

# GESTURAL COMMUNICATION AND APE LANGUAGE PROJECTS



Primate Social Behavior  
22 October 2020

# WIKIPEDIA

- Sandbox edits due tomorrow by midnight



# TODAY

- Great ape gestural communication
  - Production and meaning
  - Theories of acquisition
- Ape language projects

# GESTURAL COMMUNICATION

- Not anatomically constrained like vocal production
- Produced in social settings, not predator contexts
- Learned signals?



# WHAT IS A GESTURE?

- Movement of hands or body
- Mechanically ineffective
- Produced to achieve a goal (i.e., first-order intentional signal)



# WHAT IS A GESTURE?



# IS THIS GESTURAL COMMUNICATION?



Video credit: The Great Ape Dictionary



# EVIDENCE OF GOAL-BASED COMMUNICATION

- Persistence
- Elaboration



# PERSISTENCE AND ELABORATION

**Table 2** Composition of gestures within sequences, the response obtained to the first and second gestures in the sequence and categorisation of the response to the first gesture ( $N$  = number of cases)

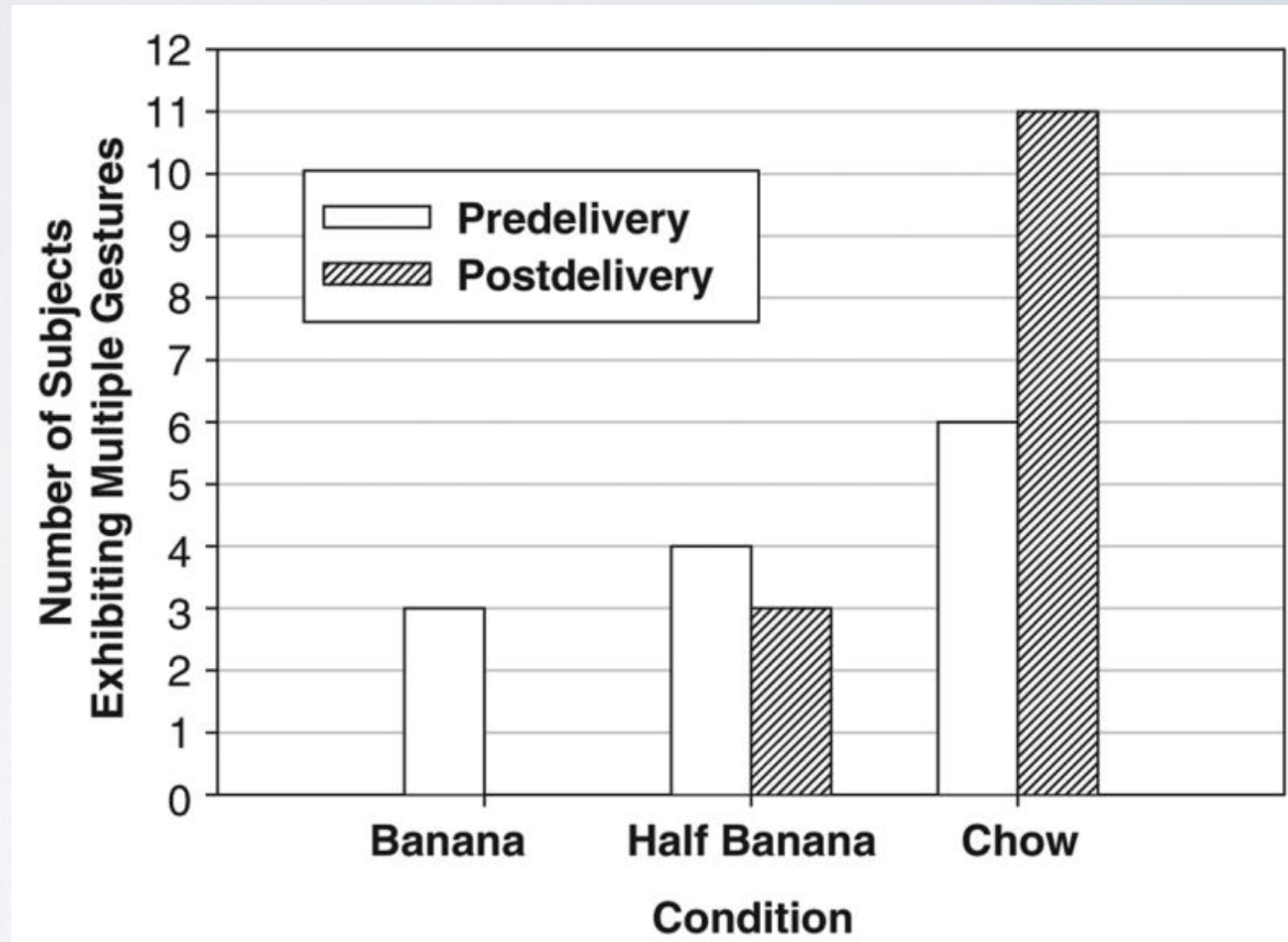
| Gesture 1<br>( $N$ ) | Goal (dominant<br>response) | Response 1               | Goal<br>match | Persistence<br>(modality) | Gesture 2             | Response 2             | Gestures 3–5                   |
|----------------------|-----------------------------|--------------------------|---------------|---------------------------|-----------------------|------------------------|--------------------------------|
| Arm flap             | Move away                   | Half move body<br>away   | Partial       | Repetition                | Arm flap              | Move body<br>away      |                                |
| Arm flap             | Move away                   | Appeasement              | None          | Elaboration<br>(v)        | Lunge                 | Appeasement            | Lunge, hit object              |
| Arm flap (2)         | Move away                   | Stop approach, sit       | None          | None                      |                       |                        |                                |
| Arm raise            | Receive groom               | Move towards<br>back     | None          | Repetition                | Arm raise             | Move towards<br>back   |                                |
| Backward<br>sweep    | Climb on back               | Attempt to climb<br>on   | Partial       | Repetition                | Backward<br>sweep     | Attempt to climb<br>on | Backward sweep,<br>brief touch |
| Backward<br>sweep    | Climb on back               | Continue activity        | None          | Elaboration<br>(v)        | Quadrupedal<br>run    | Continue<br>activity   |                                |
| Backward<br>sweep    | Climb on back               | Continue activity        | None          | None                      |                       |                        |                                |
| Elbow raise          | Approach signaller          | Half approach            | Partial       | Repetition                | Elbow raise           | Approach<br>signaller  |                                |
| Limp extend          | Body part for<br>grooming   | Partial groom<br>present | Partial       | Repetition                | Limp extend           | Groom present          |                                |
| Limp extend          | Body part for<br>grooming   | Continue activity        | None          | Elaboration<br>(t)        | Brief touch           | Sit                    | Brief touch                    |
| Limp extend          | Body part for<br>grooming   | Continue activity        | None          | Elaboration<br>(v)        | Stationary<br>peering | Continue<br>activity   |                                |
| Limp extend          | Body part for<br>grooming   | Continue activity        | None          | None                      |                       |                        |                                |

**Communicative intentions in wild chimpanzees: persistence and elaboration in gestural signalling**

Anna Ilona Roberts · Sarah-Jane Vick ·  
Hannah M. Buchanan-Smith

# PERSISTENCE AND ELABORATION

- Chimpanzees produce additional gestures when goal isn't met



Leavens et al. (2005)



