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[accionpsicologica@psi.uned.es](mailto:accionpsicologica@psi.uned.es)

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CARLOS GÓMEZ, JUAN

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## THE EMERGENCE OF EYE CONTACT AS AN INTERSUBJECTIVE SIGNAL IN AN INFANT GORILLA: IMPLICATIONS FOR MODELS OF EARLY SOCIAL COGNITION

### EL SURGIMIENTO DEL CONTACTO OCULAR COMO SEÑAL INTERSUBJETIVA EN UNA CRÍA DE GORILA: IMPLICACIONES PARA LOS MODELOS DE COGNICIÓN SOCIAL TEMPRANA

JUAN CARLOS GÓMEZ

School of Psychology, University of St. Andrews  
jg5@st-andrews.ac.uk

#### Abstract

This paper argues against both lean and rich interpretations of early social cognition in infants and apes using as an illustration the results of a longitudinal study comparing the emergence of joint attention and tool use patterns in an infant gorilla. In contrast with tool use (where well-formed manipulations resulted in near perfect rates of reward obtention) the emergence of well-formed acts of communication with eye contact not only had no effect upon the rewards obtained, but increased the proportion of “explicit denials” of requests. It is argued that this suggests eye contact is learned and used as an intersubjective signal of communicative intentionality and not through simple associative mechanisms of reward contingency detection. However, it is also argued that rich interpretations of early social cognition are not needed to explain the development of communicative and intersubjective intentions.

#### Key Words

Intentional communication, eye contact, joint attention, intersubjectivity, tool use, gorillas.

#### Introduction

Ever since the beginnings of research on early social interaction and communication in infants, there has been a theoretical tension between those willing to explain the complexity uncovered in adult-infant interaction as the result of rich underlying cognitive abilities (e.g., Bretherton et al., 1981), and those willing to propose leaner accounts of infant social cognition (e.g., Shatz, 1983). A similar tension exists among comparative researchers when trying to explain the complexity of non-human primates social interaction and the degree of similarity between human and non-human social cognition: some defend lean accounts, others rich accounts of primate social cognition. Paradoxically it is not infrequent that a lean approach towards non-human animals is accompanied by a rich approach towards human infants (Tomasello et al., 2007). In this paper I build upon earlier proposals (Gómez, Sarriá, and Tamarit, 1993; Gómez, 2007) to explore a “balanced”, intermediate approach to the social cognitive skills of infants and non-human primates.

Lean approaches typically try to explain what infants or primates do (e.g., gaze following or pointing behaviours) as simple instances of trial and error learning and associations between behaviours and outcomes with no or little

insight into the causal links that connect those behaviours with their outcomes (other people's reactions). For example, the gaze following reaction (looking at the same target as others) has been found to be a universal of primate social cognition (Gómez, 2005). However, authors like Povinelli and Eddy (1996) suggest that in non-human primates it is either a reflex reaction or a blindly learnt habit devoid of any understanding of the other's gaze as implying any sort of visual experience of an object. A similar lean approach was defended by Moore (2008) for gaze following in human infants. According to him, infants might simply be learning that turning in the same direction as others usually leads to finding something of interest. No need of invoking early theories of mind or complex social cognition for explaining this. However, an experiment by Moore himself suggests that there is more to gaze following than simple associative learning. Corkum and Moore (1998), working with 8-9 month-old infants who had not yet learned to follow gaze on their own, tried to teach them gaze following responses with selective reinforcement in an experimental setting. A group of children consistently found a reinforcing event if they looked in the same direction as an experimenter; however, a second group found the reinforcing event only if they looked in the direction opposite to where the experimenter looked. If gaze following is learned through simple association, this group of children should have learned to look in the direction opposite to the adult. However, they were completely unable to learn this reverse, unnatural contingency, whereas children in the normal gaze following group learned easily to follow the gaze of the adult. Even more surprisingly, children in the reverse contingency group spontaneously learned to follow gaze in the natural direction, despite never being rewarded for doing so. Gaze direction is not just an arbitrary stimulus: there seems to be something intrinsically directional in gaze that tightly constraints what can be learned and how it is learned. The rules of simple associative learning did not apply here.

