

The Midwife's Hypothesis: Assisted Childbirth and the Origins of Language

"The full story of the evolution of speech must include the history of selection pressures for communication in the context of overall hominid evolution." (MacNeilage 1998: 506)

"Les phénomènes de symbolisation corporelle dans les rituels animaux nous donnent peut-être accès aux origines de tout symbolique." (Atlan 1982: 32)

Speech: An elaborated lipsmack

In a 1998 article published in *Behavioral and Brain Sciences*, "The frame/content theory of evolution of speech production," Peter MacNeilage suggests an "evolutionary route from ingestive cyclicities to speech" by way "of a putative intermediate form present in many other higher primates, namely, visuofacial communicative cyclicities such as lipsmacks, tonguesmacks, and teeth chatters." (MacNeilage 1998: 499)

MacNeilage and colleagues (2000) further refine the theory. "The oscillation of the mandible for speech," they write, "may have had an original precursor in early mammals (circa 200 million years ago) in the form of mandibular oscillation for ingestive purposes (chewing, sucking, licking). It may then have been exapted for visuofacial communicative purposes (e.g., lipsmacks; see Redican 1975) in prehuman primates, and finally have become paired with phonation to form protosyllables in hominids. The oscillation of the mandible is regarded as the "Frame" for speech. Both speech phylogeny and ontogeny are regarded primarily as a matter of developing internal "Content" for frames, in the form of relatively independent movement components, which eventually give rise to various consonants and vowels." (MacNeilage et al. 2000: 154)

The telescoping of phylogeny perhaps unduly obscures the argument. As Andrew (1998) comments on the theory's original articulation, "The argument neglects those jaw, lip, and tongue movements that are reflex components of vocalisation in mammals in general. It must be true that jaw movements are controlled by neural mechanisms that first evolved to allow biting: vertebrates had jaws long before they evolved the lungs they needed to vocalise." (Andrew 1998: 513)

MacNeilage (1998) does not neglect such "reflex components of vocalisation," however. "It is surprising," he points out, "that more attention has not been drawn to the similarity between the movement dynamics of the lipsmack and the dynamics of the syllable (MacNeilage 1986). The up and down movements of the mandible are typically reduplicated in a rhythmic fashion in the lipsmack, as they are in syllables. In addition to its similarity to syllable production in motor terms, there are a number of other reasons to believe that the lipsmack could be a precursor to speech. First, it is analogous to speech in its ubiquity of occurrence. Redican (1975) believes that it may occur in a wider variety of social circumstances than any of the other facial expressions that he reviewed. A second similarity between the lipsmack and speech is that both typically occur in the context of positive social interactions. A third similarity is that, unlike many vocal calls of the other primates [unlike many other vocal calls of the primates?], the lipsmack is an

accompaniment of one-on-one social interactions involving eye contact, and sometimes what appears to be turn-taking. This is the most likely context for the origin of true language.

“Finally, in some circumstances, the lipsmack is accompanied by phonation. Andrew (1976) identifies a class of ‘humanoid grunts’ involving low frequency phonation in baboons, sometimes combined with lipsmacking. In the case he studied most intensively, mandibular lowering was accompanied by tongue protrusion, and mandibular elevation by tongue retraction. Green (1975) describes a category of ‘atonal girneys’ in which phonation is modulated ‘by rapid tongue flickings and lipsmacks.’ Green particularly emphasizes the labile morphology of these events, stating that ‘a slightly new vocal tract configuration may be assumed after each articulation’ (p. 45). Both Andrew and Green suggest that these vocal events could be precursors to speech.” (MacNeilage 1998: 504)

The term “precursor,” of course, is not meant to be taken literally, since the animals Andrew (1976), Green (1975), and Redican (1975) studied are our contemporaries. In addition, terms such as “exaptation” or “preadaptation” lose their meaning out of a palæontological context. Rather, it is the case that lipsmacks, tongue smacks, teeth chatters, grunts, girneys, and so on, are homologous with human speech. Speech, in other words, is an elaborated lipsmack.

Neurological findings by Sherwood et al. (2005) reenforce this perspective. “The neural mechanisms underlying human language,” they write, “have often been characterized as elaborations of pre-existing circuits in nonhuman primates (Deacon 1997; Gannon et al. 1998; MacNeilage 1998). In our analysis, the volume and microstructure of human orofacial motor nuclei did not differ significantly from allometric expectations. In this regard, our results suggest that human linguistic abilities are built upon cytoarchitecturally unspecialized cranial nerve motor nuclei and do not require enhancement of fine motor control of orofacial muscles. It is interesting that lateral-projection video fluorography studies indicate that movements of the tongue surface in human speech do not occur outside the domain of movement observed for feeding in macaques and humans (Hiiemae 2000; Hiiemae et al. 2002). In sum, these data support the hypothesis proposed by MacNeilage (1998) that the motor patterns of human speech are similar in form to oscillating visuofacial signals of nonhuman primates (e.g., lip smacks, tongue smacks, and teeth chatters) and may exploit conserved central pattern generators and motoneuron pool organization.” (Sherwood et al. 2005: 76–77)

“Ultimately, the goal of a comparative analysis of communication across different animal taxa is to understand the type of changes that have occurred in the evolution of communicative systems and be able to predict the communication system of a species (e.g., the type, structure, and number of signals used) based on the knowledge of its social system, ecological environment, and biological constraints. This would be particularly valuable for extinct species such as those of the hominid line, for which we can obtain some of the relevant information from the archeological record.” (Maestripietri 1997a: 274)

[Section 2]

Lipsmacks, teeth chatters, girneys, grunts, and more: The homologies of speech

“It seems reasonable,” speculates Andrew (1998), “to start with the hypothesis that a single call delivered by an ancestral mammal commonly commenced with mouth opening, and ended with mouth narrowing or closure, accompanied by contraction of the orbicularis oris.” (Andrew 1998: 513)

Whether or not this ancestral mammal’s calls would “always produce the same vowel” to which Lieberman (2006: 278) would seem to restrict it, it likely would have been capable of moving the muscles of its face. This would be especially true of the primates; in particular, the order that evolved to include monkeys, apes, and humans: the anthropoids.

That is, “Compared to strepsirrhines [lorises, lemurs, galagos, tarsiers, and such], the frontalis of anthropoids is more developed and is recruited in gestures involving raising of the forehead and eyebrows.” (Sherwood et al. 2005: 75)

Darwin (1872) notes that “many kinds of monkeys, especially the baboons, when angered or in any way excited, rapidly and incessantly move their eyebrows up and down, as well as the hairy skin of their forehead.” (Darwin 1872: 137–138)

“In addition,” Sherwood et al. (2005) continue, “the rhinarium, philtrum, and frenulum are absent, thereby permitting the development of an orbicularis oris that completely encircles the mouth (Huber 1931), enabling a greater range of movement of the lips to generate a diverse range of signals (van Hooff 1962; Chevalier-Skolnikoff 1973).” (Sherwood et al. 2005: 75)

“The lips of young oranges and chimpanzees,” Darwin (1872) points out, “are protruded, sometimes to a wonderful degree, under various circumstances. They act thus, not only when slightly angered, sulky, or disappointed, but when alarmed at anything—in one instance, at the sight of a turtle,—and likewise when pleased. But neither the degree of protrusion nor the shape of the mouth is exactly the same, as I believe, in all cases; and the sounds which are then uttered are different. [...] A similar protrusion or pouting of the lips, though to a much slighter degree, may be seen in sulky children.” (Darwin 1872: 139–140)

Moreover, “compared to monkeys, the face of great apes and humans is characterized by reduction of ear, scalp, and forehead muscles, concomitant with increased differentiation of the muscles of the midfacial region to subservise more complex configuration of the lips for feeding, vocalizing, and facial displays (Huber 1931, 1933; Andrew 1963b, 1965). Moreover, great apes and humans have relatively well-developed corrugator supercilii to draw the eyebrow downward and medially.” (Sherwood et al. 2005: 75)

In the words of Darwin (1872), “Frowning, which is one of the most important of all expressions in man, is due to the contraction of the corrugators by which the eyebrows are lowered and brought together, so that vertical furrows are formed on the forehead. Both the orang and chimpanzee are said to possess this muscle...” (Darwin 1872: 141)

In other words, “The corrugators, by their contraction, lower the eyebrows and bring them together, producing vertical furrows on the forehead—that is, a frown.” (Darwin 1872: 220)

“Taken together,” Sherwood et al. (2005) point out, “these neuroanatomic specializations for facial muscle mobility and control may have been necessary to subserve enhanced social communication skills involved in the adaptive radiations of anthropoids (van Hooff 1962; Preuschoft and van Hooff, 1995) and hominids (Potts, 2004). For example, the degree to which the mouth is opened to display the teeth is highly variable in threat expressions of macaques, depending on the intensity of the signal (Maestriperieri, 1997b). These types of fine signal gradations allow for the communication of highly nuanced information and for the dynamic flexibility needed in negotiating complex social interactions, such as alliance formation, that are typical of these species (Cheney et al. 1987; Byrne and Whiten, 1988).” (Sherwood et al. 2005: 76)

“For example,” writes Maestriperieri (1997a), “the comparison of the structure and contextual usage of facial expressions in humans and nonhuman primates suggests that the human smile is an evolutionary derivation of the bared-teeth display observed in a variety of monkeys and apes (van Hooff, 1972).” (Maestriperieri 1997a: 274)