# MEANING IN GESTURE

- One gesture for many goals
- Many gestures for one goal
- Semantically vague

Table 2. Primary or Secondary Gesture Meanings, Excluding Play

| Apparently Satisfactory Outcome        | N <sub>1</sub> (Primary) | N <sub>1+2</sub> (Primary or Secondary) | N <sub>1+2+3</sub> (Primary, Secondary, or Tertiary) |
|--|--------------------------|---|--|
| "Stop that"                            | 9                        | 16                                      | 20   |
| "Move away"                            | 7                        | 13                                      | 14   |
| "Contact"                              | 4                        | 7                                       | 10   |
| "Acquire object"                       | 4                        | 5                                       | 8  |
| "Follow me"                            | 3                        | 6                                       | 10   |
| "Move closer"                          | 3                        | 6                                       | 8  |
| "Sexual attention" (to male)           | 3                        | 5                                       | 7  |
| "Climb on me"                          | 2                        | 4                                       | 6  |
| "Initiate grooming"                    | 1                        | 3                                       | 4  |
| "Sexual attention" (to female)         | 1                        | 2                                       | 2  |
| "Reposition body"                      | 1                        | 2                                       | 2  |
| "Attend to specific location"          | 1                        | 1                                       | 1  |
| "Travel with me" (adult)               | 0                        | 2                                       | 2  |
| "Climb on you" <sup>a</sup>            | 0                        | 0                                       | 1  |
| "Travel with me" (infant) <sup>a</sup> | 0                        | 0                                       | 0  |

The apparently satisfactory outcome (ASO, as defined in [Table S1](#); see [Table S3](#) for data) listed in order of the number of gesture types (N) to which they are associated as the primary, then secondary, or tertiary ASO for each gesture type.

<sup>a</sup>These two ASOs were recorded only as the tertiary or even less frequent outcome of a gesture type, as used by the community as a whole. However, their use was necessarily limited to young infant signalers; evidently they would be more prominently represented in a study of infant gesturing.

# MEANING IN GESTURE

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- Many gestures for one goal
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**There will be a question on the next quiz about the Graham et al. (2018) reading**

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| "Contact"                              | 4                        | 7                                       | 10   |
| "Acquire object"                       | 4                        | 5                                       | 8  |
| "Follow me"                            | 3                        | 6                                       | 10   |
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# TWO THEORIES OF ACQUISITION

- Ontogenetic ritualization
- Innate repertoire

# PHYLOGENETIC RITUALIZATION





# ONTOGENETIC RITUALIZATION

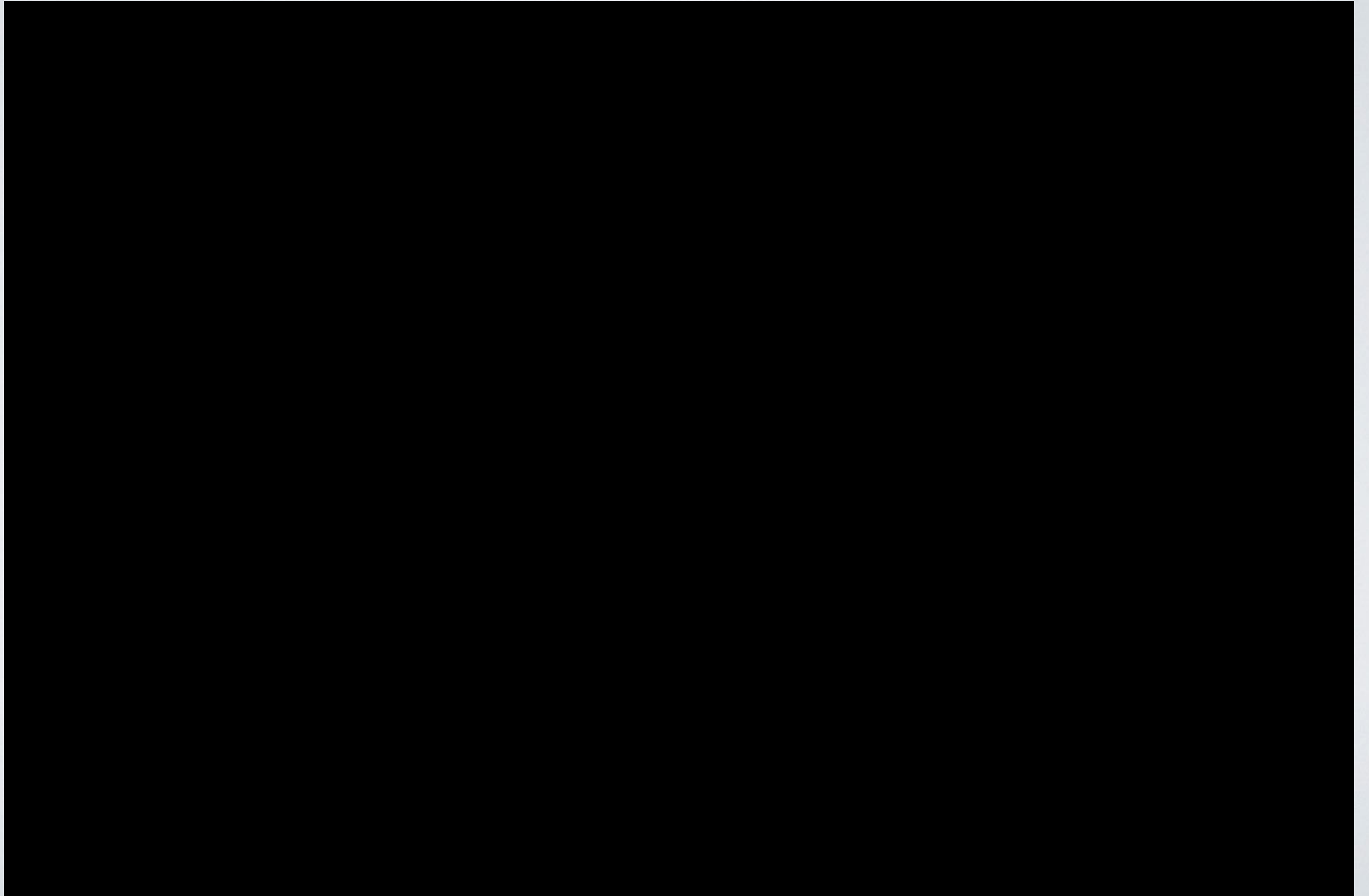
- Initial part of a behavior becomes signal for entire behavior
- ex. Play initiated by hitting partner on head —> Raising arm as if to hit partner on head becomes gesture used to initiate play

