A gradualist account of the origins of displaced reference might start with the observation that the only circumstance in which nonhumans send signals in the absence of the referent is when they are engaging in deception, such as when birds send false alarm signals in order to frighten competitors from a food source (Munn 1986). Of course, in order for our ancestors to have been able to discuss things not in evidence, the receiver of the signal would have had to be clued into the trick, which would preclude actual deception. Perhaps the line was crossed when two individuals formed a coalition to deceive another, enabling the coalition members to share an understanding that a signal was to be used independent of its referent. Once it was established that a signal could be used without its referent being present, it would have been a relatively short step to real displaced reference, unconnected to deception. Although it is a very long way from coalition-based deception using signals to human language as we now know it, perhaps this was how the transition from an animal signaling system to human language began (see Wray [2002] for more on the evolution of displaced reference). As Knight (1998a; 1998b; see also Knight et al. 1995) has pointed out, such a scenario would require high levels of trust among coalition members. This might have been facilitated by kinship and, in line with Falk's scenario, a signaling system rooted in the trustworthy soil of motherese and its precursors.

Whether displaced reference has its origin in coalitional deception or somewhere else, one thing is certain: Only a continuity theory of the origin of human language can account for this or any other discontinuity between it and nonhuman signaling systems.

ACKNOWLEDGMENTS

I thank William Irons, Beth Leech, and Lars Rodseth for their comments on a draft of this commentary.

Syntax: An evolutionary stepchild

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Abstract: Dean Falk has strategically explored "mother-infant gestural and vocal interactions . . . in chimpanzees and humans" in order to offer hypotheses "about the evolutionary underpinnings that preceded the first glimmerings of language." Though she offers compelling evidence for many interesting hypotheses as to the epigenesis of language, other possibilities have yet to be explored. Here we explore the role of gestural communication among deaf signers and the neural correlates associated with this type of communication.

In her article *Prelinguistic evolution in early hominins: Whence motherese?*, Dean Falk strategically explores "mother-infant gestural and vocal interactions . . . in chimpanzees and humans" in order to offer hypotheses "about the evolutionary underpinnings that preceded the first glimmerings of language." Though she offers compelling evidence for many interesting hypotheses as to the epigenesis of language, other possibilities have yet to be explored.

One such possibility is whether the structure/syntax of the languages we use today was molded to best fit a preestablished cortical organization for linguistics and the related tasks, and, if so, is this organization modality dependent? Is linguistic structure/syntax a function of the organization of the left-hemisphere? Is language innate; can it be evolutionarily traced? If so, what implications does this have in the ever-present question of the evolution of language?

We know from existing literature and in vivo studies that nonhuman primates communicate using gestures, a type of "signed language," and that humans for the most part communicate using a spoken language. The primary difference between signed and spoken language is that sign relies "on spatial contrasts while speech is linear and non-spatial" (Goldin-Meadow 1999). In verbal communicators, a lesion to the left hemisphere usually produces deficits on linguistic tasks, whereas damage to the right hemisphere usually produces deficits in spatial tasks. Similarly, when human nonverbal communicators sustain damage to the left hemisphere, they perform more poorly on linguistic tasks but do not exhibit the same spatial deficits that signers with right-hemisphere damage do. The implications of these findings are that in humans, sign seems to be processed as linguistic information rather than spatial information; therefore implicating the left hemisphere in linguistics, regardless of transmission (Goldin-Meadow 1999).

When deaf children of nondeaf parents are not taught to sign and have not acquired speech because of their hearing impairment, they independently create a system of gestural communication that takes on a structure similar to that of spoken language and is consistent across cultures (Goldin-Meadow 1999; Goldin-Meadow & Mylander 1998). A possible explanation for why deaf children create linguistically oriented gestures and hearing children do not, may relate to the notion that gesture needs to take on grammatical properties only when it has to carry the full burden of communication. When used in conjunction with speech, gesture does not have to convey (all) meaning; therefore, it does not assume a language-like form (Goldin-Meadow 1999).