As regards the ability of anthropoids to combine facial expressions and phonation, Andrew (1998) emphasizes, “Primate calls, particularly those that have energy over a relatively continuous range of frequencies, and so (like baboon grunts) are well suited to reveal changes in vocal tract resonances, are extensively modulated by lip, jaw, and tongue movements (Andrew 1976)... The movements that modulate baboon grunts include ‘lipsmacking,’ in which both jaw and tongue movements produce resonance changes comparable to those that cause the formant shifts that distinguish human vowels (Andrew 1976). The movements are regularly cyclic, much more so than the grooming movements from which they almost certainly derive. It is likely that this cyclicality is part of the evolution of a conspicuous display (‘ritualisation’).” (Andrew 1998: 514)

Redican (1975) claims that the lipsmack is among the most common of these conspicuous displays, and describes the gesture, thus: “The lower jaw moves up and down but the teeth do not meet. At the same time the lips open and close slightly and the tongue is brought forward and back between the teeth so that the movements are usually quite audible... The tongue movements are often difficult to see, as the tongue rarely protrudes far beyond the lips.” (Redican 1975; cited in MacNeilage 1998: 504)

Macaques

In a study of 15 communicative gestures in three species of macaques (pigtail, *Macaca nemestrina*; rhesus, *M. mulatta*; and stump-tail, *M. arctoides*), Maestriperieri (2005) found that the “Lip-Smack” and a gesture called “Bared-Teeth,” were two of the three “most frequent signals occurring in the three species, and, in all species, they were strictly directed up the hierarchy” (Maestriperieri 2005: 68).

He describes the Lip-Smack as a “rapid opening and closing of the mouth and lips, such that when the lips close they make an audible smacking sound.” (Maestripereri 2005: 60)

Bared-Teeth, on the other hand, is static rather than cyclic: “The mouth is closed and the lips and corners are retracted so that the teeth are exposed in a white band.” (Maestripereri 2005: 60)

The strict bottom-up directionality of the lipsmack does not seem to hold across all species, however. Zeller (1999) reports on a situation that seems to show the gesture being directed down the hierarchy: “In Barbary macaques [*M. sylvanus*], males have also been observed using the lipsmack as a positive gesture to infants. Burton (1970) recounts observations of a male leader crouching on his ventrum with his head down at the infant’s level, but a few feet away, lipsmacking at the infant. The infant’s response to this was to attempt to move towards the male. This was difficult because the infant’s limbs were not yet coordinated enough to allow walking, so the result was the infant dragging itself with its arms towards the male. As the infant approached, the male would either pick it up and lipsmack, or back up and encourage the infant to continue approaching by continuing to lipsmack to it. Thus the infant has the opportunity to learn that lipsmack can be associated with a friendly approach by another animal for purposes of grooming, or can accompany an approach by it to another animal.” (Zeller 1999, paragraph 6)

Studies of the lipsmack should perhaps not get too bogged down in the hierarchical dimension of the contexts in which animals use it. Rather, the affiliative, or at least face-to-face, context should be emphasized. “Although rhesus macaques have few affiliative signals relative to the other species, Lip-Smack appears to have a stronger affiliative component in rhesus than in the other species, as this signal was often unsolicited and followed by affiliation.” (Maestripereri 2005: 69)

Furthermore, though “most communication in these three species appears to revolve around issues of dominance and submission (Maestripereri 1996a, b; Maestripereri and Wallen 1997),” and “most similarities in the gestural repertoires of rhesus, pigtail, and stumptail macaques were found in submissive and assertive signals, the greatest variability in communicative patterns related to affiliation and bonding.” (Maestripereri 2005: 68)

In fact, Maestripereri (2005) reports that 60.78% of the lipsmacks observed among rhesus macaques, and 57.35% of the lipsmacks observed among stumptail macaques, were followed by affiliation. In contrast, only 18.05% of pigtail lipsmacks preceded affiliation. (Maestripereri 2005: 66)

As for Bared-Teeth, in all three species of macaques observed, the gesture was most often shown by animals after they were the targets of aggression, and as a response to the approach of a dominant conspecific. (Maestripereri 2005: 66)

Furthermore, “Submissive signals such as Bared-Teeth [...] are remarkably similar in rhesus, pigtail, and stumptail macaques, suggesting that these signals (probably along with threat displays, the play-face, Lip-Smack, and Mount) were present in the ancestor of these species. In

fact, these signals also appear in most, if not all, of the other African Cercopithecidae (Andrew 1963b; van Hooff 1967; Redican 1975).” (Maestriperi 2005: 70)

Maestriperi (2005) describes another submissive signal, called “Teeth-Chatter,” which seems to be a cyclic version of the static Bared-Teeth: “The mouth is rapidly opened and close and the lips retracted, exposing the teeth.” (Maestriperi 2005: 60)

Teeth-Chatter was “virtually unique to stumptail macaques... and was mostly directed up the hierarchy.” It is, however, associated with other gestures—such as Hip-Touch, Hip-Clasp, Mount, and Embrace—between females. (Maestriperi 2005: 68)

The gynocentric focus of the teeth chatter is borne out in Zeller’s (1999) description of the post-partum context in which it, and the lipsmack, occur: “Infant macaques of only one week old are beginning to use the rhythmic opening and closing of the mouth that derives from a suckling response, in social situations. This behaviour is a pattern which neonates have for purposes of feeding, but in social groups a new mother is the focus of intense contact by other animals. Since lipsmacks and teeth chatters are among the most frequent positive social gestures, newborns are exposed to both their mothers and her visitors exhibiting these gestures with great frequency and intensity. In my experience with infant Barbary macaques, they will begin to look at approaching animals who are lipsmacking and make efforts to open and close their mouths. An additional aspect of the gesture is the rhythmic hand clasp in which the approaching animal will often grab some part of the mother’s body and squeeze it with her hand while lipsmacking when she is close enough. This is usually seen for the most part in very intense lipsmacking interactions, and may actually derive from an infant’s hand movements of spasmodic clutching seen while nursing is occurring. Infants of one week of age are not yet able to locomote on their own, and can barely stand by themselves and yet they begin to show aspects of a social gesture in correct context. As the infant grows older and continues this behaviour, approaching animals, and the mother, orient to the infant and increase their lipsmacking intensity, even if the ultimate focus of the meeting is maternal grooming and not the infant. Mothers also lipsmack to their infant and groom them, thus reinforcing the positive social nature of this gesture for infant monkeys.” (Zeller 1999, paragraph 5)

In addition, “Teeth-Chatter has been reported in Barbary macaques (*Macaca sylvanus*; van Hooff 1967), which are believed to be the most ancestral macaque species, and in macaque species of the *silenus* group (e.g., bonnet, Tibetan, and assamese macaques), which are probably closely related to stumptail macaques (Fooden 1980).” (Maestriperi 2005: 70)

Zeller (1999) reads gesture from a learning perspective:—“Monkey mothers may direct the infant’s attention to signals being put forward by others in cases where, for example, an infant approaches another adult. If the one approached shows positive social behaviours such as lipsmacks, the mother may not intervene, while if the other shows signs of arousal such as piloerection, threat stares, or ‘push away,’ the mother may go and retrieve the infant from the other’s vicinity.” (Zeller 1999, paragraph 16)

While MacNeilage (1998) touches on the ritualization of the gestures:—“Lipsmacks occurring during grooming often have been linked with the oral actions of ingestion of various materials

discovered during the grooming process, because they often precede the ingestion of such materials. In young infants they have been characterized as consisting of, or deriving from, nonnutritive sucking movements.” (MacNeilage 1998: 504)

As does Maestripereri (2005):—“Hip-Clasp and perhaps also Touch-Genitals between stump-tail adults probably develop from ritualized interactions between adults and infants in which adults lift the infant’s hindquarters and hold them briefly while manipulating the infant’s genitals and teeth-chattering (this interaction has been referred to as ‘bridging’; Bertrand 1969; see Ogawa 1995, for *Macaca thibetana*).” (Maestripereri 2005: 70)

This “bridging” gesture, involving both oral and manual movements, may be compared to the rhythmic clasp, grabbing, and squeezing of body parts mentioned by Zeller (1999) above, along with the putative ontogeny she assigns it in the spasmodic hand-clutching of a nursing barbary macaque infant, as well as the intense grasping of objects by human “alien hand sign” patients with lesions to the medial premotor system (Goldberg 1992, cited in MacNeilage 1998: 507–508)—not to mention the stereotypical scenario of old ladies pinching the cheeks of young babes, and the paw-claw flexing or kneading of nursing infant, or affectionate adult, domestic cats.