# PREDICTIONS OF TWO APPROACHES

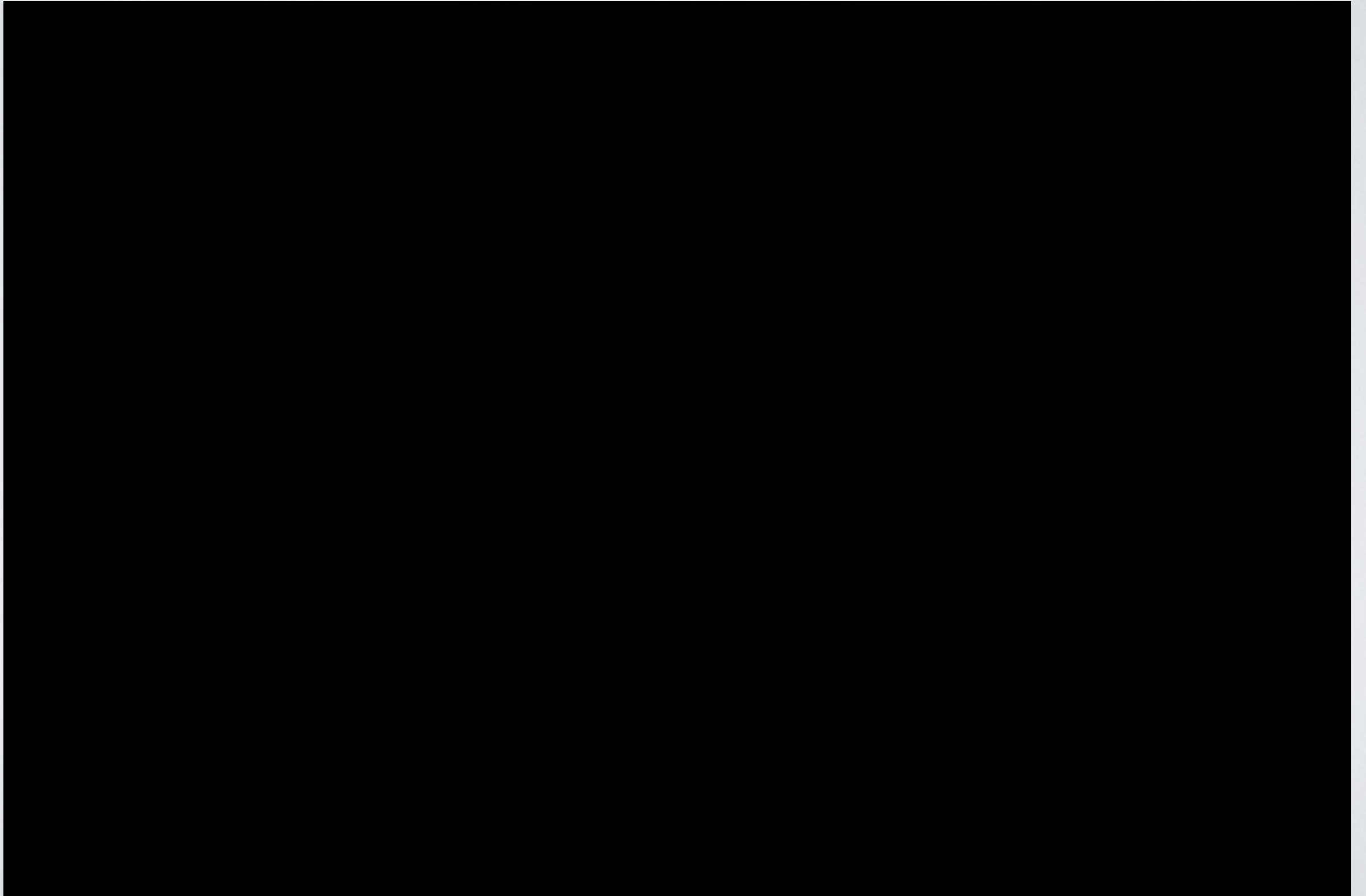
- Idiosyncrasies (ontogenetic ritualization)
- Asymmetry (ontogenetic ritualization)
- Overlap between species (innate repertoire)



# MOTHER-INFANT TRAVEL

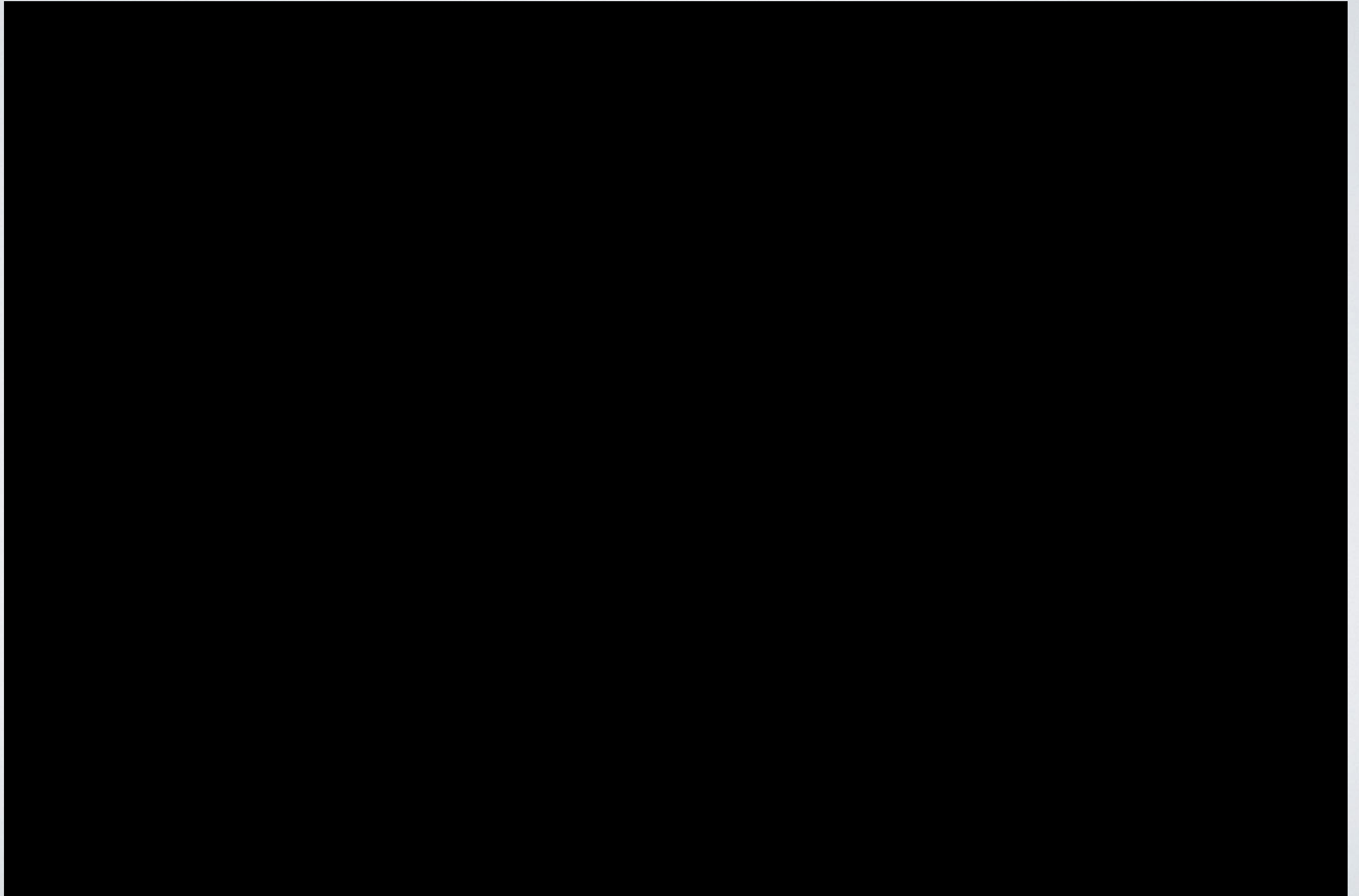


# MOTHER-INFANT TRAVEL





# MOTHER-INFANT TRAVEL



# ASYMMETRIC GESTURES

- Mothers and infants use different gestures

**Table 4** Carry gestures exhibited by mothers and infants

| Gesture modality | Gestures       | Mothers<br>( <i>N</i> = 10) | Infants<br>( <i>N</i> = 10) |
|------------------|----------------|-----------------------------|-----------------------------|
| Tactile          | Grab           | ✓                           | ✓                           |
|                  | Touch          | ✓                           | ✓                           |
| Visual           | Raise limb(s)  | ✓                           | ✓                           |
|                  | Silent pout    |                             | ✓                           |
|                  | Spin body      |                             | ✓                           |
|                  | Spread legs    |                             | ✓                           |
|                  | Step foot      |                             | ✓                           |
|                  | Present back   | ✓                           |                             |
|                  | Present venter | ✓                           |                             |