Rich interpretations posit that behaviours like gaze following and pointing (a more active, intentional way of making others look to or act upon an object), appearing or well established by the end of the second year of life in human in-

fants, reflect complex cognitive skills, including an understanding of what others can see and what they can know and ignore. For example, Tomasello et al. (2007) propose that infants use pointing in a way essentially similar to how adults do. They attribute to infants an ability to understand the informative and communicative intentions behind their own pointing and the pointing of others. In support of this interpretation they present findings like the following. When 12 month-old infants point out an interesting event to someone else, they are not happy if the person simply attends, gesticulates or emotes to them: they require that the person attends to and emotes *about* the object they are pointing at (Gómez et al., 1983; Tomasello et al., 2007). Moreover, when requesting an object with a pointing gesture, 12 month-old infants may not be satisfied if they get the object by chance. For example, if the person looks at the wrong object and gives them the right one, they typically insist and repeat their request, as if what they need is to be *understood*, not just to get a reward. Tomasello et al. (2007) argue that results like these suggest that infant communication involves a sophisticated understanding of communicative intentions, including an understanding of what is jointly known or intended.

These same authors defend, however, that non-human communication even among the great apes, our closest relatives, may be much simpler. For example, when chimpanzees and other apes point to request food or objects from others, they might be acting just on the basis of their desire to make others do things without a true grasping of what others understand and know, and especially without entering into true joint attention and action. At most, apes may understand that others have individual intentions about objects, but not communicative intentions.

In a commentary on the above paper (Gómez, 2007) I have defended the need to find an alternative "balanced" interpretation of what is involved in early social cognition, both for apes and human infants. I propose that behaviours like gaze following and pointing can be interpreted as involving a mentalistic understanding of behaviour, but one that occurs at the level of *intentionality*, not at the level of understanding the *representational* mind. In this sense, communicative intentions and shared

knowledge need not require complex representations of the type “I know that you know what I want” “or “we jointly and mutually know X”, but rather representations of *aboutness* and *mutual aboutness*, which, in turn, cannot be explained neither in human infants nor in apes as simple associative behaviours.

In what follows, I will present empirical evidence against lean interpretations of ape communication (their use of eye contact and mutual attention to regulate interaction with humans), but instead of concluding that ape social behaviour demands a rich cognitive interpretation, I will be defending a “balanced” model midway between the rich and the lean.

### Comparing tool use and communication: a case study

In lean interpretations it has been frequently suggested that infant communication or ape communication is a form of social tool use (Bard, 1990) in which the tool happens to be another animate being. Although the term “social tool” is sometimes used metaphorically, other times it is used with the suggestion that the same underlying cognitive processes might be responsible for communication and tool use in infant development. This hypothesis has been essentially discarded for human infants, because no correlation exists between the development of tool use and the emergence of intentional communication (Sarriá y Riviére, 1991). However, the parallelism is still frequently suggested for ape communication, given its “selfish” and protoimperative nature.

In the 1980s I conducted a longitudinal study on the emergence of communication and early cognitive development in a hand-reared gorilla (Muni) interacting with human adults in

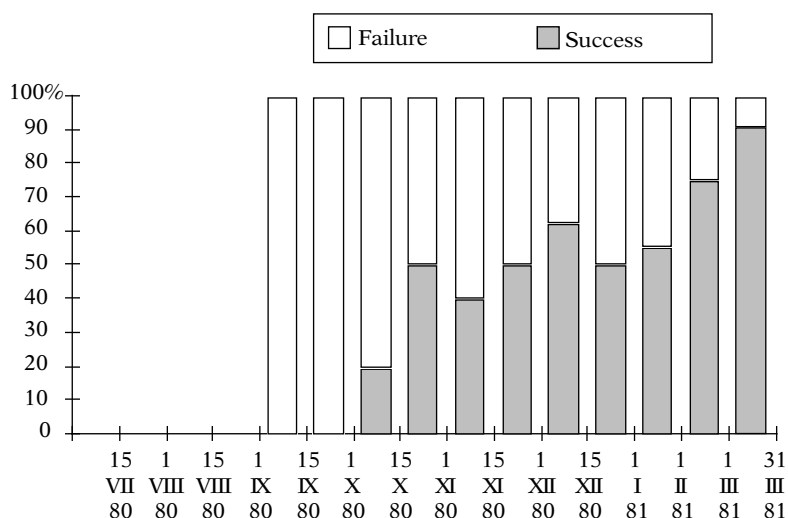
a zoo nursery setting. One of the findings was that, among other gestures, the infant gorilla developed a set of “contact gestures” consisting of taking people by their hand to places or taking the hand of people to objects she wanted them to manipulate (Gómez, 1989, 1990). This gesture seems to be ideally suited to assess the notion of communication as “social tool use”. Since the observational data collected contained also observations on the development of tool use, it is possible to make a direct comparison of the emergence of tool use as object manipulation for problem solving and social communicative strategies in similar problem solving contexts. The findings I will be discussing here correspond to the period when Muni was between 6 and 30 months of age<sup>1</sup>. In problem solving contexts, physical tool use emerged before the use of communicative strategies. I will start therefore discussing this.