A propos of ontogenetic homologies (or homologous ontogenies), a further point of MacNeilage (1998), in addition to the centrality of the *syllable*—“a continual rhythmic alternation between an open and closed mouth” (p. 499)—*as the frame of speech* (and the curious neglect of the syllable in both standard phonological theory and theories of the evolution of speech [p. 510]), was the *ontogeny of the syllable*, and its relation to the lipsmack: “Meier et al. (1997) have recently found that [human] infants may produce ‘jaw wags,’ rhythmic multicycle episodes of mouth open-close alternation without phonation—a phenomenon similar to lipsmacks—as early as 5 months of age. Then at approximately 7 months of age, infants begin to babble, producing rhythmic mouth open-close alternations accompanied by phonation.” (MacNeilage 1998: 504)

Two other facial gestures described by Maestripereri (2005) are relevant to an exploration of the homologies between speech and non-human primate communication systems. In the gesture called “Pucker,” “the lips are compressed and protruded,” while “the eyebrows, forehead, and ears are retracted.” In the gesture called “Eye-Brows,” “the scalp and brow are retracted and the mouth is open.” (Maestripereri 2005: 60)

According to Maestripereri (2005), “Pucker was the most frequent gesture observed in pigtail macaques. Pucker was never observed among stump-tails and only on a few occasions among rhesus. In pigtailed, Pucker was displayed by both males and females independent of their dominance rank and in a variety of social contexts, including mating, grooming, and interactions with infants.” (Maestripereri 2005: 67)

This observation confirmed “previous studies (Maestripereri 1996a; see also Jensen and Gordon 1970)” which found Pucker to “coordinate and facilitate the occurrence of mating, grooming, and interactions with infants.” (Maestripereri 2005: 69)

In addition, Pucker “did not have a clear relationship with dominance.” (Maestripereri 2005: 68)

Furthermore, “Eye-Brows was also unique to pigtail macaques, where it was frequently exchanged between males, irrespective of dominance rank, in conjunction with approach-retreat interactions, Hip-Touch, grunts, and occasionally brief bouts of play. Eye-Brows occurred in conjunction with agonistic support and was often followed by affiliation.” (Maestriperi 2005: 67)

Baboons

“Female baboons often approach their former victims after conflicts, then grunt to them [Cheney et al. 1995: 11]. Behavioral and experimental evidence suggest that grunts have at least two effects—they relieve the victim’s anxiety about becoming the targets of renewed aggression and facilitate friendly interactions, particularly infant handling. Thus, grunts seem to reconcile former opponents. Females are particularly likely to approach and grunt to mothers of newborn infants, perhaps because they are anxious to handle their infants.” (Silk 1996: 39)

Bonobos

Bermejo and Omedes (1999) claim that wild bonobos (*Pan paniscus*) at Lilungu in the Democratic Republic of Congo possess a vocal communicative repertoire of “15 vocal units and 19 sequences.” (Bermejo and Omedes 1999: 353)

They point out that “the nearly incessant vocal activity that takes place between members of a party of bonobos is impressive, even to the casual observer.” (Bermejo and Omedes 1999: 355)

In addition, they argue that “all vocalizations uttered by bonobos are far more structured than those of chimpanzees, *Pan troglodytes*. They are more complex and so have a greater potential to express different meanings or differences among individuals.” (Bermejo and Omedes 1999: 355)

In particular, “Most sequences have several uses and, moreover, the sequences used in each context are many and very varied. *Panting Laugh* is the only sequence that is clearly associated with only one context: play.” (Bermejo and Omedes 1999: 355)

“Transitions between vocal sounds are usually not abrupt; sequences are not followed by silence but by *Soft Mixed Series* which are uttered to end the calling bout.” (Bermejo and Omedes 1999: 355)

“In bonobos, acoustic communication is always related to facial expressions, gestures and tactile communication, while chimpanzees combine sound with other types of communication much less often. Vocal communication and vocal comprehension of *P. paniscus* seem to be very flexible.” (Bermejo and Omedes 1999: 355)

“The importance of maintaining long-term social relationships within the context of a stable group may prove to be a primary determinant of the frequency with which individuals call.

Members of bonobo subgroups are continually communicating with one another: during relaxed interactions, while there is some excitement or when there is a conflict. If mechanisms have evolved to reduce and regulate agonistic interactions, it would not be surprising if vocal communication has evolved in bonobo societies for this purpose.” (Bermejo and Omedes 1999: 355)

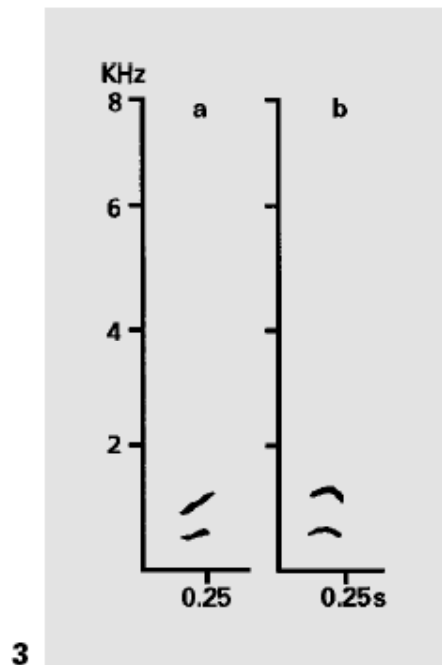


Fig. 3. *Pout moan* vocal units. **a** Increasing frequency. **b** One frequency peak.

(Bermejo and Omedes 1999: 332)

There appear to be two formants in the signal. The rising structure of (a), and the rising, then falling, structure of (b), indicates modulation, perhaps, of the supralaryngeal vocal tract.

Though Bermejo and Omedes (1999) do not indicate the articulations used in the *pout moan*, they describe it as follows: “very short (less than 0.2 s) and soft. Like *peep yelp* but with 2 harmonics. Variable shape, frequency always below 1,500 Hz.” (Bermejo and Omedes 1999: 331) Based on the generally low frequency, with both harmonics starting low, and the expressive name of the vocal unit, it would seem that lip protrusion and rounding (pouting), is involved.

As for the *peep yelp* vocalizations to which Bermejo and Omedes (1999) compare the *pout moan*, they are described as “very soft and short (0.03–0.35 s). Frequency ranges between 0 and 2,500 Hz. Varied shape, may have a peak. Uttered with mouth closed.” (Bermejo and Omedes 1999: 330)

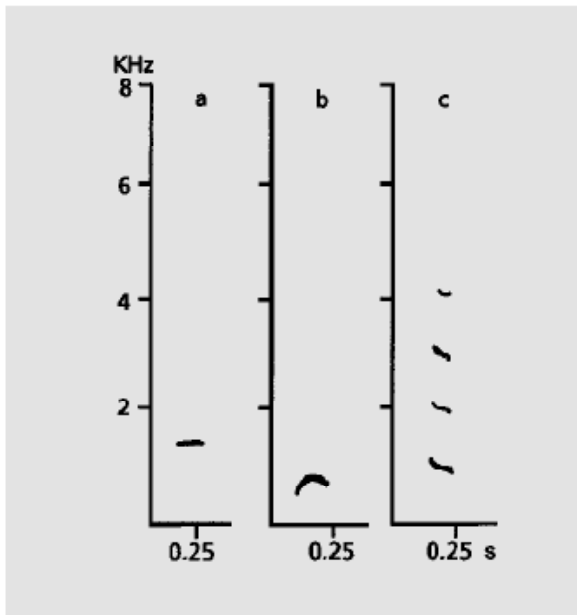


Fig. 1. *Peep yelp* vocal units. **a** Without peak. **b** With 1 frequency peak. **c** Decreasing frequency, harmonics.

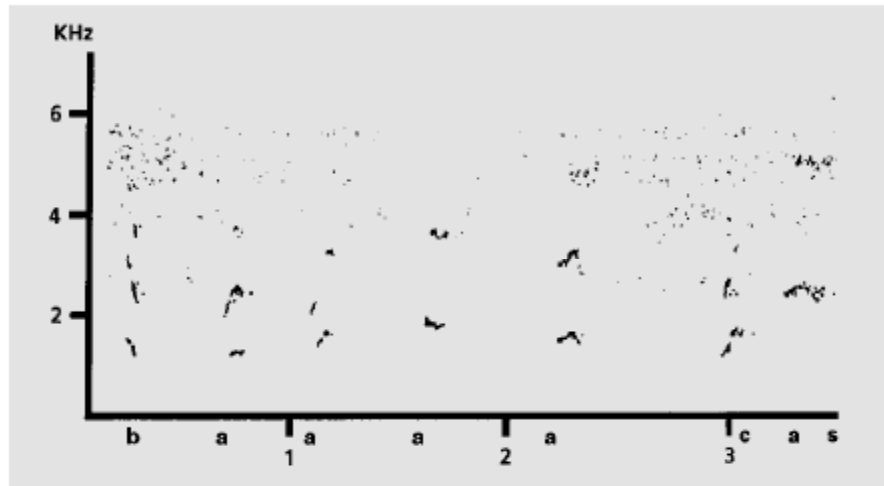
(Bermejo and Omedes 1999: 330)

They state that, “*Peep Yelps, Peeps* and *Grunts* are those mainly used when foraging animals are in close proximity.” (Bermejo and Omedes 1999: 356)

Bonobos also make *peep yelps* in a display Bermejo and Omedes (1999) call *Play-Like Incitement*. “The display is usually performed by two males, one adult and the other subadult. Occasionally it is used by a male and female in a play-like context.

“The performer always oriented to another individual and gave some form of display, usually a rocking or swaying movement in the same rhythm as the vocalization. The visual display behaviour of bonobos is unspectacular, and the vocal aspect appears to be more important, showing a very well-defined sequence of sounds. The vocal incitation started with *Peep Yelps* and lengthened into *Whistles* (fig. 48). The target individual responded with *Peep Yelps, Barks* made up of *whistle-barks* or *Screams*. Then *peep yelps* and *whistles* form a sort of dialogue, going rapidly back and forth between the two antagonists. At that point one individual started chasing the other. The former uttered long *whistles* with a sharp rise and fall of frequency at the beginning and end of the vocal unit, while the latter used *scream-barks* and later *Screams*. The pursuer stopped and the other individual then started the whole sequence again. The sound structure of their *Screams* changed over time, becoming of similar length during each phase of the encounter.