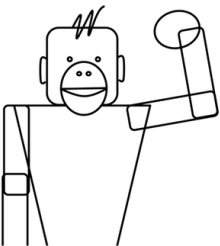
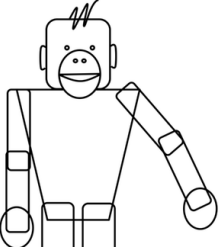
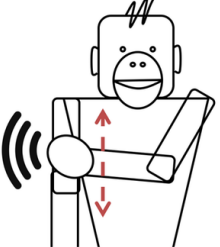
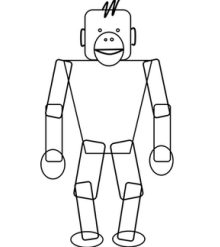
# IDIOSYNCRATIC GESTURES

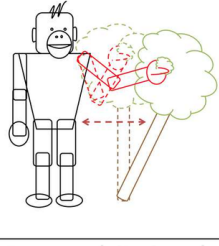
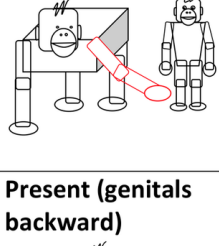
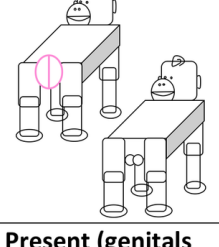
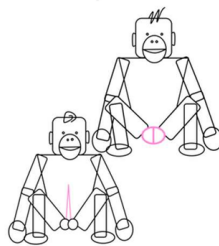
- Top 3 hangers only infants to use 'leg spread' gesture

**Table 5** Carries preceded by hanging

| Infant  | Percentage of agent-initiated carries in which the infant is hanging prior to initiation (%) |
|---------|--|
| Luiza   | 21.6   |
| Loto    | 8.9  |
| Fimi    | 7.4  |
| Kivu    | 6.4  |
| Habari  | 4.8  |
| Nayembi | 2.5  |
| Hongo   | 2.2  |
| Kalli   | 1.8  |
| Huenda  | 0  |
| Kesi    | 0  |

# OVERLAP BETWEEN SPECIES

| Gesture Type   | Bonobo ASOs  | Chimpanzee ASOs  |
|--|--|--|
| <b>Arm raise</b><br>          | <u>Climb on you</u> 34%<br>Initiate grooming 22%<br>Initiate copulation 20%<br>Initiate GG-rubbing 16%<br>Contact 6%<br>Climb on me 2%<br><br><i>Ambiguous</i><br><br>[9(50): f=3.13, df=12,96 p=0.0009] | Acquire object 48%<br>Move away 19%<br>Move closer 15%<br>Stop behaviour 11%<br><u>Climb on you</u> 7%<br><br><i>Ambiguous</i><br><br>[ $\chi^2=65.71$ , df=14 p<0.0001] |
| <b>Arm up</b><br>            | Contact 80%<br>Climb on me 20%<br><br><i>Tight</i><br><br>[3(15): f=85.14, df=12,24 p<0.0001]  | -  |
| <b>Big loud scratch</b><br> | <u>Initiate grooming</u> 100%<br><br><i>Tight</i><br><br>[10(41): f=893.1, df=12,108 p<0.0001]   | <u>Initiate grooming</u> 82% <sup>1</sup><br>Travel with me 16% <sup>1</sup><br>Follow me 2%<br>Climb on me 1%<br><br><i>Tight</i><br><br>[f=45.33, df=14, 238 p<0.001]  |
| <b>Bipedal stance</b><br>   | Initiate copulation 50%,<br>Initiate GG-rubbing 50%<br><br><i>Loose</i><br><br>[4(12): f=4.46, df=12,36 p=0.0002]  | -  |

| Gesture Type  | Bonobo ASOs   | Chimpanzee ASOs   |
|---|---|---|
| <b>Object Shake</b><br>                  | Initiate GG-rubbing 58%<br><u>Initiate grooming</u> 33%<br><u>Initiate copulation</u> 8%<br><br><i>Loose</i><br><br>[3(12): f=1.42, df=12,24 p=0.223] | Follow me 73%<br><u>Initiate copulation</u> 12% <sup>1</sup><br>Move away 8%<br>Stop behaviour 3%<br>Acquire object 2%<br>Move closer 2%<br><u>Initiate grooming</u> 1% <sup>1</sup><br><br><i>Tight</i><br><br>[f=7.68, df=14,168 p<0.001] |
| <b>Present (climb on)</b><br>           | <u>Climb on me</u> 100%<br><br><i>Tight</i><br><br>[7(34): f=4720, df=12,72 p<0.0001]   | <u>Climb on me</u> 100%<br><br><i>Tight</i><br><br>[f=1820.37, df=14,28 p<0.001]  |
| <b>Present (genitals backward)</b><br> | -   | "Present (sexual)" in Hobaiter & Byrne, 2014 includes "Present (genitals forward)" and "Present (genitals backward)"  |
| <b>Present (genitals forward)</b><br>  | Initiate GG-rubbing 64%<br><u>Initiate copulation</u> 36%<br><br><i>Loose</i><br><br>[41(45): f=64.47, df=12,480 p<0.0001]                            | <u>Initiate copulation</u> 74% <sup>1</sup><br>Contact 20%<br>Acquire object 4%<br>Initiate grooming 1% <sup>1</sup><br>Follow me 1%<br>Stop behaviour 1%<br><br><i>Tight</i><br><br>[f=50.80, df=14,238 p<0.001]                           |

90% overlap in form between chimpanzee and bonobos



# GESTURES: INNATE SIGNALS WITH FLEXIBLE USAGE

- Idiosyncrasies disappear as observation time increases
- Fewer idiosyncrasies in the wild
- Extensive overlap in gestural repertoires
- Ontogenetic Ritualization explains small portion of gestures

# GESTURES: INNATE SIGNALS WITH FLEXIBLE USAGE

- Production constrained
- Usage flexible
- Goal-oriented



# APE LANGUAGE PROJECTS





# APE LANGUAGE PROJECTS

- Acquisition
- Meaning
- Grammar
- Usage



# APE LANGUAGE PROJECTS

- 10-20 different projects (1920s-1990s)
- Remove constraints of vocal production
- Raise apes in a linguistic environment

# SPEECH-TRAINED APES





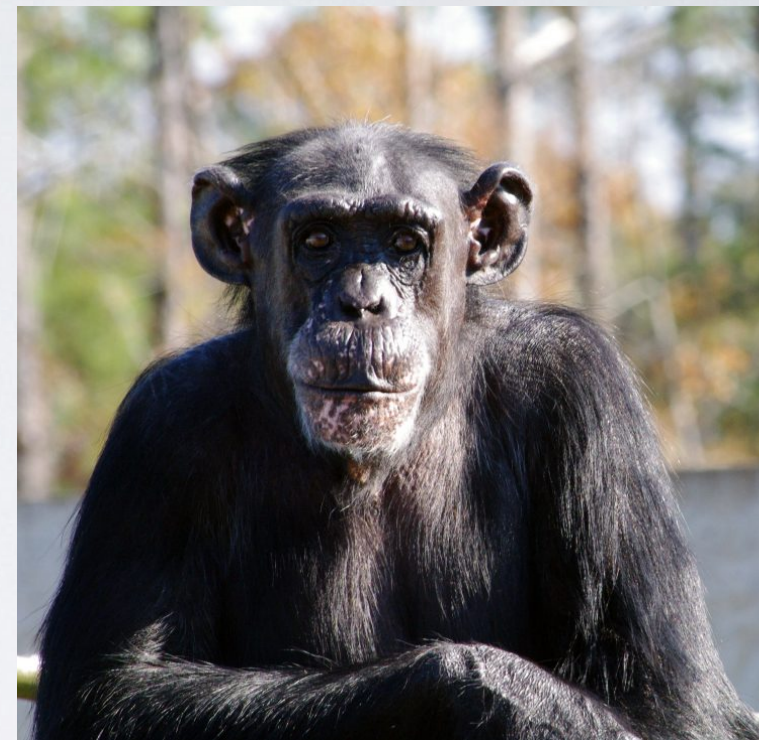
# APE LANGUAGE MODALITIES



Lexigram (Kanzi)



Sign language (Koko)



Tokens (Sarah)



# APE LANGUAGE ACQUISITION

- Word learning in apes analogous to word learning in children?