### *How Muni learned to use tools effectively*

The key for successful tool use (for example, using a stick to obtain an out of reach object or placing a pole or a box such that it can be used as a “ladder” to reach an object) consists of applying to the tool a force appropriate to its weight and the movement one is trying to provoke, orienting this force in the appropriate direction and for the necessary time and upon the correct part of the target and the intermediary objects. While the object is being moved in the desired direction, one must typically monitor the relative positions of means and ends and make adjustments to the force and direction of the tool as a function of the position of the object and the final goal. Checking looks at the tool, object and goal are typically part of this

<sup>1</sup> Muni was wild-born in Equatorial Guinea. She had been wounded by poachers and given to the Zoo for veterinary treatment. After recovery, she was hand-reared by persons in the nursery environment of the Zoo according to typical hand-rearing routines (Fritz and Fritz, 1985), which include extensive contact with adult humans who act as surrogate attachment figures and some human infant-like routines, such as bottle feeding and occasionally nappy and cloth wearing, as well as access to a variety of toys. Researchers were integrated as part of the team of people taking care of the gorilla. Muni spent her first year in the zoo in daily contact with human adults (about 8 hours per day). After that she was integrated into a group with other orphan gorilla infants of similar ages, but she continued to enjoy a few hours of contact with humans a few days per week (see Gómez, 1992, for more methodological details).

**Figure 1. Development of the ability to successfully use tools to solve problems between september 1980 (age 9 months) and March 1981 (age 15 months). Results are presented in 15 days intervals, except those corresponding to 1981 which are presented in 1 month intervals. They show percentage of tool using attempts that were successful.**



adjustment process. For example, when trying to lean a pole on the wall to be able to climb on it to reach the latch of a door, Muni would look alternately to the pole, the wall and the latch position while groping until a stable position close enough to the latch was found.

Muni perfected her tool using skills slowly but steadily. As shown in figure 1, her first attempts at using tools were completely unsuccessful and only little by little, week after week, she gained in mastery and reached a success level of 90%. This increase in successful tool manipulation (from 0% to 90% in five months) reflects how the gorilla learned from experience how best to handle tools in relation with other objects and substrates.

### *How Muni learned to recruit people's help in solving problems*

Muni's first attempts at recruiting humans to help her solve a problem seemingly consisted

in using them as inanimate objects that she tried to move mechanically in the required direction (13 months of age), as if they were just one more manipulable object. This later gave rise to gently suggesting the desired movement and waiting for the humans to execute it on their own (20 months of age), which was followed by making eye contact while gently leading the humans and/or their hand to the appropriate object or location (29 months of age). This has been described in detail in Gómez (1990, 1991, 2004). Muni, therefore, passed through a number of stages in the development of her idiosyncratic contact gesture —taking people by the hand or taking the hand of people to objects<sup>2</sup>.

The key element in the development of these gestures was their coordination with eye contact patterns. Indeed I suggested that it is this coordination that confers communicative intentionality to the behaviours displayed by the gorilla (Gómez, 1991). This point was supported by the fact that some children with autism, who

<sup>2</sup> Contact gestures were not Muni's only way of interacting with humans. She also offered objects or extended her arm in a sort of pointing gesture, as ways not only of requesting help with problems or actions leading to extrinsic rewards, but also to regulate cooperative interactions of the type described by Hubley and Trevarthen (1979) as "secondary intersubjectivity" (Gómez, in press).



