by pointing to a person or object. However, it also applied to a small number of action gestures (*go, come, chase, open*).

Limitations of the Grammar (p.567)

The authors discuss some other regularities in element order which were not very frequent. For instance, one 3-element pattern observed in 7/8 cases was in action-action-point to agent: e.g. CHASE-BITE- point to person. But they acknowledge that grammatical rules are in fact very limited in Kanzi's symbol use. i) only a very small proportion of his output was in combinations of elements; ii) in terms of the presumed pragmatic function of the output, 96% were judged to be requests, and only 4% to be statements or indicatives.

DISCUSSION (pp. 568-574)

The authors conclude that the degree of element ordering in Kanzi's performance implies some overlap in chimpanzee and human capacities: "The capacity for grammatical rules (including arbitrary ones) in Kanzi's semiotic productions shows grammar as an area of evolutionary continuity." (p.572); "Finally, Kanzi's capacity to invent simple grammatical or protogrammatical rule provides clues to the evolutionary origins of grammar, as well as a mechanism for historical language change in the absence of genetic evolution. This inventive capacity suggests that the ancestor of the pigmy chimpanzee may have had the cognitive prerequisites to invent a protogrammar. This protogrammar could then have provided an evolutionary foundation for the later development of full-blown grammar, just as the two-word stage of child language forms a developmental foundation for the more complex and abstract adult grammar that follows." (p.574).

Lecturer's comment

This is rather a lot to conclude from the performance of one animal which has had very lengthy and intensive exposure to human interventions. It is equally possible to point to the very limited use of combinations of symbols in this animal as confirming the conclusion that no amount of training can produce human-like communication by a non-human primate. (Terrace *et al*, 1979; Premack, 1986)

Greenfield, P.M. and Savage-Rumbaugh, E.S. (1993) Comparing communicative competence in child and chimp: the pragmatics of repetition. *Journal of Child Language*, 20, 1-26.

Abstract

“Through an analysis of chimpanzee-human discourse, we show that two *Pan troglodytes* [the usual] chimpanzees and two *Pan paniscus* [pigmy] chimpanzees (bonobos) exposed to a humanly devised symbol system use partial or complete repetition of others' symbols, as children do: they do not produce rote imitations, but instead use repetition to fulfil a variety of pragmatic functions in discourse. These functions include agreement, request, promise, excitement, and selection from alternatives. In so doing the chimpanzees demonstrate contingent turn-taking and the use of simple devices for lexical cohesion. In short, they demonstrate conversational competence. Because of the presence of this conversational competence in three sibling species, chimpanzees, bonobos, and humans, it is concluded that the potential to express pragmatic functions through repetition was part of the evolutionary history of human language, present in our common ancestor before the phylogenetic divergence of hominids and chimpanzees. In the context of these similarities, two interesting differences appeared: (1) Human children sometimes used repetition to stimulate more talk in their conversational partner; the chimpanzees, in contrast, use repetition exclusively to forward the non-verbal action. This difference may illuminate a unique feature of human linguistic communication, or it may simply reflect a modality difference (visual symbols used by the chimpanzees, speech use by the children) in the symbol systems considered in this research. A second difference seems likely to reflect a true species difference: utterance length. The one- and two-symbol repetitions used by the chimpanzees to fulfil a variety of pragmatic functions were less than half the maximum length found in either the visual symbol combinations addressed to them by their adult human caregivers or the oral repetitions of two-year-old children. This species difference probably reflects the evolution of increased brain size and consequent increased memory capacity that has occurred since the phylogenetic divergence of hominids and chimpanzees four to seven million years ago.”

METHODS (p. 7)

They used a method of discourse analysis based on that published by Ochs Keenan (1977) for children.

EXPLORATORY STUDY (p. 9)

Used Austin and Sherman when they were 7 and 8 yrs old, and had 100 lexigrams available to them. A computer printout of all symbol use by the researcher and subject was analysed in relation to detailed contextual notes made by the researcher. Two sessions of about an hour with each animal were analysed. (Transcripts had been published in 1984). 5 and 6 instances of "Confirm/agree" and "Request" were recorded for Austin, and 9, 3 and 5 instances of "Confirm/agree", "Confirm with specification" and "Counterclaim" were observed for Sherman.

MAIN STUDY (p. 15)

Used Kanzi and Mulika when they were 5 and almost 2 years old. The analysis was based on every lexigram they produced during one month.