“One of the oldest females of the group usually followed both males closely during the chasing; if she became actively involved, it was always to attack the pursued individual while emitting *Barks*.” (Bermejo and Omedes 1999: 351)



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Fig. 35. *Peep Yelps*: 5 *peep yelps* (A), 1 *yelp* (B) and 1 *hiccup* (C).
(Bermejo and Omedes 1999: 344)

Furthermore, “*Peep* sequences are among the most important vocalizations in bonobos. They seem to constitute the close calls of this species, as defined by Harcourt and Harcourt [1986] and Harcourt et al. [1993] for gorillas (*Gorilla gorilla*). Subtle signals such as *Peeps* might be a sufficient means of communication when individuals are very familiar with one another [de Waal 1988], as might be the case for individuals in stable parties.” (Bermejo and Omedes 1999: 355)

Peeps are described as “the shortest sounds uttered by bonobos, hardly ever longer than 0.01 s. Very small frequency range and very variable shape.” (Bermejo and Omedes 1999: 333)

“When prevented from nursing, and even if they were close to or in contact with their mothers, infants uttered very short and soft *peep yelps* and *peeps* accompanied by an intense pout. As excitement increased, these sounds rose in frequency, were uttered more often with a broad grin and eventually culminated in loud *scream*-like cries. Mothers were very sensitive to these sounds and readily reacted to them.” (Bermejo and Omedes 1999: 347)

“Sequences composed of soft elements such as *Peeps* and *Soft Mixed Series* sequences (‘contact calls’) possibly function primarily to inform group members of each others’ relative locations and thus to contribute to their co-ordination and cohesion during progressions.” (Bermejo and Omedes 1999: 356)

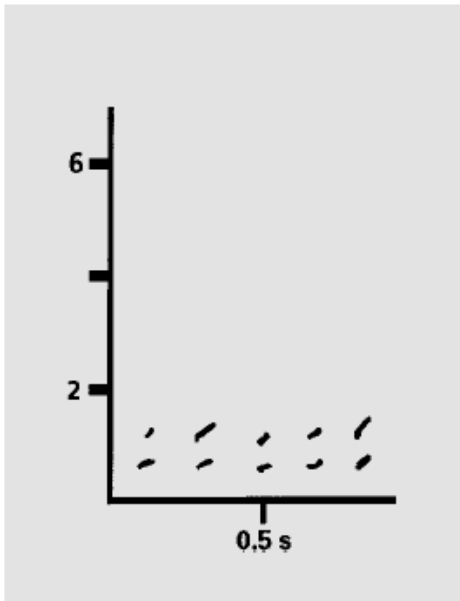


Fig. 17. *Pout Moan* sequence: 5 *pout moan* vocal units.

(Bermejo and Omedes 1999: 337)

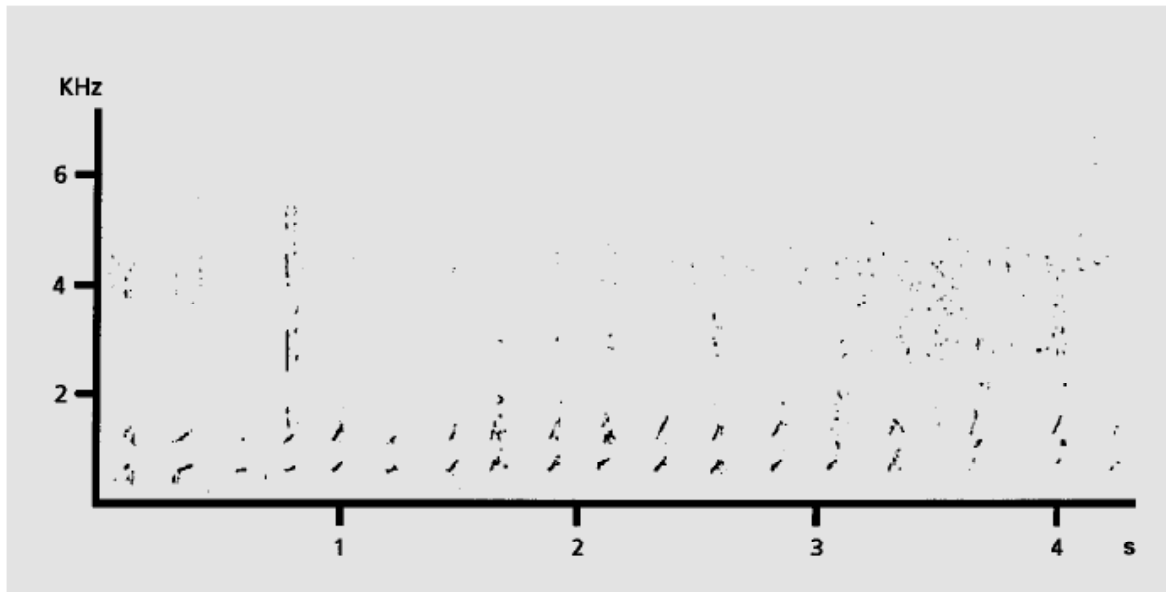
There are five vocal units in the space of one second. This is close to the average human syllable rate of about 7/sec.

Pout Moan sequences: “Very occasionally composed of a high number of elements (up to 40).” (Bermejo and Omedes 1999: 337)

“Individuals within a party might spread out through several feeding trees to find new food sources. On such occasions, the most typical sequence of sequences heard is: various individuals utter *Hooting*, while 2 or 3 animals may use short *Bark* sequences; 1 individual utters *Hiccups* and *Whistles*, others answer by *Hooting*; it may end in *bark*, *soft bark* or *pout moan*.” (Bermejo and Omedes 1999: 342)

“Juveniles when playing commonly used *Peep Yelps*, *Peeps* (fig. 36) and *Hiccups*. Juveniles might also use *Muffled Bark* (fig. 37) or *Croak* occasionally.

“Very typical play sequences start with *Peeps*, then *Soft Barks* and, at the end, *Pout Moan* (fig. 38) made up of rhythmical elements. If 2 individuals were playing, they intercalated the vocal units emitted.” (Bermejo and Omedes 1999: 344)



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Fig. 38. *Pout Moan*: 17 *pout moan* vocal units. Play fight.

(Bermejo and Omedes 1999: 345)

“Some other play sequences used mainly when animals initiated contact are: (i) 1 individual: *Peep Yelp* and then *Panting Laugh*; (ii) 2 individuals: both might use *Barks* (*bark* units with noisy component), *Grunts* and *Soft Barks*; (iii) *Barks* (units with *scream* component), then rhythmical *Grunts* or *Pout Moan* with maybe a *peep* or a *soft bark*.” (Bermejo and Omedes 1999: 346)

“When it rained, bonobos were restless and they usually remained grouped in small areas. Several individuals vocalized at the same time mainly *Soft Barks*, but also *Grunts*, *Pout Moan*, *Peep Yelps*, *Whistles* and *Soft Barks*. Vocalizations were given throughout all rainy periods.” (Bermejo and Omedes 1999: 351–352)

“Bonobos very often vocalized when grooming: *Hiccups*, *Whistles*, *Peep Yelps* (fig. 35) and *Peeps*. *Whistle* sequences emitted while grooming were formed by *whinewhistles*. In general, the vocal units that made up the sequences used during grooming were widely and irregularly spaced.” (Bermejo and Omedes 1999: 344)

Another call of interest is the “*Composed bark* (fig. 10a, b): loud, of medium duration (0.20–0.50 s). Composed of two parts, the first one is similar to a *pout moan*, but of lower frequency and the second is like a *bark* with 1 peak which usually starts with noise. Considered as a single vocal unit because, although there is a slight interval between the two, the first part was never recorded on its own.” (Bermejo and Omedes 1999: 334)

10

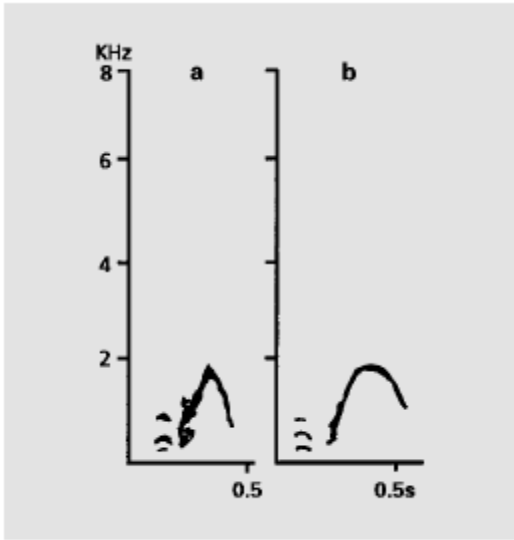


Fig. 10. *Composed bark* vocal units. **a** First part noisy. **b** Rounded peak.
(Bermejo and Omedes 1999: 334)

Composed barks also occurred in sequences: “rhythmic series of *composed barks* occasionally started by a *whistle* or a *bark*. The later units of the series have a far less noisy component than the first ones. Vocal units: 3–18.” (Bermejo and Omedes 1999: 339)