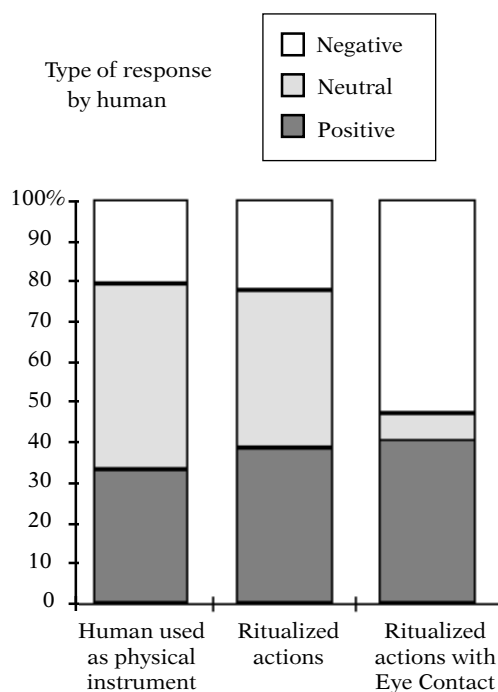
display hand-taking contact gestures similar to those found in Muni, however fail to coordinate them with eye contact behaviours (Phillips et al., 1994).

However, contact gestures are ideal candidates to be considered as by-products of associative learning or social tool use based upon physical attempts at spurring humans into action. The use of eye contact in communication can be construed as a simple case of stimulus discrimination in an operant learning scenario, where making eye contact is both an effective way of spurring others into action and a discriminant stimulus signaling the availability of the other. Maybe Muni discovered by chance the usefulness of looking humans into their eyes, thereby making it more likely that they would respond positively to her demands? Could these behaviours be just instances of social tool use (in the literal sense) devoid of any understanding of communicative intentions? A way of addressing this question is to have a look at the impact that incorporating eye contact had on the communicative efficiency of Muni in problem solving situations.

### Comparing physical and social tool use

When we compare the development of “social tool use” with the development of physical tool use in terms of increase of effectiveness in reaching the final goal, the surprising finding is that in social tool use there is no such increase. Figure 2 shows the proportion of gorilla acts that resulted in a positive reaction from the human (i.e., complying with the request or intended effect; dark part of the columns) in problem solving contexts. In figure 2 unsuccessful reactions are further subdivided into “neutral” (the person does not react helping the gorilla, although she may allow her to act, for example climbing up him/her) and “negative” (not only the human fails to help, but also actively intervenes to prevent the effect, e.g., fastens more tightly the cage’s latch after the gorilla requests to be taken out or makes the negative reaction explicit, gesturing and saying “No” as a way of demonstrating unwillingness to comply).

**Figure 2. Types of response given by humans to acts performed by the gorilla to recruit their help in problem solving. Columns show the percentage of positive (active help), neutral (no response) or negative (active denial) responses given to each type of request. Surprisingly, well-formed acts of communication (ritualized actions with eye contact) are not more effective in provoking positive responses, but they provoke more active denials.**



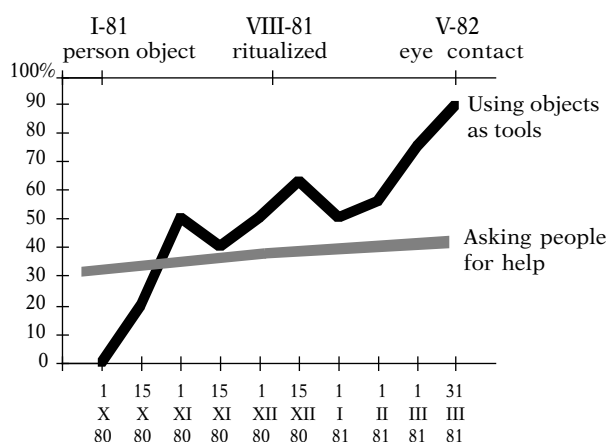
In physical tool use there was a steady increase in the proportion of successful problem solving reflecting manipulative mastery. In contrast, when using people, the many changes that occur in the acts used by the gorilla (action ritualization and schematization, and coordination with joint attention behaviours, such as eye contact and gaze alternation) do not result in an increase in success —whatever the action, the human helps only in less than 40% of the time.