A cortical region implicated in nonverbal communication is the superior temporal sulcus (STS). When congenitally deaf signers and hearing expert signers are presented both with sign language and with nonmeaningful gestures, activation of the STS was noted (Allison et al. 2000). Furthermore, while viewing American Sign Language sentences, those who are unfamiliar with the language showed no activation of the STS. These results are indicative of the STS's role in the perception of ASL. Further support of this hypothesis can be seen when studying monkeys. "In monkeys, responsiveness of STS cells was greater to a hand making a movement than to a bar of the same size making the same movement, demonstrating that the cells are preferentially responsive to biological motion" (Allison et al. 2000; Rizzolatti & Arbib1998; 1999; Rizzolatti et al. 1996; 2002). This applies to humans in that the cellular organization of the STS may provide a predisposition for the perception of communicative or meaningful hand gestures, but not for meaningless hand movements.

The cortical response to the observation of action in both human and nonhuman primates is very similar and supports the above findings. In humans, PET studies revealed that the observation of an action, such as grasping, activated the STS, the inferior parietal lobule, and the inferior frontal gyrus (area 45); all activation sites were limited to the left hemisphere (Rizzolatti & Arbib 1998). The activation found in humans parallels that found in nonhuman primates on similar tasks, thereby indicating "that, in primates, there is a fundamental mechanism for action recognition" (Rizzolatti & Arbib 1998). This is very interesting because the stimuli used in these experiments were not tied to linguistics; however, the findings may implicate "that this action-recognition mechanism has been the basis for language development" (Rizzolatti & Arbib 1998).

These findings suggest that the left hemisphere may not simply be responsible for language tasks, but for all linguistic tasks, including the recognition and processing of multiple modalities of communication – one of these modalities being gestural communication, from which it may be possible that language as we now know it has evolved. In Rizzolatti and Arbib (1998), a notion is put forth that the nonhuman primate homolog to the human cortical area known as Broca's is area F5 (the rostral part of the monkey ventral premotor cortex). "The reasons for this view are that both F5 and Broca's area are parts of inferior area 6 and their location within the agranular frontal cortex is similar; and cytoarchitectonically, there are strong similarities between area 44 (the caudal part of Broca's area) and F5" (Rizzolatti & Arbib 1998).

The major difference in conceptualization of these two areas is that Broca's is commonly associated with speech, F5 with hand

https://doi.org/10.1017/S0140525X04310113 Published online by Cambridge University Press

movements. However, it is only the dorsal part of F5 that is responsible for hand movements, not inclusive of the ventral part, which is representative of mouth and larynx control, the prerequisites for speech (Rizzolatti et al. 1998). Furthermore, PET studies (such as the ones mentioned above) have implicated Broca's area in action-recognition of certain hand movements (e.g., Rizzolatti et al. 1996). It is possible that this hand movement recognition was the precursor to the recognition of meaningful hand movements (e.g., pointing or indicating danger), which are also processed in the left hemisphere. Furthermore, these meaningful hand movements are a basis for communication, a gestural communication that, coupled with the development and evolution of controlled mouth and larynx movements, could have evolved into a verbal communication that we use today.

ACKNOWLEDGMENT

The authors thank Tom Myers for help in preparing this commentary.

Motherese is but one part of a ritualized, multimodal, temporally organized, affiliative interaction

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Abstract: Visual (facial), tactile, and gestural, as well as vocal, elements of mother-infant interactions are each formalizations, repetitions, exaggerations, and elaborations of ordinary adult communicative signals of affiliation – suggesting ritualization. They are temporally organized and enable emotional coordination of the interacting pair. This larger view of motherese supports Falk's claim that the social-emotional elements of language are primary and suggests that language and music have common evolutionary foundations.

Falk's article emphasizes the important roles of visual, gestural, and tactile signals to infants, in addition to the vocal aspects that have been the primary locus of language origin studies. Her arguments about the importance of sociality and affect in mother-infant prelinguistic interchanges would be strengthened if they also incorporated provocative evidence that in the interactions these multimodal behaviors are *temporally coordinated.* If mothers "[modify] their vocal and gestural repertoires to shape and consciously control" infant behavior (sect. 3.2.1), it can be pointed out that shaping and controlling are temporal processes.

Infants are born prepared to engage in temporally organized interactions (Trevarthen 1997; 1999). Desynchronization experiments reveal that infants as young as 4- to 8-weeks old (Murray & Trevarthen 1985) expect social contingency, defined as "interpersonal sequential dependency," in which the behavior and affect of both partners (as expressed in face, voice, and bodily movement) are coordinated or "attuned" (Jaffe et al. 2001, pp. 13–14; Stern et al. 1985). When normal ongoing playful interaction via dual video is experimentally desynchronized (i.e., the baby is presented with a slightly delayed replayed recorded sequence of just-experienced positive interaction with the mother), 6- to 12-week-old infants show signs of psychological distress such as averted gaze, closed mouth, frown, grimace, fingering of clothing, and the displacement activity of yawning (Murray & Trevarthen 1985; Nadel 1996; Nadel et al. 1999). This emotional/behavioral coordination is more than "social." It is *relational,* and, like motherese (which is but one element in the engagement), it has developmental benefits and adaptive implications.

