language, does not Falk's logical argument collapse? Or, should she have used *protomotherese* and then explained under which constraints motherese evolved from protomotherese? The root of this aporia may be the second fallacy that permeates this article.

From the kind of indirect evidence the author marshals in support of her hypothesis, she is clearly implying that the observation of developmental behaviors, in both primates and humans, provides reliable information regarding the evolution of these behaviors. The assumption made by Haeckel in 1866 that ontogeny "recapitulates" phylogeny seems to be the reason Falk devotes a good half of her paper to reviewing the abundant literature pertaining to early language learning and to apes' maternal behavior. Although the latter may have changed over time in response to environmental conditions and may even be susceptible to cultural variations (Van Schaik et al. 2003), the former cannot yield any clues regarding the origin of language. To think that the ontogenic development of language learning can be a window on the evolution of language as such is not a tenable option. The idea that ontogeny (the growth of an embryo) recapitulates phylogeny (the evolutionary history of a species) has long been discredited. Yet Haeckel's notorious biogenetic law still provides a powerful metaphoric model to which Falk bears witness in her conclusion: "Motherese . . . is the *only* available model for elucidating how humans universally acquire spoken languages today, and therefore may have acquired them in the past" (sect. 4, para. 1, emphasis Falk's). This statement is either trivial (all children learn their native languages along the same developmental steps now as they did in the past) or a play on words ("acquire" does not have the same meaning in the premise as in the conclusion). This is not a robust argument.

Would only going back in time, as Falk rhetorically suggests in her final paragraph, enable us to discover the "true" origin of language and settle the debate? This is unlikely. We are contemporary of many evolutionary processes that we experience and observe without understanding them in spite of investing considerable resources to solve the problem of their true nature. The conundrum of language origins is only one aspect of our ignorance of the very ontology of language. This does not mean that we should not keep trying to formulate hypotheses, notably regarding interdependent, multilinear evolutionary factors.

Bipedalism, canine tooth reduction, and obligatory tool use

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Abstract: Bipedalism in the earliest hominid specimens is always accompanied by the reduction of projecting canine teeth. Body size is smaller than chimpanzees or humans, but molar teeth are markedly larger. Use of a pointed stick for defensive purposes on the one hand, and digging for USOs on the other, may be why bipedalism was selected for. Passing such learned behavior to the next generation may have played a role in selecting for language.

There is another aspect of the circumstances associated with the adoption of a bipedal mode of locomotion that may well have contributed to the development of the linguistic realm. Hominid bipedalism is slow, and our early bipedal relatives were relatively small of size (Hartwig-Scherer 1993). The survival of small, slow-footed hominids on the African savannas or the adjacent open woodlands would only have been possible if they had possessed a means of defense which transcended that of the other primates that are found in similar kinds of habitats. Baboons defend themselves with truly formidable canine teeth, but the early hominids had canine teeth that did not project beyond the occlusal surface of the rest of the teeth in the dental arch.

The late Sherwood Washburn made the observation that if the baboon were to employ a digging stick to assist in foraging, it could nearly double its food-getting efficiency (Washburn 1959; 1960). This may very well have been the key that allowed the early hominids to compete successfully with baboons and warthogs for survival in the African savannas during the Pliocene. It has been noted that "the digging stick redirected is a more effective defensive weapon than even the formidable canine teeth of the average male baboon" (Brace 1995). The need for carrying such a dual-purpose tool may well have been the selective force that led to the development of habitual bipedalism, as it is awkward at best for a quadruped to move effectively from one place to another when one forelimb is carrying an item essential for survival and is therefore unable to play a role in support.

It has recently been said that "Canines don't just fade away, they must have been actively reduced by natural selection," yet no scenario for their reduction by selection has been suggested (Deacon 1997). However, the case has been made that traits *will* "just fade away" if they are not maintained by selection. Darwin offered a series of examples in the *Origin of Species* (1859, pp. 134–49, 454). Forty years ago, I labeled the process the "probable mutation effect" (Brace 1963; 2000, Ch. 5). This is fully compatible with "neutral theory" in molecular biology (Brace, in press; Kimura & Ohta 1969).