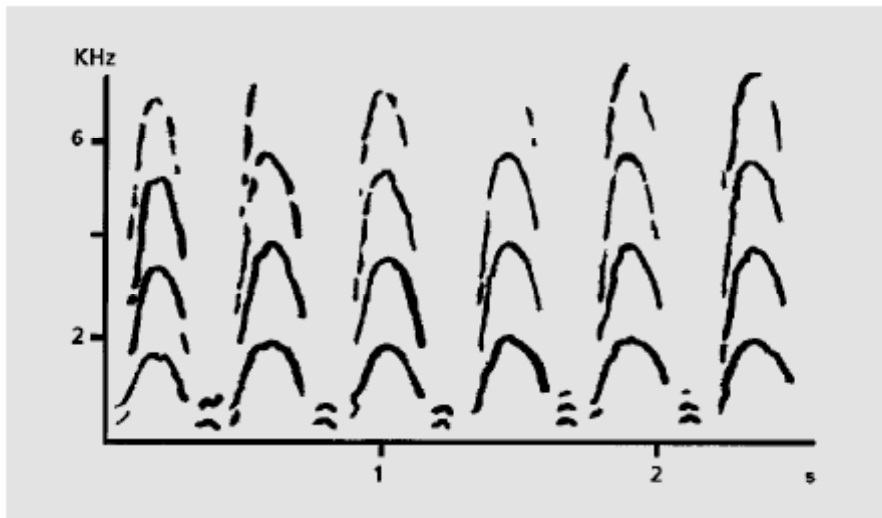


Fig. 25. *Composed Barks*: sequence of 6 units.
(Bermejo and Omedes 1999: 339)

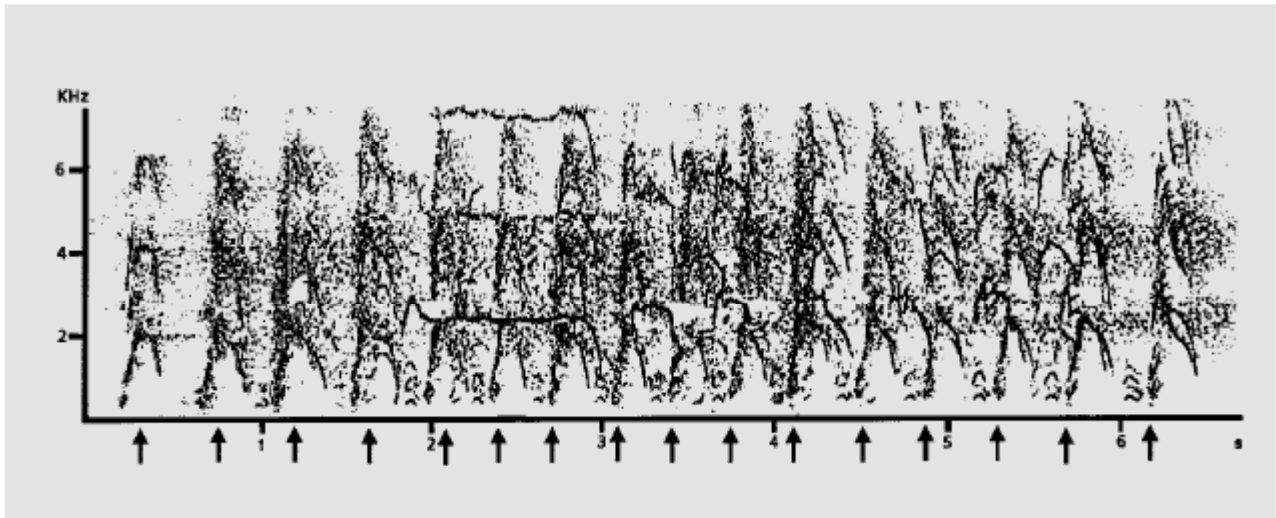


Fig. 33. *Composed Barks*: sequence of 16 units (arrows), 2 *barks* at the beginning, then 14 *composed barks*, simultaneously another individual emits *whistles* and *barks*. Ground feeding.

(Bermejo and Omedes 1999: 343)

“During displays, bonobos rock the upper part of their body in a slight hunch, and squat or stand in a quadrupedal posture. Sometimes animals also assume bipedal postures and walk for short distances dragging branches or food. In both behaviours the vocalizations used are *Mixed Whistle* (fig. 46) or *Soft Mixed Series*, composed of rhythmically uttered units; they might end in a *hiccup* or *soft bark*. Occasionally *Low Hooting* and *Composed Barks* (fig. 47) were also heard.”

(Bermejo and Omedes 1999: 350)

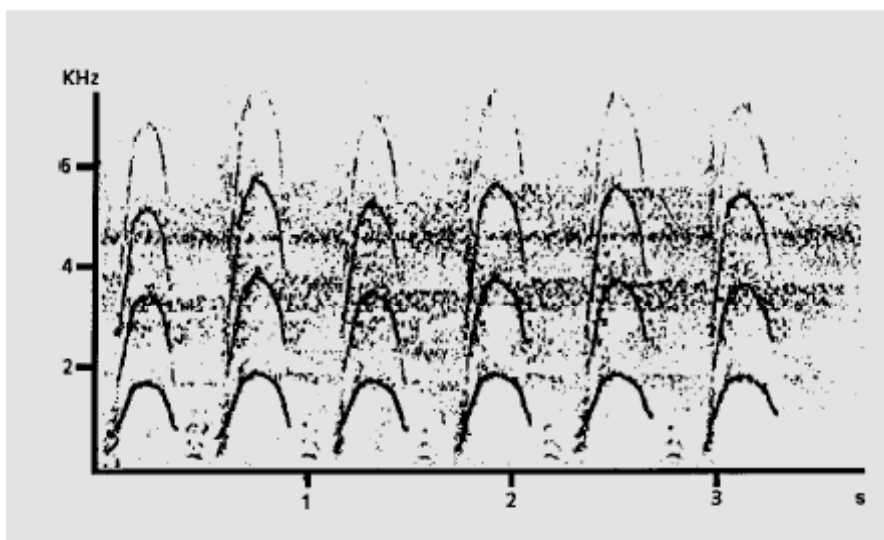


Fig. 47. *Composed Barks*: sequence made of 7 units.

(Bermejo and Omedes 1999: 350)

“Whimper, pout-mouth, grimace and *Scream* sequences occasionally accompanied copulation. Copulating females uttered *Screams* usually during eye contact with their partner. They usually started with 1 or 2 *scream-whistles*, then a series of *screams* that gradually turned into *bark-screams*, then usually at the end a *whistle* or a *scream-whistle*.” (Bermejo and Omedes 1999: 347)

“Silent teeth baring and *Scream* were often accompanied by a rocking gesture while soliciting genitogenital rubbing [between females]. Genitogenital rubbing was normally performed in silence, although on some occasions *Screams*, made of 1 or 2 short and soft *screams*, were used.” (Bermejo and Omedes 1999: 348)

[Section 3:]

Group size, social structure, and social dynamics

“Viewing language, however, as a form of communication adapted to the social environment may allow us to understand *why* language evolved and explain some of its peculiar characteristics.” (Maestriperi 1997a: 275)

“From a functional and evolutionary perspective, communication is a social adaptation. As long as the survival and reproduction of a living organism is affected by the presence and activity of other living organisms of the same or of a different species, the ability to exchange information between these organisms will be selected for by natural or sexual selection.” (Maestriperi 1997a: 273)

“In my view, an evolutionary approach to communication would mainly involve identifying the selective pressures and the constraints [imposed by the physical environment, the organisms’ own biological characteristics, and their phylogenetic history] that are responsible for differences in how organisms communicate and in what they communicate to each other.” (Maestriperi 1997a: 273)

“It may be argued that whereas the richness of the dominance/submission communicative repertoire reflects the potential for competition and conflict within groups, affiliative signals and bonding patterns probably reflect the need for intragroup cohesion and cooperation for defense against predators or competition with other groups.” (Maestriperi 2005: 69)

“Rhesus macaques live in a relatively despotic and nepotistic society characterized by high rates of aggression and spatial avoidance, and in which grooming and agonistic support mainly occur within clusters of matrilineal kin (Bernstein and Ehardt 1985; Kaplan 1977).” (Maestriperi 2005: 58)

“In a despotic and nepotistic society like that of rhesus macaques there may be little pressure to develop a sophisticated system of affiliative signals and bonding patterns. Maintenance of group structure and coordination of behavior between individuals can be effectively achieved if a few unequivocal indicators of differences in dominance are recognized and if unrelated or distantly-ranked individuals simply avoid each other (Maestriperi 1999).” (Maestriperi 2005: 69)

“The social dynamics of pigtail macaques are quite similar to those of rhesus macaques, but the lower levels of spatial avoidance, the higher reconciliation frequency, and the higher rates of approaches and grooming between pigtail females relative to rhesus (Bernstein et al. 1983; Maestriperi 1994) suggest that the pigtail macaque society is more cohesive and conciliatory than the rhesus society.” (Maestriperi 2005: 58)

“In pigtail macaques, instead, complex dynamics of intragroup cooperation and high levels of social tolerance appear to have led to the evolution of intense affiliative communication and bonding patterns.” (Maestriperi 2005: 69)

