

# DIFFERENCES AND SIMILARITIES BETWEEN THE NATURAL GESTURAL COMMUNICATION OF THE GREAT APES AND HUMAN CHILDREN

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The majority of studies on animal communication provide evidence that gestural signaling plays an important role in the communication of nonhuman primates and resembles that of pre-linguistic and just-linguistic human infants in some important ways. However, ape gestures also differ from the gestures of human infants in some important ways as well, and these differences might provide crucial clues for answering the question of how human language –at least in its cognitive and social-cognitive aspects– evolved from the gestural communication of our ape-like ancestors. The present manuscript summarizes and compares recent studies on the gestural signaling of the great apes (*Gorilla gorilla*, *Pan paniscus*, *Pan troglodytes*, *Pongo pygmaeus*) to enable a comparison with gestures in children. We focused on the three following aspects: 1) nature of gestures, 2) intentional use of gestures, 3) and learning of gestures. Our results show, that apes have multifaceted gestural repertoires and use their gestures intentionally. Although some group-specific gestures seem to be acquired via a social learning process, the majority of gestures are learned via individual learning. Importantly, all of the intentional produced gestures share two important characteristics that make them crucially different from human deictic and symbolic gestures: 1) they are almost invariably used in dyadic contexts and 2) they are used exclusively for imperative purposes. Implications for these differences are discussed.

## 1. Introduction

One of the enduring questions is how spoken language, which is thought to be unique to humans, originated and evolved. One important way to address this question is to compare speech to the systems of vocal communication evolved in other animals, especially in non-human primates (hereafter primates) (e.g., Marler, 1977; Seyfarth, 1987; Snowdon, 1988; Zuberbühler, 2003).

The majority of studies investigated vocal communication and revealed that call morphology and call usage seem to have only limited flexibility (Liebermann, 1998; Corballis, 2002). However, recent data provided evidence that vervet monkeys use different alarm calls in association with different predators (leading to different escape responses in receivers) and therefore raised the possibility that some nonhuman species may, like humans, use vocalizations to make reference to outside entities (Cheney & Seyfarth, 1990). But it has turned out since then that alarm calls of this type have arisen

numerous times in evolution in species that also must organize different escape responses for different predators, including most prominently prairie dogs and domestic chickens (Owings & Morton, 1998). And importantly, there is currently no evidence that any species of ape has such referent specific alarm calls or any other vocalizations that appear to be referential (Cheney & Wrangham, 1987; however see Crockford & Boesch, 2003 for context specific calls). This implies that it is highly unlikely that alarm calls of monkeys could be the direct precursor of human language - unless at some point apes used similar calls and have now lost them.

Interestingly, gestural or ideographic communication systems have to some extent been mastered by human-reared great apes (e.g. Gardner, et al, 1989; Savage-Rumbaugh, et al, 1993). Though by no means 'language', these projects have shown intentional, referential use of numerous gestures and ideograms (Gardner, et al., 1989; Savage-Rumbaugh, 1986), accurate usage under double-blind conditions, and understanding of human speech. These findings support the hypothesis that the evolutionary roots of language might have evolved in the visual-gestural modality (e.g., Condillac, 1971; Hewes, 1976; Armstrong et al., 1995; Dunbar, 1996; Arbib, 2002). In addition, recent studies provide evidence that gestural signaling plays an important role in the natural communication of primates and resembles that of prelinguistic and just-linguistic human infants (Plooi, 1978, Tomasello et al., 1985). However, ape gestures also differ from the gestures of human infants in some important ways, and these differences might provide crucial clues for answering the question of how human language -at least in its cognitive and social-cognitive aspects- evolved from the gestural communication of our ape-like ancestors. The question thus arises: what is the nature of the gestural communication of nonhuman primates, and how do they relate to human gestures and language?

The present manuscript is based on observations of the communicative signaling of the four great apes species (*Gorilla gorilla*, *Pan paniscus*, *Pan troglodytes*, *Pongo pygmaeus*). To enable a qualitative comparison with gestures in children, we focused on the three following aspects: First we investigated the nature of gestures by examining whether they are used dyadic, triadic, imperative (used to get another individual to help in attaining a goal, cf. Bates, 1976) and/or declarative (used to draw another's attention to an object or entity merely for the sake of sharing attention, cf. Bates, 1976).