The australopithecine life history pattern as shown by tooth root formation is more like that of a chimpanzee than that of a modern human being (Smith 1992). Newborns, then, may well have had the aspects of greater maturity characteristic of chimpanzee neonates, and also may well have been able to cling to the maternal fur. It has been said that "it is not inconceivable that the first step across the symbolic threshold was made by an australopithecine with roughly the cognitive capabilities of a modern chimpanzee" (Deacon 1997, p. 340), and with a tiny "vocabulary" of 5 or 10 words and only two or three types of combinatory rules like toddlers' syntax (p. 41). Those beginnings may very well have been analogous to what is being called "motherese." From that point on, the adaptive value of symbolic expression can very easily be seen as the selective force that led to the increase in brain size. The coevolution of language and brain size follows from there to the point where language as we know it characterizes all human groups (Deacon 1997, Part 3).

Oldowan tool-making australopithecines were evidently scavenging in the Late Pliocene in Africa about 2.5 million years ago (Hay 1976; Shipman 1986). By the Early Pleistocene, just under 1.9 million years ago, the Oldowan toolmakers were practicing what has been called "persistence hunting" (Bortz 1985). Two major changes in the australopithecine body made this possible, one clearly documented and the other surmised on reasonable grounds. The first was the achievement of the body proportions of recent members of the genus *Homo.* Early Pleistocene body proportions are remarkably similar to those of living humans (Ruff & Walker 1993). The other change, which we can infer but cannot prove, is the loss of the normal mammalian fur coat, presenting a bare and sweat-gland-endowed skin to the atmosphere. If, as we guess, our early hunters were engaging in persistence hunting, then there should have been strong selection for developing the means of dissipating metabolically generated heat. We know that humans today have more capacity for sweating than any other mammal (Macfarlane 1976, p. 185), and Falk herself has shown that a mechanism for cooling the contents of the cranium was clearly evolving between the time of the late australopithecines and that of the early members of the genus *Homo* (Falk 1990).

The emergence of that toolmaking and hunting member of our own genus also saw a major increase in brain size, putting it about halfway between that of the chimpanzee and the human ranges (Begun & Walker 1993; Vekua et al. 2002). Rate of maturation was also about halfway between the ape and the human condition (Smith 1993). *Homo* was now living the life of a facultative carnivore that had spread out of Africa and across the warmer portions of the entire Old World. As with that other highly mobile member

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of what Alan Walker has called the "large carnivore guild," *Canis lupus,* the wolf, there should have been mate exchange between adjacent groups throughout the entire expanse of hominid occupation: that is, no isolation and no speciation. The advantages for symbolic communication in a creature so poorly endowed to be a carnivore had to constitute a considerable force of selection. However, the chances are implausibly remote that more than one species of hominid undertook to pursue a way of life that is so wildly atypical for a primate. Now as to why there is no hint of the beginnings of symbolic usage in any other species in the world, it may well be because not one of them uses tools invented by previous generations as elements essential to their survival.

Hominin infant decentration hypothesis: Mirror neurons system adapted to subserve mother-centered participation

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Abstract: Falk's hominin mother-infant model presupposes an emerging infant capacity to perceive and learn from afforded gestures and vocalizations. Unlike back-riding offspring of other primates, who were in no need to decenter their own body-centered perspective, a mirror neurons system may have been adapted in hominin infants to subserve the kind of (m)other-centered mirroring we now see manifested by human infants soon after birth.

A necessary condition for the selective advantage and protolanguage emergence and propagation specified by Falk may have been an emerging infant capacity to perceive, understand, and learn from the gestures and vocalizations afforded by the vigilantly attending mothers. Pertaining inter alia to meaning identification, acquisition, and propagation (sect. 3.2.1), I propose this hominin infant-decentration hypothesis: Compensating for the loss of the body-clinging advantage that enables offspring of other primates to perceive and learn without having to transcend the body-centered perspective shared with the carrying mother, those hominin offspring able to learn to cope and take care by (m)other-centered perception of distal vocalizing and gestural articulation would have had a selective advantage and a contributing impact.

A neurosocial support system has been discovered that may have lent itself to subserve such an emerging capacity. Rizzolatti and Arbib (1998) have identified a mirror neurons system in the modern chimpanzee and in the human brain (see also Stamenov & Gallese 2002), and I have suggested that this system has been adapted to subserve infant learning by other-centered perception in human interaction (Braten 2000; 2001; 2002; 2003a).