“The frequency of aggression in stumptails has been reported as higher than in rhesus and pigtailed (Butovskaya 1993a, b; de Waal and Ren 1988; Weigel 1980). Although some authors reported that stumptail aggression only rarely escalates to serious biting (de Waal and Ren 1988), according to others biting is as frequent as in rhesus and more frequent than in pigtailed (Bernstein 1980; Ruehlmann et al. 1988). Stumptail macaques also exhibit higher rates of proximity, contact, huddling, and grooming than rhesus and pigtailed (Bernstein 1980, Butovskaya 1993a; de Waal and Ren 1988; Maestriperi 1994). The co-existence of high intragroup aggression and high cohesion in stumptail macaques could be related to the retention of supernumerary adult males in the social group for competition with other groups or protection from predators (e.g., Bertrand 1969; Estrada et al. 1977). Stumptail males have been reported as being twice as aggressive as rhesus males and four times as aggressive as pigtailed males (Ruehlmann et al. 1988). Stumptail males are also significantly larger and more aggressive than females and easily overpower them also in sexual interactions, where forced copulations are not unusual (Bernstein et al. 1983; Bertrand 1969; Ruehlmann et al. 1988). Moreover, post-copulatory tying with females, prolonged mate guarding, and surreptitious copulations suggest intense mating and sperm competition between stumptail males (Brereton 1993; Estep et al. 1988).” (Maestriperi 2005: 58–59)

“The variety of assertive and submissive signals observed in stumptail macaques suggests a great potential for intraspecific conflict. Communication of dominance and submission, however, is also frequently accompanied by expressions of reassurance and bonding, suggesting the need for intragroup cohesion and cooperation.” (Maestriperi 2005: 69)

comments:

1. higher rates of grooming relevant for insights into human evolution (since it is hypothesized that larger groups require more grooming time, and larger groups characterized hominids)
2. retention of supernumerary males relevant for insights into human evolution: human groups do retain supernumerary males
3. the retention of supernumerary males for fighting other groups and protection from predators relevant for human evolution: since group size is directly proportional to predation pressures: and it is hypothesized that primary cause of larger group size in hominids was predation and intergroup conflict
4. prolonged mate guarding is relevant for insights into human evolution: what, after all, is marriage, if not prolonged mate guarding?
5. surreptitious copulations: here is the key to human morality
6. forced copulations also probably relevant—but what to do about greater male size? [less sexual dichotomy in humans represents more equal playing ground in terms of conflict between the sexes(?)]

“I suggest that PPCC [i.e., peaceful postconflict contact] is a signal meaning that the original conflict is over and that the signaler’s immediate intentions are now benign. These signals reduce uncertainty about whether aggression will continue and enable former opponents to reestablish peaceful contact. Thus, the primary function of PPCC is not to repair damaged social

relationships. Instead, PPCC is a means to a more immediate end—reestablishing contact with former opponents with no implicit long-term consequences.” (Silk 1996: 39)

“Quiet and inconspicuous signals can evolve when there is no conflict of interest between the signaler and the receiver (Krebs and Dawkins 1984). Natural selection is expected to favor honest signals of intent if actors who give such signals of intent are better off than actors who give dishonest signals, and if recipients who attend to such signals are better off than those who do not. It is easy to imagine that these conditions could be met after conflicts in primate groups.” (Silk 1996: 39)

[Material to Use]

Speech

“...the descent of the human tongue into the pharynx [...] did not yield a profound ‘leap’ in the efficacy of speech as a means of communication. The human tongue and supralaryngeal vocal tract allow us to produce perceptually salient quantal vowels with less effort (we don’t have to change the shape of our tongue). The quantal supervowel [i] also enhances the process of vocal tract normalization, contributing to the robustness of human speech as a means of communication. However, we could communicate vocally, albeit with somewhat greater articulatory efforts and perceptual uncertainty, if we were unable to produce [i]’s. The word identification error rate might increase by 5 to 10 percent, and it might be necessary to listen to a longer stretch of speech before deciding what words you actually had heard, but encoded speech communication still would be possible.” (Lieberman 2006, pp. 364–365)

“Quantal sounds have perceptually salient acoustic properties that can be produced with a certain degree of sloppiness on the part of a speaker. Speech communication would be perfectly possible without quantal sounds, but they enhance the robustness of the communicative process.” (Lieberman 2006, p. 279)

“...the human tongue increases the risk of choking to death and we have to keep in mind that there would have been no selective advantage for its evolution unless some form of speech were already present in the species ancestral to *Homo sapiens*. Natural selection works by enhancing existing capabilities.” (Lieberman 2006, p. 365)

“The factor that structures the consonant [and vowel] sound patterns of many languages seems to be Stevens’s (1972) quantal factor. Stevens showed that, at certain locations along the roof of the mouth, a constriction will result in two formant frequencies converging. These formant frequency convergences yield readily perceived peaks in the frequency spectrum, analagous to saturated colors.” (Lieberman 2006, p. 345)

COMMENTS

- (1) Comparative studies are needed (or maybe there already are such studies?) to see whether or not the acoustic signals of other animals’ vocal communications show quantal (spectral peak, convergence of formants) phenomena similar to humans’ quantal [i], [u], and [a].
- (2) The quantal nature of speech (the fact that constrictions at particular locations in the supralaryngeal vocal tract result in spectral peaks) suggests that there should be some statistical correlation between vowels and consonants in all the world’s languages (e.g., [ti], [di], [ka], and [ga] should occur more frequently than [ta], [da], [ki], and [gi]. I think that studies by MacNeilage (REFERENCES?) support this, as does my own analysis of Kobon, a language of Papua New Guinea (GET APPROPRIATE PAPERS).
- (3) The greater articulatory efforts and perceptual uncertainty that Lieberman claims would result in speech lacking in quantal vowels is quite similar to when one has to communicate using a language one does not know too well: despite the greater efforts and the misunderstanding, communication more or less happens.

(4) In any case, for organisms using a vocal communicative system lacking in quantal phenomena, their perceptual system would be coadapted to the articulatory system: whatever sounds an organism would be able to produce, it would also be able to hear.

“... the shape of the tongue is almost identical for all vowel sounds and is moved about as an almost undeformed body. Some speakers produce all of the vowels of English (the most intensively studied language) with their tongues in the *same* position, except for the quantal vowels [i], [u], and [a]. These speakers use lip maneuvers (protrusion and constriction) and adjustments in larynx height to generate the formant frequencies that specify different vowels. Moreover, different speakers employ different tongue positions when they produce the same vowel.” (Lieberman 2006, p. 343)

“...quantitative studies consistently show that the human tongue is simply moved about as an almost undeformed body with appropriate lip maneuvers, [and] sometimes raising the larynx (for an [i]) or lowering it (for a [u]).” (Lieberman 2006, p. 287)

“Laryngeal descent, absent tongue displacement, lowers formant frequencies but does not increase phonetic range.” (Lieberman 2006, p. 275)

“Deer [and other animals, including humans] apparently associate lower formants with greater size and biologic fitness, which perhaps explains the lower larynges of male deer and the prevalence of calls with transiently lowered larynges during the mating season.” (Lieberman 2006, p. 275)

“... in the late 1960s, the late Ignatius Mattingly examined the database of formant frequency values of the Peterson and Barney (1952) study. Mattingly found almost no overlap between male and female vowels. Men whose voices had high pitches nonetheless sounded male. [...] despite the overlap in stature and SVT [supralaryngeal vocal tract] length [in males and females], male formant frequencies were consistently lower and appeared to be the primary acoustic cue signaling gender. Mattingly reasoned that adult males most likely lengthened their SVTs by protruding their lips slightly; they may have also lowered their larynges, effectively producing ‘male-speak’ vowels that had lower formant frequencies. Women apparently employed different tactics, smiling slightly as they talked to shorten the effective length of their SVTs.” (Lieberman 2006, pp. 276–277)

“A subsequent study revealed that children growing up in Connecticut about fifty miles from Haskins Laboratories produced gender-specific speech at an early age. No one tutored the children; some unconscious process of imitation and ‘statistical’ inference resulted in their modeling their vocal behavior on these prevailing male-female patterns. At age five years, boys and girls as a group do not differ in height or weight. Nor are there systematic differences in their larynges that would result in lower voice pitch for boys. However, the boys’ voices were consistently recognized as belonging to boys because they lowered the formant frequencies of their vowels by protruding and rounding their lips (Sachs, Lieberman, and Erikson 1972). These articulatory maneuvers will lower formants (Chiba and Kajimaya 1941; Fant 1960). The girls,

except for some who were considered tomboys, smiled and retracted their lips slightly, thereby producing higher formant frequencies.” (Lieberman 2006, p. 277)

COMMENTS

(1) The “appropriate lip maneuvers” that Lieberman mentions include: a) retraction of lips and baring slightly of teeth, smile- or grimace-like for vowels such as [i] (and [I], [e], [E], and [æ] to lesser degrees?), which raises formant frequencies; and b) protruding and rounding lips for [u] (and [U] and [o]), which lowers formant frequencies. The vowel [a] tends to have no lip maneuvers, or neutral lip maneuvers (?).