Second, we investigated if apes use their gestures intentionally, focusing on the key characteristics for intentional communication in children (Piaget, 1952; Bates, 1976; Bruner, 1981), -a) means-ends dissociation and b) special sensitivity to the social context.

- A) Means-ends dissociation can be characterized by the flexible relation of signaling behavior and goal. An individual uses for instance a single gesture for several goals (touch for nursing and riding) or different gestures for the same goal (*slap ground* and *bodybeat* for play).

- B) Sensitivity to the social context: The sender performs a gesture toward a recipient for the purpose of communication. Evidence for specifically communicative intent includes the signaler's alternation of gaze between goal and recipient (Bates, 1979; observed in wild chimpanzees, Plooi, 1978), persistence to the goal, or adjustment to audience effects (Tomasello et al., 1997).

Our third goal concerned the learning of gestures by focusing on individual and group variability to distinguish between underlying social and individual learning processes. Following Tomasello and colleagues (Tomasello et al., 1994) similarities in the gestural repertoires within a group and group specific gestures would provide evidence for the existence of a social learning process, whereas individual differences that overshadow group differences (i.e., a lack of systematic group differences, idiosyncratic gestures) imply that an individual learning process is involved.

## 2. Methods

Two chimpanzee, two bonobo, two gorilla and two orangutan groups were observed in different European zoos. The communicative behavior of 46 subadult focal animals was videotaped for an average of 12.5hrs/individual (sampling rule: behavior sampling/focal animal sampling; recording rule: continuous recording). We analyzed an average of 1530 gestures per species.

## 3. Results

### *Gestural repertoire*

Based on auditory, tactile and visual components we formed three signal categories: auditory gestures generate sound while performed, tactile gestures include physical contact with the recipient, and visual gestures generate a mainly visual component with no physical contact.

Bonobos: The bonobos used 20 different distinct gestures: one auditory (5%), eight tactile (40%) and eleven visual gestures (55%). On average each individual used 11 gestures.

Chimpanzees: The chimpanzees used 28 different distinct gestures: three auditory (11%), nine tactile (32%), and 16 visual gestures. On average each individual used 9.5 gestures.

Gorillas: Overall the gorillas performed 33 different distinct gestures: six auditory (18%), 11 tactile (33%) and 16 visual gestures (49%). On average each individual used 20 gestures.

Orangutans: The orangutans used 26 different distinct gestures (see figure 1): 12 tactile and 14 visual gestures. On average each individual used 16 gestures.

The majority of these gestures were dyadic and imperative. Exceptions to this pattern were the gestures *move*, *peer* (bonobos), *palm-up* (chimpanzees), *move*, *object shake*, *peer*, *straw wave* (gorillas), *hold hand in front of the mouth*, *offer arm with food pieces*, *offer food*, *present object*, *shake object* (orangutans). These gestures although imperative, were clearly triadic since they involved an outside entity (food, object), the sender and the receiver.

#### *Intentional use of gestures*

Means-ends dissociation: The bonobos used on average in every context approximately two ( $\pm 0.6$ ) different gestures, the chimpanzees 3.2 ( $\pm 0.4$ ), the gorillas 3.2 ( $\pm 1$ ), and the orangutans 5.3 ( $\pm 1.2$ ) gestures. Concerning the use of gestures in different contexts, the bonobos utilized on average 2.7 ( $\pm 1.48$ ) gestures in more than one context, the chimpanzees 1.3 ( $\pm 0.2$ ), the gorillas 3.8 ( $\pm 2.6$ ), and the orangutans 1.5 ( $\pm 0.9$ ).