This is due to the fact that, during the first phase, when Muni clumsily dragged and tried to climb upon people, humans would nonetheless react helping her (as one typically does with children) independently of how communicatively inept her attempts were. Of course, hu-

man help depended upon a number of constraining factors, such as the object of the request. If a forbidden food, or the precious notebook of the researcher were the targets of the gorilla, no help was given. Once Muni developed her joint attentional and intentional ways of making requests, the same constraints applied, and only requests that were pertinent and permissible would be responded to positively. I know of no study investigating this issue with human children, but I predict that negatives will probably be as high as in this gorilla study.

Tool use and people use are fundamentally different. Physical instruments are radically different to social instruments. The reaction of the physical tool depends upon the skill of the manipulator in exploiting the object properties. The reaction of the person, however, depends ultimately upon her will and assessment of the situation. The will of people around Muni remained curiously unaltered over time. If we measure their compliance with requests, this was completely unconnected with the gorillas increasing sophistication in communicative behaviour (see Figure 3 for a direct comparison).

**Figure 3. Direct comparison of the effect of increasing skill and complexity in tool manipulation and human interaction upon the rate of success in problem solving situations (percentage goals attained). Whereas tool use becomes increasingly effective with time, communicative strategies keep a similar success rate independently of their sophistication.**



But of course this is not the whole story. There is an important change in the way people react to well-formed communicative requests with joint attention: a dramatic increase in active negatives versus neutral or non-committal reactions. This increase in “actively negative” reactions would appear to be highly paradoxical. Is well-formed communication a less efficient way of social problem solving? How can we then explain the progressive development of increasingly complex communicative procedures that replace their tougher, literally more manipulative earlier counterparts? If efficiency is measured only in terms of obtaining the desired reward, well-formed communication makes no difference. But if we consider in which way the reward fails to be obtained, a key difference emerges: when not conceding the reward, humans changed from just ignoring non-communicative or hardly communicative attempts, to explicitly *denying* a communicative request. Now, *denying* is a communicative act: it involves, first of all, acknowledging that a request has been made, for example by attending to the gorilla and making eye contact and other facial, vocal, and verbal reactions; this is then followed by a “negative”, i.e., further gestures, vocal, facial, and verbal reactions, that may involve reference to the object (e.g., the door not to be opened) gaze alternation, and even in cases where the reward must definitely not be obtained by the gorilla, taking preventive measures, like tightening the door latch.

Communication by the gorilla engenders communication by the human independently of how much the gorilla understands of the human negatives: probably nothing of the verbal content, but much of the emotional content expressed in the face, voice and gestures. If the gorilla just tries to drag the human to a door she wants open, the human might just resist and get free of the gorilla’s grip. However, when the gorilla requests with attention contact, the human says “No” and acts “No” in face to face communication with the gorilla.

### The eyes in the tool

Eye contact is a key element in identifying acts as communicative. In eye contact one is

not simply looking at the other, but at a very special part of the other —the eyes. When using instruments there is gaze alternation between the tool and the reward. For example, Muni would visually gauge the distance between the end of a pole and its target destination. From a social tool use perspective one could argue that looks at the other follow the same logic: checking if the social tool is acting in the right direction. However this would only explain gaze alternation between the target and the relevant parts of the acting human, usually his hands or his legs. Why did the gorilla (and why do human infants) include looks at the eyes of the person (and gaze alternation between eyes and target) if the eyes themselves perform no action on the target and looking into the eyes had no effect upon the ultimate resolution of the problem?

A lean interpretation would be that the eyes of the other could act as a discriminatory stimulus associated with the probability of the other acting in response to a request. After all only if the others are attending to the gestures they can react to them; also, humans like eye contact and maybe they are more willing to respond when looked at in the eyes. This would be similar to having a red light in a Skinner box that, when turned on, signals that food will be delivered if the lever is pressed. Rats quickly learn to press only if the light is on, and maybe even to press a different lever to turn the light on (the equivalent of calling the attention of someone). However one would expect these operants to be learned only if they do make a difference in the proportion of rewards obtained. If the light is not predictive of a higher probability of reward, and turning the light on makes no difference to the probability of getting the reward, then why incorporating all these new, costly patterns of behaviour?