# APE LANGUAGE ACQUISITION



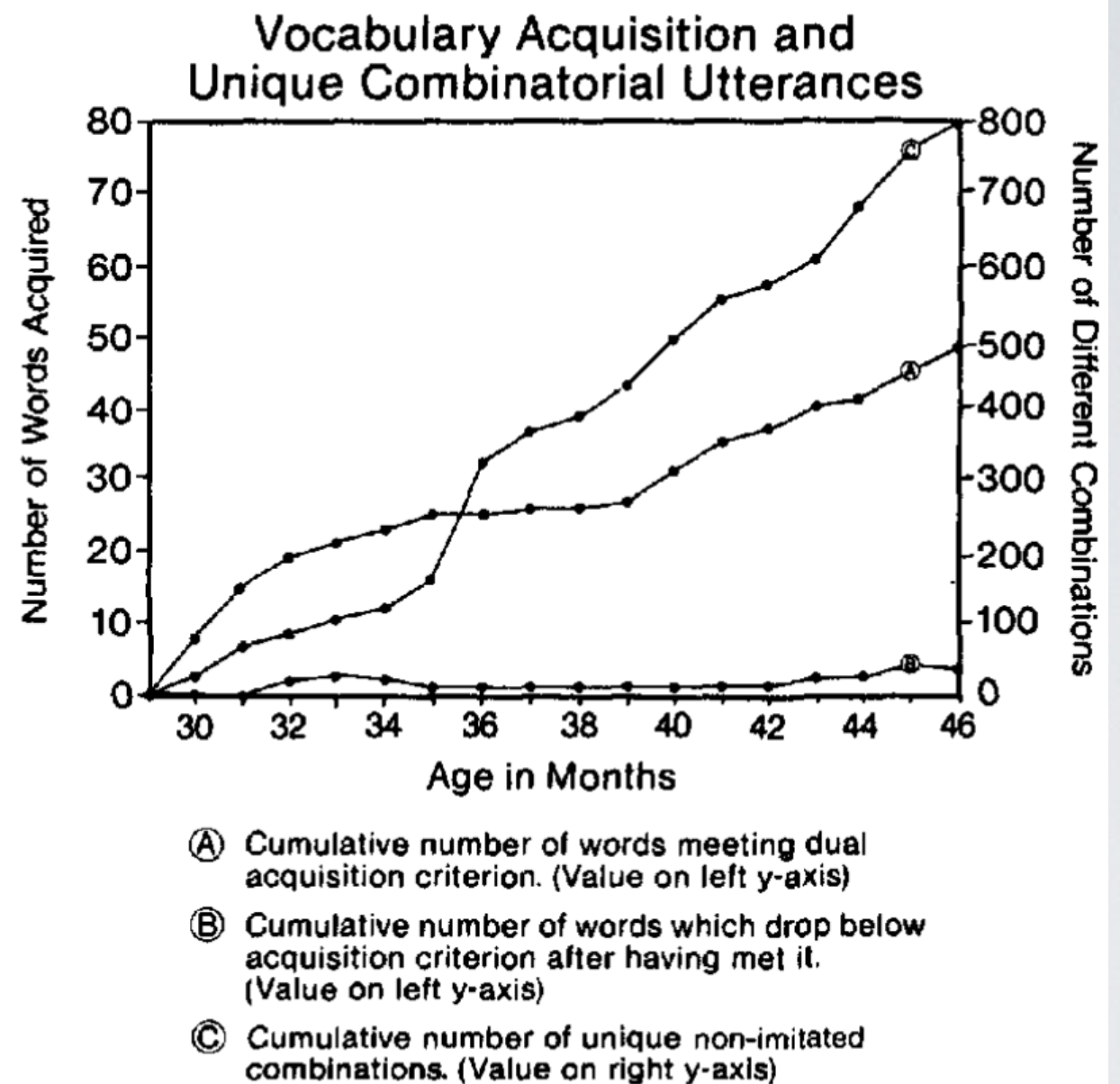
# APE LANGUAGE ACQUISITION





# VOCABULARY

- Hundreds of words
- Comprehension exceeds production



*Figure 1. Kanzi's acquisition of vocabulary items that met concordance criterion during the 17-month study period.*