I have argued (Dissanayake 2000; 2001) that mother-infant interaction is a ritualized behavior like those described by ethologists (e.g., Eibl-Eibesfeldt 1989, pp. 439–40; Tinbergen 1952) for other animals, in which behaviors from one context (here, ordinary communicative indications of adult friendliness or readiness for contact) are altered – simplified or stereotyped, repeated, exaggerated, and elaborated – and take on new meaning in a new context (here, mother-infant interaction). The "ritualized" facial expressions of adults in interactions with infants typically include widened eyes, raised eyebrows, and a sustained open mouth or smile, all of which in their unritualized form indicate affiliation or friendly intention. Gesturally, adults sharply bob back their heads or nod rhythmically to infants, again presenting an exaggeration of head movements that conventionally signal affiliation in adults. Adults lean toward and away from an infant and give rhythmic touches and pats – again, friendly human gestures that are also common in many nonhuman primates. Vocalizations to infants by human mothers, as Falk describes, are soft, breathy, undulant and inviting, or soothing, with much repetition – that is, exaggerations of nonthreatening and affiliative adult utterances.

These components of mother-infant interaction do not occur in isolation, and they appear to be processed crossmodally (Schore 1994), as the pair co-create and share a common pulse and emotional quality which Trevarthen and Malloch (2000) call "affecting chains" or sequences of expression.

Ritualized, multimodal, temporally coordinated interactions are important in their own right at 4 to 12 weeks of age, long before they are co-opted and altered further for didactic language-learning purposes at age 5–8 months and later. Falk remarks (sect. 2.2) that ID speech contributes initially to emotional regulation, then to socialization, and finally to the organization of speech. If for "ID speech," one substitutes "the package of ritualized behaviors, including temporal, dialogic, and emotional aspects," one further emphasizes the importance of the emotional (prosodic) elements of speech (phylogenetically and ontogenetically), and its dialogic nature – overlooked aspects that Falk seeks to remedy.

Incorporating this additional evidence of the social-emotional nature of the interaction also supports Falk's suggestion that motherese could have been a precursor to (or antecedent of) the social grooming origin and function of language. It additionally supports suggestions that music and language have a common evolutionary foundation (Morley 2002).

Falk describes well in section 3 the anatomical changes in bipedal, large-brained hominins that required new adaptive strategies for the survival of relatively undeveloped infants. If mothers made ritualized affiliative signals in several modalities to their infants, they would concurrently reinforce affiliative circuits in their own brain; infants in turn would respond affectively, displaying their interactive lovability and thereby attracting maternal care. Co-creating a dialogue within a common pulse would further coordinate the affective state of the participants, promoting willing maternal care (i.e., infant survival and maternal reproductive success). Even today, neurobiologists describe the pathological effects to infants of defective interactive abilities of either infant or mother (Aitken & Trevarthen 1997, Koulomzin et al. 2002; Schore 1994; Trevarthen & Aitken 1994) corroborating others' findings about the beneficial effects of mother-infant interaction.

I suggest that putting the baby down and interacting vocally at a distance would have come, evolutionarily, *after* the establishment of ritualized mother-infant interaction as described here. The importance of face-to-face communication is evinced in "still face" experiments with 2- to 9-month-old infants (Murray & Trevarthen 1985; Tronick 1989), in which an expressionless mother provoked infant distress, and also in the prominence of mutual gaze, a striking feature of mother-infant interaction in many if not all cultures. Falk points out that "mothers unconsciously establish eye contact with infants and then use motherese to maintain joint attention" (sect. 2.2). Actually, however, the capacity for "sustained mutual visual regard" – normally a threat signal, although it also appears in affiliative contexts in bonobos – is present by approximately the second month (Beebe 1982, p. 171). Accompanied by adult smiling and soft, repeated vocalizations, mutual gaze in an infant's early weeks accomplishes more than joint attention. Some researchers consider face-to-face communication and/or mutual gaze critically important to subsequent

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