Mulika had 87 repetitions: 37 (43%) were "Confirm/agree" and 46 (53%) were either "Request" or "Imitate/Request".

Kanzi had 62 repetitions: 46 (74%) were "Confirm/agree" and 10 (22%) were either "Request" or "Imitate/request".

EXAMPLES (Table 3, p. 16: Lexigrams are capitalized)

"Confirm/agree"

Person: Let's see what's on TELEVISION
Mulika: TELEVISION (*goes to video deck and gestures to it*).

"Request"

Person: Look Muli I found PRIVET-BERRYs in our REFRIGERATOR
Mulika: PRIVET-BERRY. (*Person takes berries out of refrigerator freezer and offers Mulika one, Mulika takes it*)

"Imitation/request"

(*Mulika reaches for Person's Coke*)

Person: COKE (*showing Mulika the lexgram*)
Mulika: COKE

GENERAL DISCUSSION (pp 20-24)

The authors claim that repetition of symbols cannot be used as a dividing line between human and chimpanzee, since the repetitions in chimpanzees are similar to some of the simplest occurring in 1- and 2-yr old children. However, they acknowledge that children's repetitions become very different. "A principle difference was that repetitions were used by children, but not chimpanzees, to keep conversation going, to elicit further verbalization. This difference could show that motivation to keep a conversation going and to use language for its own sake is, among primates, unique to the human species. Secondly, children develop symbolic means of referring to pragmatic functions, and the chimpanzees studied did not do this (e.g. did not have anything corresponding to "I agree"). Thirdly, chimpanzee repetitions were primarily of single lexigrams, whereas children often repeat several words. The authors accept that sentence length is probably "a true species difference" (p. 22).

Lecturer's comments and overall conclusions

Although these studies draw attention to the fact that symbol repetition by chimps is not necessarily just blind imitation, they also support the position that chimpanzee symbol use is unlike human language in being a) **syntactically very limited**; and b) **tied very closely to immediate tangible goals**.

Thus the work by Greenfield and Savage-Rumbaugh (1990,1993) Jensvold and Gardner (2000) and Bodamer and Gardner (2002) does little to alter the conclusion of an immense gap between trained apes and human infants (e.g. Wallman, 1992): the 1990 chapter has Kanzi doing 'action precedes object' only about twice a week with 96% of his output judged to be requests, while Greenfield and Savage-Rumbaugh (1993) admit that their subjects used repetitions only for requests, not conversationally or to express agreement.

Similarly the results reported by Jensvold and Gardner (2000) and Bodamer and Gardner (2002) can readily be interpreted as Thorndikean conditioned responses reinforced by tangible goals, as opposed to human-like conversations.