In the developmental trajectory of Muni there was a lack of relation between making eye contact and increasing the probability of getting the reward in a problem solving situation. Looking at the eyes had no effect whatsoever on the ultimate success of a request, but it did upon the way in which she failed to gain the reward. The effect of making eye contact was, first, an increase in the probability of being told if the reward was going to be given or not. This has the benefit of clarifying if the lack of success

is due to the request not having reached its destination and therefore must simply be repeated (maybe after calling the attention of the other) or must be abandoned, or made in a different way. The effect of making eye contact is not mechanical or quantifiable in terms of reward obtention. It is an *expressive* or *intersubjective* effectiveness. Looking at someone while gesturing has the effect of making the other look and gesture back at you, and what matters then is not only if you obtain or not your goal, but the intersubjective relation with the other.

## Conclusions

As with the cases discussed in the introduction (the impossibility of teaching infants “counter gaze following” or the insistence of infants on “being understood” and not just obtaining a reward), the emergence of well formed acts of communication in this infant gorilla is not related to learning the contingencies of reward delivery. The game of social interaction and communication is played on a different ground. The introduction of eye contact and mutual attention brings the interaction between gorilla and human into the realm of what Trevarthen called *intersubjectivity* (Hubble and Trevarthen, 1979; Gómez, 1998). Lean interpretations of the associative type cannot explain the development of early communication and social interaction. But this does not mean that we must accept rich interpretations in terms of sophisticated, adult-like theory of mind skills.

Eye contact and its associated patterns (mutual facial and vocal expressions) are behaviours specialized in fulfilling *ostensive* functions (in the sense of Sperber and Wilson, 1986), i.e., signalling that one is acting with a communicative intention. Although communicative intentions can be construed and understood in very complex ways as implying mutually embedded, higher-order intentional relations (“wanting someone to understand that one wants him to understand...”), it is also possible to understand them, in their first ontogenetic and phylogenetic manifestations, as more primitive forms of *second-person* intentional relations. Mutual gaze used in referential communication (pointing to



an object or, in the case of the gorilla discussed here, taking hands to ask someone to act upon an object) captures the main properties of the Gricean structure of communication (Gómez, 1994, 1996, 2004). It signals out the existence of mutual, shared attention: it is a sign of each participant overtly attending to the attention of the other. When one tries to put this in words, a complex, mutually embedded structure results (“you attend to me attending to you attending to me... attending to X”). However, this pattern of mutual attention is achieved without these complex computations. It is a form of second-person intentionality that precedes metarepresentational embeddedness (Gómez, 1996, 1998, 2004, in press). If ostension is interpreted in meta-representational terms, the problem of mutual knowledge demands complex cognitive mechanisms capable of computing higher-order intentionality relations. However, if ostension is interpreted in terms of *intentionality* (in the original Brentanian sense of relations of aboutness), then ostension becomes *mutual aboutness* that is computed by a specialized mechanism more closely comparable to an emotion—the emotion of ostension—than to cognition (Gómez, 2009, 2010).

The failure of simple conditioning or associative paradigms to account for elementary social cognitive skills does not mean that learning does not play a role in the development of skills such as gaze following, mutual gaze, or communicative gesturing. The crux of the matter is *what* is learned and *how* it is learned. Simple associative contingency models fail to take into account the perceptual and cognitive constraints governing learning in infants and other apes; for example, the perception of an illusory “line of gaze” or the elicitation of those “ostensive emotions” in eye to eye contact. Early social cognition hinges upon the perception, understanding, and experience of relations of *intentionality* in the Brentanian sense of relation of aboutness connecting agents and objects (Gómez, 2008, 2009). This, I propose, is an evolutionarily more primitive and basic form of mentalism that offers the possibility of developing “balanced” models of early social cognition in development and evolution avoiding the shortcomings of lean and rich models.

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