(2) In addition to their ability, like deer, to raise and lower their larynges, non-human primates, unlike deer (?), are able to retract their lips and bare their teeth, as well as protrude and round their lips. These lip maneuvers are associated with particular communicative gestures and particular emotions. In addition, if phonation is present, the lips retracted–teeth bared gesture will sound something like [i] to a human, while the lips protruded and rounded gesture will sound something like a [u] to a human, based simply, it would seem, on the spectral properties of the formants. Thus, even if it is assumed that non-human primates cannot use their tongues to change their SVT constriction, and despite the fact that their tongues are positioned in their mouth, rather than half in mouth, half in pharynx, as in humans, they can use their larynges and their lips to change their formant frequencies. Have there been acoustic studies of these gestures? (REFERENCES?)

(3) Pharyngeal constriction (pharyngealization), which lowers formant frequencies (?), is also used to signal gender differences in languages such as Arabic (REFERENCES?). It would seem that other animals, including non-human primates, are also able to constrict their pharynxes. Also, my own experience in France, where it seemed obvious that men lowered, and women raised, to stereotypic degrees, their formant frequencies.

(4) The sociocultural factors (can also mention cases where males would utilize higher frequencies, such as in theatre or gay cultures, and females lower, such as lesbians or women in stereotypically male jobs, such as police, military, or construction), in addition to the anatomic factors, involved with transiently raising or lowering formant frequencies, raise the possibilities of sexual selection, either Darwinian or Zahavian, being involved. And bear in mind that raising or lowering formant frequencies, despite the real length of SVT and intrinsic properties of larynges (F0), is a form of—lying, or manipulation (not just of one’s own articulatory apparatus) of others. (PARASITISM)

“...formant frequency dispersion [third formant minus first formant (F3-F1)] tracks body size in non-human primates and other animals [e.g., SVT length is directly proportional to body size, and formant frequency dispersion is inversely proportional to SVT length] (Fitch 2000)...” (Lieberman 2006, p. 278)

These “findings establish a preadaptive basis for formant frequency variations playing a role in human speech. Coupled with the fact that formant frequencies, patterns used for communication, can be produced or perceived by a wide variety of mammals (Warden and Warner 1928; Baru 1975; Owren and Bernacki 1988; Owren 1990; Fitch 1997) and birds (Heinz, Sachs, and Sinnott 1981; Dooling 1992), [this] data demonstrate, beyond reasonable doubt, that many species vocally communicate critical information, thereby enhancing their biologic fitness, using formant frequency patterns. Moreover, monkeys (Riede et al. 2005) and chimpanzees (Slocombe and

Zuberbuhler 2005) make use of formant frequency patterns as well as F0 patterns to convey referential information. These comparative studies establish a critical link between human speech, which relies on formant frequency encoding, and the vocal communications of other species. And it [sic] may explain why we have peculiar tongues. [Do we? Rather, it seems, it is the *placement* of the tongue that is different from other primates: rather than fully in mouth, our tongue is placed half in mouth, half in pharynx, giving a 1:1 oral:pharyngeal ratio.] Vocal communication that relied on formant frequency patterns would have provided an adaptive value for anatomy that enhanced the process of vocal tract normalization through the production of the supervowel [i].” (Lieberman 2006, pp. 278–279)

COMMENTS

(1) The quantal vowels (or “supervowels”) [i] and [u] seem to be used as “perceptual anchor point[s] for vocal tract normalization” (Lieberman 2006, p. 115); that is, listeners use these vowels to estimate a speaker’s SVT length.

(2) Estimation of speaker’s SVT length and use of quantal vowels as referents in acoustic space help the listener to distinguish the speaker’s other, non-quantal, vowels: “Human listeners, therefore, clearly interpret vowel sounds by means of a perceptual process that involves knowledge of the physiologic constraints of the SVT, including its length.” (Lieberman 2006, p. 118)

(3) From studies (such as Fitch’s) showing that other animals use F0 and formant frequencies to estimate body size, Lieberman (2006, p. 278) incorrectly concludes that other animals “always produce the same vowel” [what he seems to be missing is that the studies must have measured the same behavior–call type to make comparisons; in this case, he would be right if he said that “these creatures always produce the same vowel in the same call”] [READ REFERENCES!]

(4) Even in the absence of quantal vowels, if there is a given call-behavior invariant (such as a specific call that, deer, use in the mating season) in any given animal vocal communication system, that allows animals to estimate body size, this information could be used by the animals to calculate SVT length, and therefore could be used as a perceptual anchor for vocal tract normalization in the same way as humans do.

(5) Since there are call-behavior invariants, and animals do use them calculate body size, and most animals have many other calls, these calls could very well have vowel- and consonant-like—that is, speech-like—properties, because the animals could calculate an appropriate articulatory-perceptual space for the call inventory of each animal, based on vocal tract normalization–body size estimation.

(6) Non-human primates a) use F0 and formant frequencies to calculate body size; and b) make communicative facial gestures, such as retracting lips and baring teeth, protruding and rounding lips, and relaxed open jaw expression, that are very similar to the “appropriate lip maneuvers” associated with the human quantal vowels [i], [u], and [a], respectively.

(7) Therefore, one can conclude that a) in addition to its spectral properties resulting from vocal tract constriction in a particular place, each quantal vowel is also associated with a particular facial gesture or “appropriate lip maneuvers”; b) these appropriate lip maneuvers are homologous to the relevant communicative facial gestures in non-human primates; and c) therefore the quantal vowels are homologous to particular non-human primate vocalizations, and the quantal nature of [i], [u], and [a] derives not just from their proximate spectral nature, from their emotional phylogeny.

(8) Possible test: a) Non-human primate bare-teeth grimace associated with fear; therefore, in a statistical test of the world's languages, do words signifying the *facial gestures and emotions* associated with fear correlate with vowels that involve the lip maneuvers appropriate for [i]; that is, is there a preponderance of [i]'s in such words, as in fear [fir]? b) Likewise, non-human primate protrude, rounded lip gesture associated with begging sadness (pouting); any correlations with words of world's languages that signify pouting and their containing rounded vowels? c) In the world's languages, do words such as smile, grimace, grin, tend to contain [i], as well as dental or alveolar consonants? d) Likewise, for words for mouth and lips: do they tend to have rounded vowels, bilabial consonants?

(9) Another way of thinking about the situation: Quantal vowels as homologues to long-distance calls of non-human primates. In up-close, face-face communication, the actors know the body size of each other, do not need to use sounds to calculate vocal tract length. Vowel (and consonant) inventories inversely correlated with speech-group size: larger the group, more likelihood of having to calculate body size and vocal tract length from sound, more need for quantal vowels. Hence, the shift in, English, towards the quantal vowels over time, as the population of English speakers increased and frequency of encountering strangers, with unknown SVT lengths, increased. In a small society where most encounters are up-close, face-face, intimate, less need of quantal vowels; more opportunity for there to be subtle differences in vowels and meaning. Thus, for instance, the chimpanzee pant-hoot, a long-distance call involving lip rounding and protrusion, is a homologue to the quantal vowel [u], and is used by listening chimps, especially those in other groups, far away, who cannot see the chimp making the call, as a way to estimate the caller's body size, as well as calibrate the rest of the calls in its repertoire. Conversely, the calling chimp wants to use the call to lie about his body size, to make himself seem to be larger, by using lower frequencies.

Human speech evolved out of the interplay of both long-distance and intimate calls. Intimate calls such as the lipsmack, the homologue of the syllable of speech; quantal vowels, homologues of long-distance calls. The evolution of speech involved both cooperation, as well as parasitism or manipulation. Both an "arms race" between caller and hearer (especially between in-group and out-group), and selection pressures to cooperate (especially in an in-group).

In other words, just as babbling and speech are homologous in ontogeny, so too are the lipsmack and speech in phylogeny. The lipsmack, and related communicative facial gestures, is a shared primitive feature of the anthropoid primates, while the syllabic frame of speech is the derived feature characteristic of hominids. The lipsmack is a "preadaptation" for speech. Conversely, speech is an elaborated lipsmack, and both evolved in the context of mutual grooming.

Lipsmack

"Lund and Enomoto (1988) characterize mastication as 'one of the types of rhythmical movements that are (sic) made by coordinated action of masticatory, facial, lingual, neck and supra- and infra-hyoid muscles' (p. 49). In fact, this description is apt for speech." (MacNeilage 1998, p. 503)

“Is it a mere coincidence that the frame dominance pattern that we have found in both babbling and the earliest words is similar to the pattern postulated here for the earliest speech of hominids, or is this pattern showing us the most basic properties of hominid speech production? If the earliest speech patterns were not like this, what *were* they like and why? And why has this question not received attention?” (MacNeilage 1998, p. 505)

“If babbling and early speech patterns are similar to those of the first language, what was it like? I have proposed ‘that the conjoint set of sounds and sound patterns favored in babbling *and* in the world’s languages constitutes, in effect, the fossil record of true speech’ (MacNeilage 1994).” (MacNeilage 1998, p. 505)

“... the evolution of the mouth open-close alternation for speech [e.g., the syllable] is seen as the tinkering of an already available motor cyclicity [e.g., the lipsmack] into use as a general purpose carrier wave for time-extended message production, with its subsequent modulation increasing message set size.” (MacNeilage 1998, p. 506)

“According to the F/C [frame/content] theory, the evolution of the control of the movements of speech from prespeech vocalizations involved preexisting phonatory capacities and a specific series of adaptations proceeding from ingestive cyclicities, via visuofacial cyclicities [e.g., lipsmacks], to syllables, which ultimately became modulated in their internal content.” (MacNeilage 1998, p. 511)

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The Midwife's Tale: Assisted Childbirth and the Origin of Language

Argument

The midwife's tale begins with a simple constraint. Large-brained, bipedal hominids cannot exist without assisted childbirth. To pass a large-brained fetus through a narrow pelvic opening, especially the first time she tries to do it, a hominid mother needs help. Neither she nor her child will survive without it. Assisted childbirth allowed mother and infant to survive, and their hominid descendants to evolve. The unique human anatomical syndrome of large brain and narrow pelvis adapted to upright walking evolved in the context of assisted childbirth, as did speech and language. Assisted childbirth evolved in the context of mutual grooming. Midwifery, in a way, is a specialized, elaborated case of mutual grooming.