Sensitivity to the social context -adjustment to audience effects-: We found a significant difference between the use of tactile and visual gestures among all species based on a variation in the degree of visual attention of the recipient (Wilcoxon-test:  $P < 0.05$ , for further details see Liebal et al., 2004, Liebal et al., in review, Pika et al. 2003, Pika et al., 2005, Tomasello et al., 1994). There was no significant difference between the uses of auditory versus visual gestures and auditory versus tactile gestures. On average, the bonobos performed 79% ( $\pm 10$ ) of their visual gestures to an attending recipient, the chimpanzees 87% ( $\pm 2$ ), the gorillas 89% ( $\pm 12$ ), and the orangutans 98.8% ( $\pm 2$ ). However, tactile gestures were performed to an attending recipient in 50% (bonobos and chimpanzees,  $\pm 10$ ), 66% (gorillas,  $\pm 13$ ), and 67% (orangutans,  $\pm 10.3$ ).

#### *Learning of gestures*

Following Tomasello and colleagues (Tomasello et al., 1994) high levels of concordance of gestural repertoires within a group and group-specific gestures would provide evidence for the existence of a social learning process, whereas individual differences that overshadow group differences (i.e., a lack of systematic group differences, idiosyncratic gestures) imply that mainly an individual learning process is involved. To assess the degree of concordance in the performance of gestures between and within the two groups we used Cohen's Kappa statistics (see, Tomasello et al., 1997). The between and within-group Kappas of the bonobos (within-group Kappa: 0.5; between group Kappa: 0.45) and chimpanzees (within-group Kappa: 0.34; between group Kappa: 0.24) showed very low degrees of concordance (Altmann, 1991), the between and within-group Kappas of the orangutans (within-group Kappa: 0.7; between group Kappa: 0.68) 'moderate' levels of agreement, and the between and within-group Kappas of the gorillas showed an 'excellent' strength of agreement

(within-group Kappa: 0.8; between group Kappa: 0.72) (Altmann, 1991). All species showed similar degrees of concordances between and within-groups.

The bonobos and gorillas used three idiosyncratic gestures, the chimpanzees 13, and the orangutans two.

The bonobos and gorillas performed two group-specific gestures and the orangutans one. All group-specific gestures cannot be easily explained due to different physical conditions or different social settings.

#### **4. Discussion**

This manuscript aimed to provide a qualitative overview of the gestural communication of the great apes to enable a qualitative comparison with gestures in children. We focused on the three following aspects, 1) nature of gestures, 2) intentional use of gestures, and 3) major learning mechanism involved in the acquisition of gestures.

Overall, our results showed that apes have multifaceted gestural repertoires. The majority of these gestures were dyadic and imperative. However, some gestures to obtain food or to play with an object were used triadically.

Concerning the intentional use of gestures, all apes used their gestures flexibly, by utilizing one signal for several contexts and several signals for a single context. In addition, all four species adjusted the use of gestures to the attentional state of the recipient, preferentially performing visual gestures to an attending recipient. Therefore, we can conclude that apes communicate by using intentional acts identified through their flexible relation of signaling behavior and goal and the signaler's sensitivity to the social context.

Focusing on the learning of gestures, our data showed that the gorillas showed the highest level of concordances of gestural repertoires between and within-groups, the chimpanzees and bonobos the lowest. Furthermore, concordances in gestural repertoires between and within-groups did not differ significantly. In addition, all great ape species developed idiosyncratic gestures. Overall these findings support, based on our defined indicators for individual learning, the hypothesis that ontogenetic ritualization is the main learning process involved.

However, we found group-specific gestures in a group of bonobos, gorillas and orangutans. These findings imply that at least some gestures are acquired via a social learning process.

All of the intentional gestures used by apes therefore share two important characteristics that make them crucially different from human deictic and symbolic gestures: 1) They are mainly used in dyadic contexts and attract the attention of others to the self and, not triadically, to some outside entity. Human infants in contrast gesture from their very first attempts in addition to dyadic gestures triadically, that is for persons to external entities (Carpenter et al., 1998). 2) Ape gestures seem to be exclusively used for imperative purposes to request actions from others. Human infants in contrast use gestures imperatively

but also declaratively to direct the attention of others to an outside object or event, simply for the sake of sharing interest in it or commenting on it. Although the majority of differences are quantitative and not qualitative, the crucial findings is that apes don't use gestures to communicate about outside entities or comment on it. This propensity seems to be unique for human communication and might have been derived from the cognitive ability that enables humans to understand other persons as intentional agents with whom they may share experience (Tomasello, 1999).

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