Kanzi's vocabulary acquisition

# VOCABULARY

- Hundreds of words
- Comprehension exceeds production

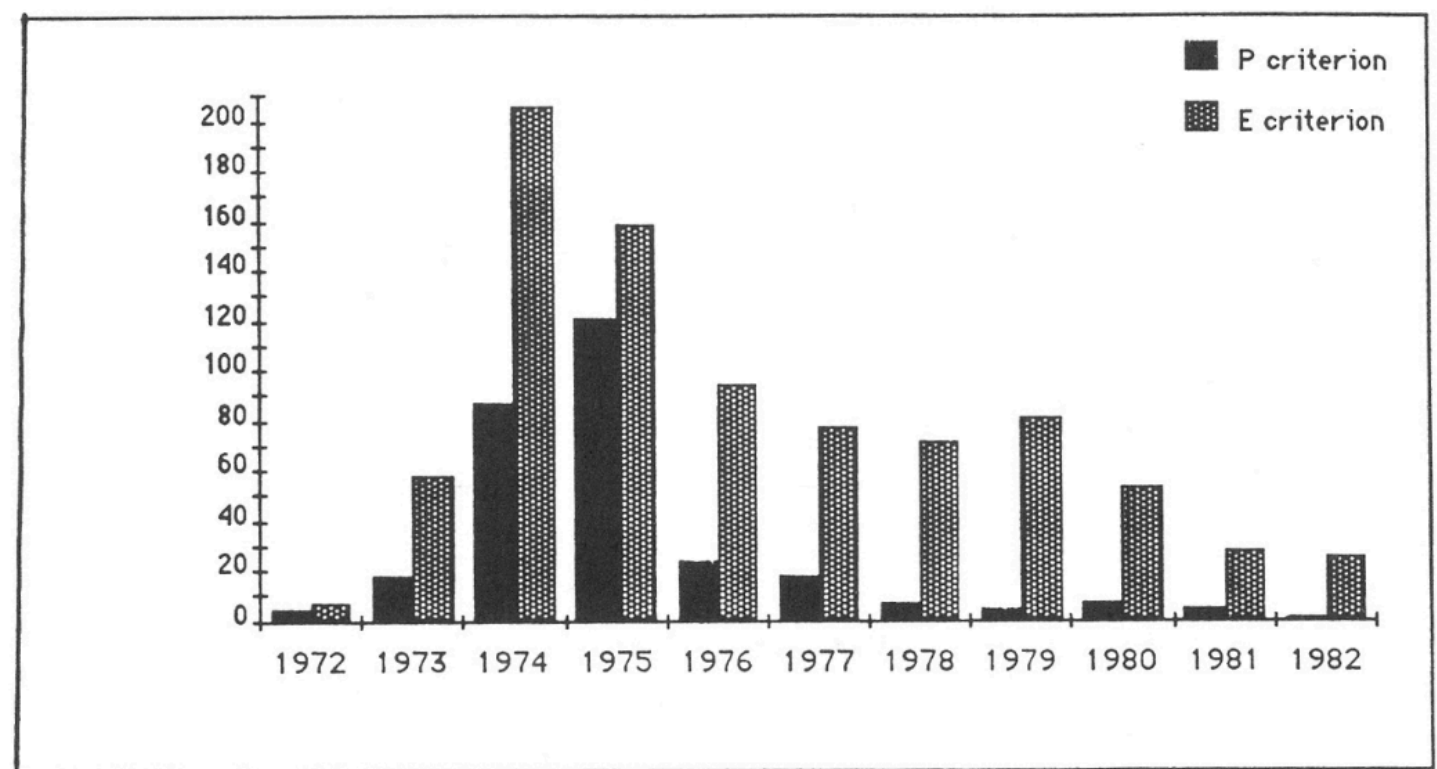


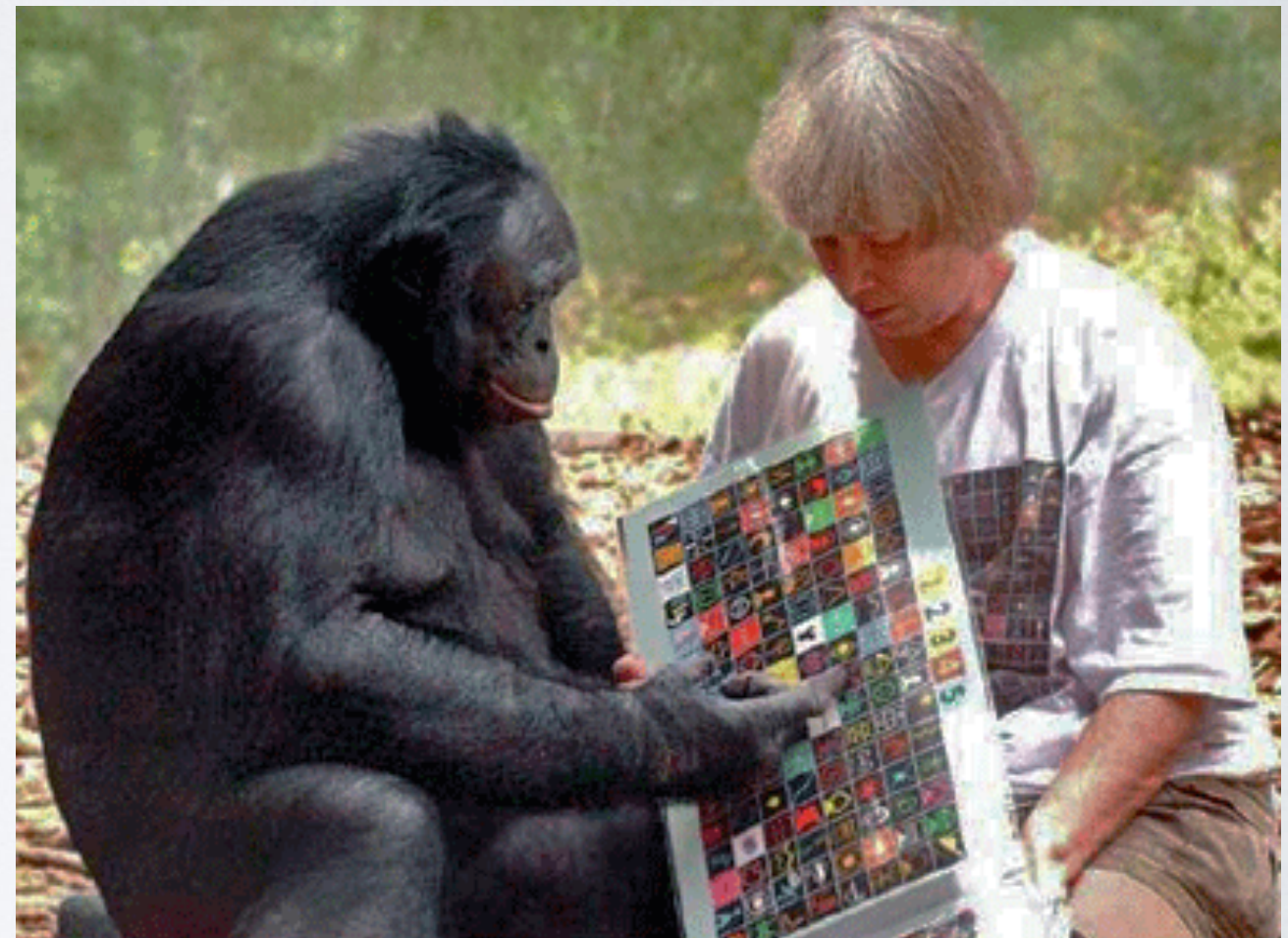
Figure 1. Number of new words added annually to Koko's vocabulary (P and E criteria) for the first ten years of Project Koko. Total distinct words: 290 words (P criterion) and 876 words (E criterion).

Koko's vocabulary acquisition




























# WHAT DO SIGNS/LEXICONS MEAN?

- Representational/symbolic?
- Learned association?













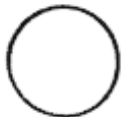

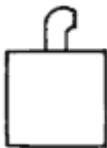

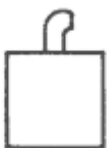
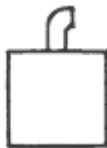
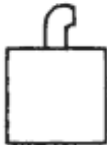