Schematically, mutual grooming consists of two components: a manual component and an oral component. The technical skills required for midwifery evolved out of the manual component of grooming; speech evolved out of the oral component. For the sake of argument, the midwife's tale calls the oral component of mutual grooming the *lipsmack*, and the manual component, the *handpick*. Lipsmack and handpick are the primitive features of grooming, shared by all non-human primates. In hominids, the derived homologues of these two features are speech and the technical skills required for assisted childbirth. In other words, the lipsmack evolved into speech; the handpick, into assisted childbirth. Assisted childbirth breaks the anatomical constraints of bipedalism, allowing a large brain—filled with all things human—to evolve. In humans, language and manual skills are so closely tied together because both evolved out of the oral and manual components of mutual grooming within the context of assisted childbirth.

Grooming Overview

In cats and other mammals with paws instead of hands, grooming has only one, oral, component. The oral component can be broken down into the *lick* and the *fleabite*. The fleabite is a brief burst of rapid chewing. The opening and closing actions of the fleabite are faster than those for normal chewing of food. Grooming consists of sequences of licks and fleabites. In addition to grooming the self, cats also use this sequence of licks and fleabites for affiliative, communicative behavior towards another cat. A cat will show affection for another cat with a brief burst of licking and fleabiting. This grooming of another cat does not usually last long, for cats spend most of their time grooming themselves, not each other. Grooming the other, or *allogrooming*, in cats, is largely communicative; practical grooming is largely of the self, or *autogrooming*.

In primates, however, allogrooming is both communicative and practical. Primates spend much of their time grooming each other. Since primates are mammals with hands, grooming has two components. Hands and mouth are both used to pick through another's fur. The oral component of grooming consists of licking, and an oral gesture homologous with the cat's fleabite. Like the cat fleabite, the primate fleabite is a rapid chewing action in which the opening and closing of the jaw is faster than for normal chewing of food. Like the cat's fleabite, the primate fleabite has both practical and communicative functions. The communicative aspect of the primate fleabite is called by primatologists the *lipsmack*. The lipsmack is an affiliative, communicative gesture that many primates use to show either a desire to groom, or a wish to be groomed by, another. It is

thus often used at the start of a session of mutual grooming. It is also used during grooming. The practical fleabite and the communicative lipsmack, of course, grade into each other. But, in terms of orofacial gesture, both are repetitive, syllable-like, rapid opening and closings of the mouth. And both, intentionally or not, are sometimes accompanied by phonation. For the sake of the midwife's tale, all that matters is that the primate lipsmack and the syllable of human speech are homologous. The lipsmack is the primitive feature from which the derived syllable evolved. Speech, in a way, is an elaborated lipsmack. And just as the lipsmack occurs in the context of mutual grooming, so too does speech. Speech is an elaborated lipsmack that evolved in the context of the specialized mutual grooming called midwifery, or assisted childbirth. The primitive manual component of primate grooming is the *handpick*. A subset of manual sequences involved in the handpick became elaborated and specialized in the context of assisted childbirth, and evolved into the midwife's technical abilities.

[USED MATERIAL:]

“Submissive signals such as Bared-Teeth and Present are remarkably similar in rhesus, pigtail, and stumptail macaques, suggesting that these signals (probably along with threat displays, the play-face, Lip-Smack, and Mount) were present in the ancestor of these species. In fact, these signals also appear in most, if not all, of the other African Cercopithecidae (Andrew 1963b; van Hooff 1967; Redican 1975).” (p.70)

“Teeth-Chatter has been reported in Barbary macaques (*Macaca sylvanus*; van Hooff 1967), which are believed to be the most ancestral macaque species, and in macaque species of the silenus group (e.g., bonnet, Tibetan, and assamese macaques), which are probably closely related to stumptail macaques (Fooden 1980).” (Maestriperieri 2005: 70)

“Hip-Clasp and perhaps also Touch-Genitals between stumptail adults probably develop from ritualized interactions between adults and infants in which adults lift the infant’s hindquarters and hold them briefly while manipulating the infant’s genitals and teeth-chattering (this interaction has been referred to as ‘bridging’; Bertrand 1969; see Ogawa 1995, for *Macaca thibetana*).” (Maestriperieri 2005: 70)

Facial communicative gestures of rhesus, pigtail, and stumptail macaques relevant for the evolution of speech (Maestriperieri 2005: 60):

Summary of Maestriperieri (2005):

Three groups of macaques observed for 100 hours each at Yerkes National Primate Research Center in Lawrenceville, Georgia.

rhesus (*Macaca mulatta*) group: 2 adult males, 26 adult females with subadult, juvenile, and infant offspring, for a total (N) of 78 individuals

pigtail (*M. nemestrina*) group: 5 adult males, 28 adult females with offspring; N=65

stumptail (*M. arctoides*) group: 8 adult males, 17 adult females with offspring; N=38

Gestures showing rhythmic cyclicity (relevant to syllable):

Lip-Smack (LS)

- Rapid opening and closing of mouth and lips, such that when the lips close they make an audible smacking sound
- More frequent in pigtails than rhesus and stumptails; no significant difference between rhesus and stumptails: $P > R = S$
- One of most frequent signals in all three species (p. 68)
- Almost all lipsmacks were directed up the hierarchy (from subdominant to dominant) in pigtails; slightly more than 75% of lipsmacks were directed up hierarchy in stumptails; slightly less than 75% of lipsmacks directed up hierarchy in rhesus
- Pigtails: 14.58% of lipsmacks were displayed after receiving aggression; 26.39% in response to an approach (usually by a dominant); 19.59% in conjunction with a spontaneous approach (i.e., the unsolicited approacher lipsmacks); 18.04% prior to affiliation

- Rhesus: 1.96% of lipsmacks were displayed after receiving aggression; 1.96% in response to an approach; 52.95% in conjunction with a spontaneous approach; 60.78% prior to affiliation
- Stumptails: 8.82% of lipsmacks were displayed after receiving aggression; 20.58% in response to an approach; 41.17% in conjunction with a spontaneous approach; 57.35% prior to affiliation

Teeth-Chatter (TC)

- Mouth rapidly opened and closed; lips retracted, exposing teeth
- Common in stumptails; virtually absent in pigtailed and rhesus: S>R=P
- Directed up the hierarchy
- “Virtually unique to stumptails” (p. 68)
- “Often associated with Hip-Touch, Hip-Clasp, Mount, and Embrace between females” (p. 68)

Gestures with no rhythmic cyclicity, but relevant to vocal tract modulation:

Pucker (PC)

- “Lips compressed and protruded; eyebrows, forehead and ears retracted”
- “Common in pigtailed; very rare in rhesus and nonexistent in stumptails”
- “Most frequent gesture observed in pigtailed macaques; never observed among stumptails; only on a few occasions among rhesus” (p. 67)
- “In pigtailed, displayed by both males and females independent of dominance rank, in a variety of social contexts, including mating, grooming, and interactions with infants” (p. 67)
- “Does not have clear relationship with dominance” (p. 68)
- “Previous studies showed that Pucker is used to coordinate and facilitate the occurrence of mating, grooming, and interactions with infants. (Maestripieri 1996a; see also Jensen and Gordon 1970)” (p. 69)

Bared-Teeth (BT)

- Mouth closed; lips and lip corners retracted, exposing a white band of teeth
- More frequent in stumptails than rhesus and pigtailed, with no significant difference between rhesus and pigtailed: S>R=P
- One of most frequent signals in all three species (p. 68)
- Almost always directed up the hierarchy in all three species
- Submissive signal elicited when dominant performed Face-Inspect on subdominant (p. 68)

Eye-Brows (EB)

- Scalp and brow retracted; mouth open
- Unique to pigtailed (p. 67)
- “Frequently exchanged between males, irrespective of dominance rank, in conjunction with approach-retreat interactions, Hip-Touch, grunts, and occasionally brief bouts of play” (p. 67)
- “Occurred in conjunction with agonistic support; often followed by affiliation” (p. 67)

Lip-Smack and Bared-Teeth “were frequent (≥ 1 event per individual) in all three species but their frequency of occurrence was significantly different...”

“Lip-Smack was more frequent in pigtaails than in rhesus and stumptails [...] there was no significant difference between rhesus and stumptails” [LS(P>R=S)]

Bared-Teeth was “more frequent in stumptails than in rhesus and pigtaails, with no significant difference between rhesus and pigtaails.” [BT(S>R=P)]
(Maestriperri 2005: 62–63)

Eyebrow seemed to be displayed only by rhesus

“Pucker was common in pigtail macaques, but very rare in rhesus and nonexistent in stumptails.

In contrast, Teeth-Chatter [was] common in stumptails but virtually absent in the other two species.” (Maestriperri 2005: 64)

PC(P>R=S)

TC(S>R=P)