Comparative studies of infant-adult interaction in humans and chimpanzees. In conjunction with the pertinent comparative findings referred to in the target article, the virtual absence of prolonged eye-contact in chimpanzees, as stressed by Bruner (1996, p. 163, with reference to Savage-Rumbaugh et al. 1993), should be mentioned. Having compared for a decade infant-adult interactions and infant-carrying modalities in humans to those in chimpanzees, I can confirm this, at least as pertaining to the chimpanzees I have studied in a southern Norway zoo and wildlife park. When clinging to the mother's back, offspring of great apes learn to orient themselves in the world in which they operate from the carrying mother's stance. Moving with her movements, they may even be afforded the opportunity to learn by copying her movements (perhaps in the way that Byrne [1998] terms "program-level imitation") without having to transcend their own (egocentric) body-centered perspective. In my periodic studies of captive chimpanzee-offspring relations, I have observed how an infant, when old enough to cling to its mother's back, not only bodily moves with her movements but often adjusts its head to the mother's movement direction, thereby appearing to be gazing in the same direction as the mother. When a mother holds the infant in front of her for grooming (which adults more often do from behind one another), a sort of face-to-face situation is established, but not for the kind of reciprocal interplay entailing mutual gazing and gesticulation that we observe in human infant-adult pairs.[1]

Before the invention of baby-carrying facilities (attributed by Leakey 1995, p. 94, to early *Homo erectus*), hominid species may have been faced with extinction when turning bipedal, I have submitted, if their young offspring were unable to listen and learn to cope and take care by (m)other-centered mirroring and participation (Braten 2000, p. 275). Such a capacity is at play in early human ontogeny.

On the ontogenetic path to verbal conversation. Regardless of whether they are "hardwired" to process speech and sign language (sect. 3.2.1), human newborns demonstrate a readiness to mirror facial expressions and gestures (Kugiumutzakis 1993; 1998; Meltzoff & Moore 1977; 1998), and young infants' impressive speech perception may entail an innate perceptual-motoric link (Kuhl 1998, p. 306). In contrast to the Piagetian attribution of an *egocentric* point of departure for children's development of language, requiring decentration as the child matures, we believe we have now found evidence of infant capacity for *altercentric* mirroring and self-with-other resonance soon after birth (Braten 1998; Stern 2000; Trevarthen 1998), facilitating the ontogenetic path to speech in the culture into which the infant is born. This path comprises inter alia these steps: The first vocal imitation of /a/ in the first hour of life (Kugiumutzakis 1998), as well as mutually attuned protoconversation in the first months of life (Trevarthen 1974; 1990; 1998), and speech perception entailing that by age 6 months the infant has already begun to "turn a deaf ear" to sound distinctions that make no sense in the ambient language (Kuhl 1998). This is soon followed by the babbling onset of well-formed syllables and production of vowels approaching those of the native language, coinciding with joint attention and acknowledgment of self-other agency at about age 9 months (Akhtar & Tomasello 1998; de Boysson-Bardies 1999; Hobson 1998; Locke 1993; Tomasello 1999a). Such steps are precursory and supportive of verbal conversation to come with its reciprocal and participant characteristics. Not only may the speaker coprocess his own production from the listener's stance (in line with Mead's [1934] notion of anticipatory response). The listener may co-articulate the speaker's production as if she or he were a coauthor, as predicted by Liberman's (1957; 1993) motor theory of speech perception, and by Braten's (1974; 2002) simulation-of-mind model of conversation. Such virtual coarticulation from the other's stance is manifested when a listener completes the speaker's aborted sentence or answers a half-spoken question, supported by the capacity for other-centered mirroring and resonance that we see at play in protoconversation and response to motherese (Braten 1988; 2003b; Stern 2000; Trevarthen 1998).

Neurosocial support. In the primate neurobiology there appears to be a ground for systems that could have lent themselves to adaptation for decentration in the genus *Homo* to subserve such (m)other-centered mirroring. Mirror neurons have been found to discharge in the macaque brain both when another is observed grasping a morsel and when the monkey itself is grasping the morsel (Di Pellegrino et al. 1992). Referring to evidence of a mirror-neurons system in the human brain, Rizzolatti and Arbib (1998) suggest its possible support of the first primitive dialogue, and I have predicted that such a system would be found to subserve learning by other-centered perception and participation, and will be found to be impaired in subjects with autism (Braten 1998; 2002). Entailing an allocation that comprises Broca's area, which is activated not only upon speech but also upon (imagination of) hand rotation, such an adapted mirror-neurons system may thus pertain to the phylogenesis and sociogenesis of both spoken and sign language (see target article, sect. 3.2.1) by subserving virtual (other) participation (Braten 2003a; 2003b) in the performance of observed instructors and partners.

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