# SARAH'S SYMBOLS

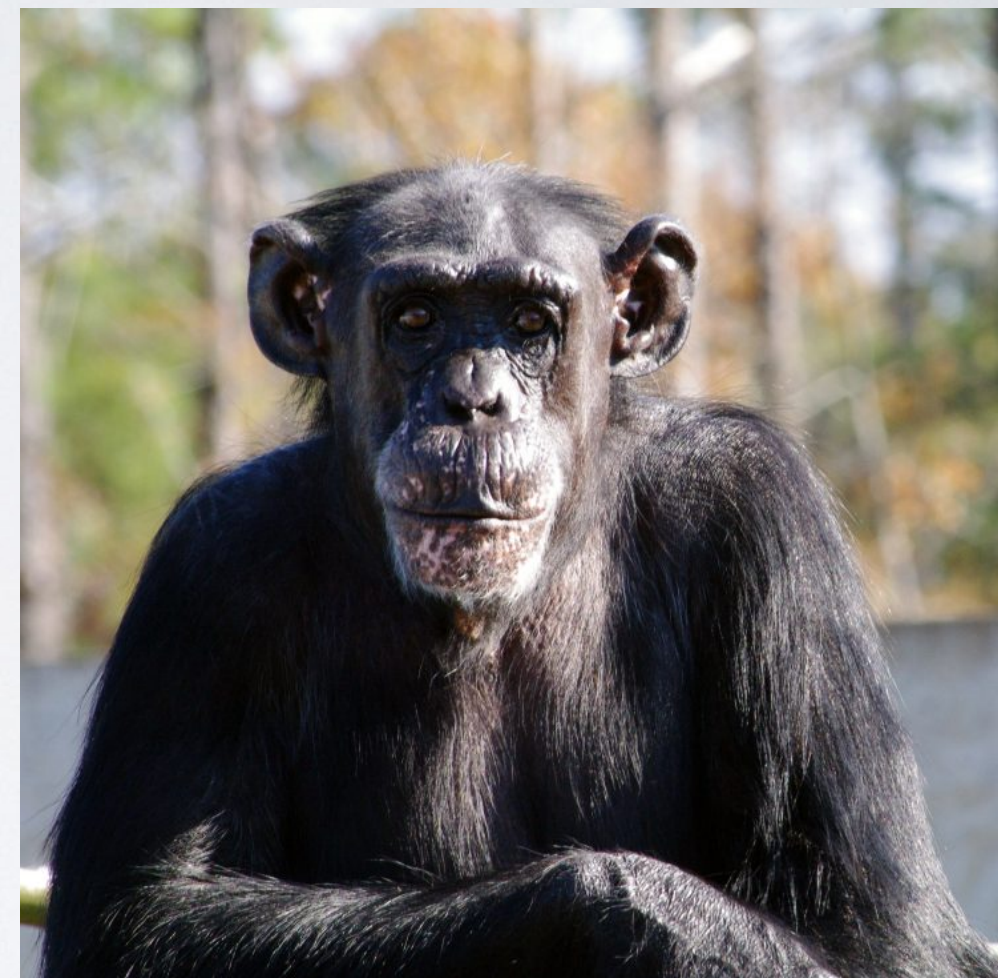
| NOUNS   |  |   |   |   |
|---|--|---|---|---|
|    |     |     |    |   |
| SARAH   | MARY   | PAIL  | DISH  |   |
|    |     |     |    |    |
| CHOCOLATE   | APPLE  | BANANA  | APRICOT   | RAISIN  |
| VERBS   |  |   |   |   |
|  |   |    |  |  |
| IS  | GIVE   | TAKE  | INSERT  | WASH  |
| CONCEPTS/CONDITIONALS   |  |   |   |   |
|  |  |  |   |   |
| SAME  | DIFFERENT  | NO-NOT  |   |   |
|  |   |  |  |   |
| NAME OF   | COLOR OF   | ?   | IF-THEN   |   |
| ADJECTIVES (COLORS)   |  |   |   |   |
|  |   |  |  |   |
| RED   | YELLOW   | BROWN   | GREEN   |   |





# SARAH'S SYMBOLS

| ALTERNATIVE FEATURES  |   |    |    |
|---|---|---|---|
|    |    |     |    |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |



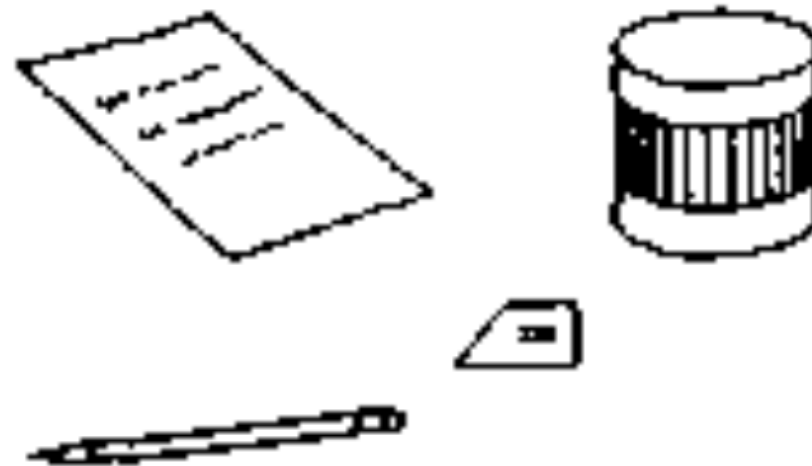
**FEATURE ANALYSIS** of an actual apple and the plastic word for “apple” was conducted. Sarah was shown an apple or the word and made to choose from alternative features: red or green, round or square, square with stem or plain square and square with stem or round. Sarah gave plastic word for “apple” same attributes she had earlier assigned to apple.

# SARAH'S ANALOGIES

**Problem A**



**Problem B**





# SARAH'S ANALOGIES

Table A5  
*Stimuli in Experiment 3B*

| Trial | A                    | A'            | B                    | B'            | C             | Sarah's choice |
|-------|----------------------|---------------|----------------------|---------------|---------------|----------------|
| 1A    | apple peel           | peeled apple  | orange peel          | peeled orange | —             | same           |
| 1B    | apple peel           | peeled apple  | orange peel          | —             | orange seed   | diff           |
| 1C    | apple peel           | peeled apple  | orange peel          | —             | peeled banana | diff           |
| 2A    | wet wood             | water sprayer | wet, cut paper       | bowl of water | —             | same           |
| 2B    | wet wood             | water sprayer | wet, cut paper       | —             | scissors      | diff           |
| 2C    | wet wood             | water sprayer | wet, cut paper       | —             | wet plant     | diff           |
| 3A    | closed can           | can opener    | painted, closed lock | key           | —             | same           |
| 3B    | closed can           | can opener    | painted, closed lock | —             | paint brush   | diff           |
| 3C    | closed can           | can opener    | painted, closed lock | —             | door knob     | diff           |
| 4A    | painted, sanded wood | sandpaper     | marked, erased paper | eraser        | —             | same           |
| 4B    | painted, sanded wood | sandpaper     | marked, erased paper | —             | pencil        | diff           |
| 4C    | painted, sanded wood | sandpaper     | marked, erased paper | —             | peeler        | diff           |

# GRAMMATICAL COMPREHENSION

**“Put the hat on the ball” vs “Put the ball on the hat”**

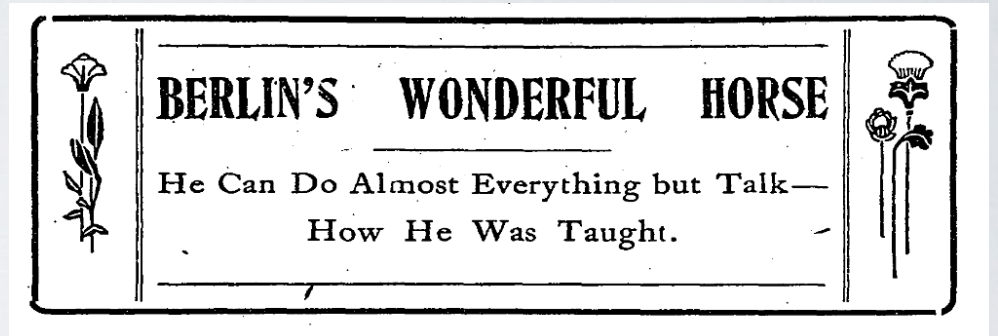


# GRAMMATICAL COMPREHENSION

## **“Put the hat on the ball” vs “Put the ball on the hat”**

- Kanzi correctly performed both sets of actions 74% of the time (compared to 65% for 2-year-old child)

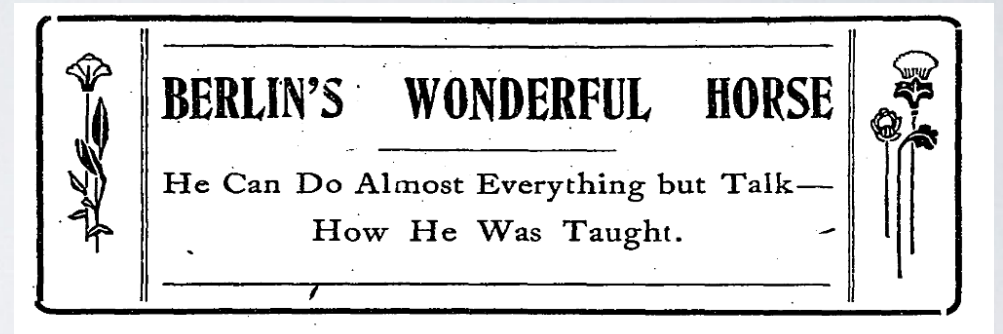
# CLEVER HANS



If the eighth day of the month comes on a Tuesday, what is the date of the following Friday?