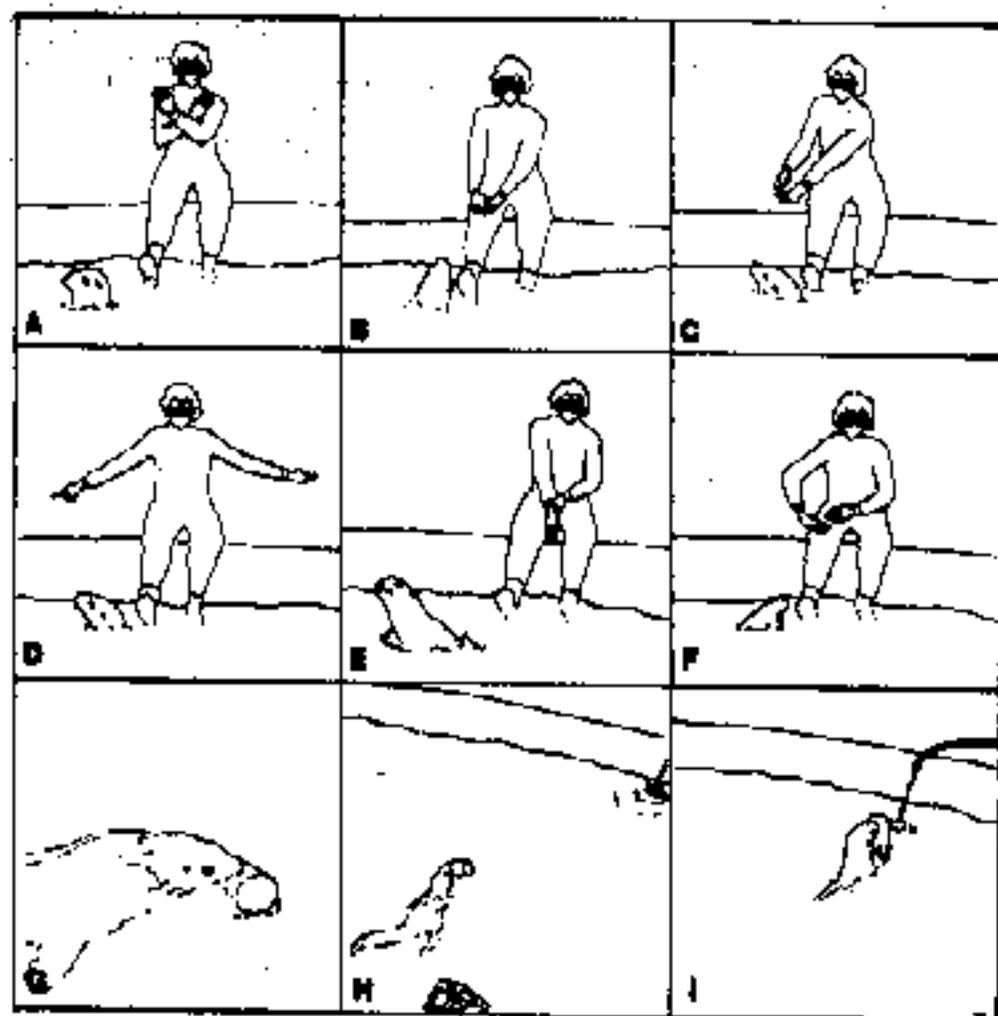
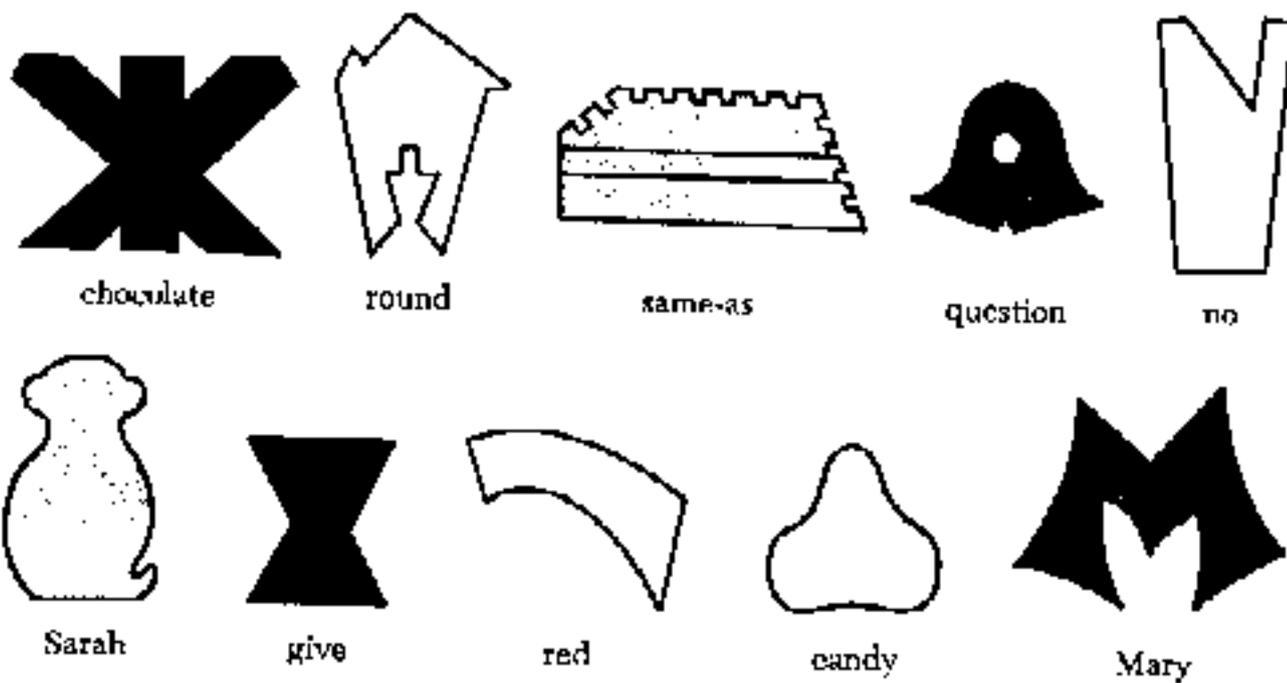