# CLEVER HANS



If the eighth day of the month comes on a Tuesday, what is the date of the following Friday?

- Social genius; bad at math



# GRAMMATICAL COMPREHENSION





# GRAMMATICAL PRODUCTION

- Production: Kanzi uses V-O construction in 66% of instances
- Variation doesn't seem to alter meaning

# GRAMMATICAL PRODUCTION

- Nim Chimpsky no preferences for O-V or V-O constructions

**Table 3**  
*Comparison of Most Frequent Combinations*

| Kanzi              | Nim         |
|--------------------|-------------|
| 2 items            |             |
| Chase person(g)    | Play me     |
| Person(g) chase(g) | Me Nim      |
| Chase(g) Person(g) | Ticle me    |
| Person(g) pat(g)   | Eat Nim     |
| Chase bite         | More eat    |
| Chase Kanzi        | Me eat      |
| Person(g) come(g)  | Nim eat     |
| Tickle ball        | Finish hug  |
| Bite person(g)     | Drink Nim   |
| Come(g) chase(g)   | More tickle |
| Ball tickle        | Sorry hug   |
| Chase Sue          | Tickle Nim  |
| Kanzi chase        | Hug Nim     |
| Surprise money     | More drink  |
| Bite chase         | Eat drink   |
| Pat(g) person(g)   | Banana me   |
| Kanzi grab         | Nim me      |
| Grab person(g)     | Sweet Nim   |
| Chase bite         | Me play     |
| Pat(g) this(g)     | Gum eat     |
| Chase come(g)      | Tea drink   |
| Person(g) go(g)    | Grape eat   |
| Ball pat(g)        | Hug me      |
| Person(g) bite     | Banana Him  |
| Chase tickle       | In pants    |

3 items

Chase person 1(g) person2(g)  
 Person 1(g) pat(g) person2(g)  
 Person 1(g) person2(g) pat(g)  
 Person 1(g) chase person2(g)  
 Person 1(g) grab person2(g)  
 Person 1(g) chase(g) person2(g)  
 Person 1(g) person2(g) chase  
 Kanzi chase person(g)  
 Chase bite person(g)  
 Person(g) chase Kanzi  
 Person 1(g) grab(g) person2(g)  
 Chase grab person(g)  
 Person(g) chase Kanzi  
 Person 1(g) person2(g) bite  
 Chase Kanzi person(g)  
 Person 1(g) tickle person2(g)  
 Person(g) Kanzi chase  
 Person 1(g) tickle person2(g)  
 Kanzi person(g) chase  
 Chase five Kanzi  
 Chase person(g) Kanzi  
 Pat(g) person 1(g) person2(g)  
 Bite chase person(g)  
 Person 1(g) person2(g) chase(g)  
 Sue bite person(g)

Play me Nim  
 Eat me Nim  
 Eat Nim eat  
 Tickle me Nim  
 Grape eat Nim  
 Banana Nim eat  
 Nim me eat  
 Banana eat Nim  
 Eat me eat  
 Me Nim eat  
 Hug me Nim  
 Yogurt Nim eat  
 Me more eat  
 More eat Nim  
 Finish hug Nim  
 Banana me eat  
 Nim eat Nim  
 Tickle me tickle  
 Apple me eat  
 Eat Nim me  
 Give me eat  
 Nut Nim nut  
 Drink me Nim  
 Hug me hug  
 Sweet Nim sweet



# USAGE: WHAT DO THEY TALK ABOUT?

- 96% imperatives
- Mostly about play and food

**Table 3**  
*Comparison of Most Frequent Combinations*

| Kanzi              | Nim         |
|--------------------|-------------|
| 2 items            |             |
| Chase person(g)    | Play me     |
| Person(g) chase(g) | Me Nim      |
| Chase(g) Person(g) | Tickle me   |
| Person(g) pat(g)   | Eat Nim     |
| Chase bite         | More eat    |
| Chase Kanzi        | Me eat      |
| Person(g) come(g)  | Nim eat     |
| Tickle ball        | Finish hug  |
| Bite person(g)     | Drink Nim   |
| Come(g) chase(g)   | More tickle |
| Ball tickle        | Sorry hug   |
| Chase Sue          | Tickle Nim  |
| Kanzi chase        | Hug Nim     |
| Surprise money     | More drink  |
| Bite chase         | Eat drink   |
| Pat(g) person(g)   | Banana me   |
| Kanzi grab         | Nim me      |
| Grab person(g)     | Sweet Nim   |
| Chase bite         | Me play     |
| Pat(g) this(g)     | Gum eat     |
| Chase come(g)      | Tea drink   |
| Person(g) go(g)    | Grape eat   |
| Ball pat(g)        | Hug me      |
| Person(g) bite     | Banana Him  |
| Chase tickle       | In pants    |

## 3 items

Chase person 1(g) person2(g)  
 Person 1(g) pat(g) person2(g)  
 Person 1(g) person2(g) pat(g)  
 Person 1(g) chase person2(g)  
 Person 1(g) grab person2(g)  
 Person 1(g) chase(g) person2(g)  
 Person 1(g) person2(g) chase  
 Kanzi chase person(g)  
 Chase bite person(g)  
 Person(g) chase Kanzi  
 Person 1(g) grab(g) person2(g)  
 Chase grab person(g)  
 Person(g) chase Kanzi  
 Person 1(g) person2(g) bite  
 Chase Kanzi person(g)  
 Person 1(g) tickle person2(g)  
 Person(g) Kanzi chase  
 Person 1(g) tickle person2(g)  
 Kanzi person(g) chase  
 Chase five Kanzi  
 Chase person(g) Kanzi  
 Pat(g) person 1(g) person2(g)  
 Bite chase person(g)  
 Person 1(g) person2(g) chase(g)  
 Sue bite person(g)

Play me Nim  
 Eat me Nim  
 Eat Nim eat  
 Tickle me Nim  
 Grape eat Nim  
 Banana Nim eat  
 Nim me eat  
 Banana eat Nim  
 Eat me eat  
 Me Nim eat  
 Hug me Nim  
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 Me more eat  
 More eat Nim  
 Finish hug Nim  
 Banana me eat  
 Nim eat Nim  
 Tickle me tickle  
 Apple me eat  
 Eat Nim me  
 Give me eat  
 Nut Nim nut  
 Drink me Nim  
 Hug me hug  
 Sweet Nim sweet

USAGE: WHAT DO THEY TALK ABOUT?



# USAGE: WHAT *DON'T* THEY TALK ABOUT?

- Declarative sentences or questions
- Perspectival construction
- e.g., 'I broke the vase' vs 'the vase was broke'
- Indication of new vs old knowledge
- e.g., 'Fred broke the window.' "NO, it was Joe."

# WHAT DID THE APE LANGUAGE PROJECTS TELL US?

- Despite removing constraints on production, results appear similar to natural vocal and gestural communication
  - Signals are representational
  - Signals are goal-oriented
  - Scant evidence of second-order intentionality



# HUMAN VS. PRIMATE COMMUNICATION: KEY DISTINCTIONS

- Absent in non-human primate communication:
  - Desire to inform, share information
  - Common conceptual ground
  - Recursive mind-reading

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**All central to human communication**

**All depend on Theory of Mind**

# HUMAN VS. PRIMATE COMMUNICATION: KEY DISTINCTIONS

**“Look at X”    vs    “Gimme X”**



Questions?