Figure 1. Example of a standard sign combination and response for the sea lion Rocky. (The complete sign sequence is WATER, WHITE SMALL BOTTLE FETCH. The general combinatorial form is O-p-M-M-O-A. A. The object sign WATER is given, and Rocky turns to search for the object. B. The signaler pauses between the signs designating the two separate objects in the relational sign combination; Rocky remains at station, awaiting the next sign. C. The modifier WHITE is given, and although Rocky turns slightly to her left, she does not scan the pool area. D. The modifier SMALL is given, and again, Rocky turns slightly to her left but does not scan the pool area. E. The object sign BOTTLE is given, and Rocky searches for the object designated by the combined modifier and object signs [WHITE SMALL BOTTLE]. F. The action sign FETCH is given, and Rocky remains at station until released by the signaler's foot drop. G. Rocky goes to the bottle and has started to move it while scanning the pool for the destination or goal item, in this case, a stream of water. H. Rocky approaches the stream of water while pushing the bottle. I. Rocky places the bottle in contact with the stream of water, a correct, reinforced response to the sign combination.)

FEATURES ANALYSES OF APPLE AND "APPLE"

	+	-	OBJECT		WORD
			+		+
			+		+
			+		+
			-		-

these features, one at a time, to four caged juvenile chimpanzees. His star pupil was Sarah, who began her language training at the age of four.



Some examples of plastic "words" from Sarah's language

(PREMACK et al. 1970)

Premack's strategy for teaching Sarah was a model of simplicity. Sarah and her teacher sat across from each other, Sarah in her cage and

Jensvold, M. L. A., & Gardner, R. A. (2000). Interactive use of sign language by cross-fostered chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, 114(4), 335-346.

Transcriptions of signs

An 'X' following a gloss (e.g. GIMMEX) indicates immediate **repetition** of the sign.

A question mark (?) following a sign indicates a questioning inflection.

A slash (/) following a sign indicates judgment of an utterance boundary according to rules used in the Gardners' laboratory (page 336)

The time values in the lefthand column indicate hours:minutes:seconds from the beginning of the videotape that was being transcribed.

Washoe and Dar are the names of two of the 4 chimpanzees studied.

Trial #3	(page 337)	<i>Example 1 in lecture</i>
1:04:35	Washoe:	ME GIMMEX/
1:04:40	Probe 1:	questioning expression
1:04:41	Washoe	GIMME/
1:04:49	Probe 2	WHAT?/
1:04:51	Washoe	MEX GIMMEX/
1:04:54	Probe 3	NOT UNDERSTAND?
1:04:56	Washoe	FOOD GIMME/

<i>Trial #5</i>	<i>(page 338)</i>	<i>Example 3 in lecture</i>
0:08:46	Washoe:	FRUIT GIMMEX/
0:08:49	Probe 1:	WHO FUNNY?
0:08:51	Washoe	ROGER/
0:08:54	Probe 2	WHERE CAT?/
0:08:56	Washoe	ROGER GIMMEX/
0:09:03	Probe 3	WHERE CAT?
0:09:05	Washoe	GIMMEX/

Bodamer, M. D., & Gardner, R. A. (2002). How cross-fostered chimpanzees (*Pan troglodytes*) initiate and maintain conversations. *Journal of Comparative Psychology*, 116(1), 12-26.

Probe 1. This was the single sign WHAT?/

Example

Tatu: PERSON TIME/

Probe1: WHAT?/

Tatu: FOOD TIME FOOD TATU/

Probe 2. The interlocutor followed the chimpanzee's rejoinder to Probe 1 with one of four different types of probes — WHAT, on topic, affirmative, or denial.

e.g. 4. Denial

Example

Washoe: FLOWER GIMME FLOWER FRUIT FLOWER HUG HURRY/

Probe 2: NO SORRY CAN'T/

Washo: FLOWERX/

Lecturer's comments

Although these exchanges are interpreted as "conversations" they could alternatively be described as repeated goal oriented conditioned responses reinforced by tangible outcomes.