THE OBSTETRIC DILEMMA AND THE ORIGIN OF LANGUAGE

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Theories of language's origin can suffer from interdependent premises and conclusions. A non-circular theory might involve a biological trigger that is unique to humans and predates behavioral modernity. The obstetric dilemma is a promising candidate. Over millions of years, brain size increased and locomotion became bipedal, exacerbating parturition. Human infants became more helpless—unable to cling or crawl. Infant survival depended increasingly on complex carer-infant communication. Of the available physical signals, fundamental frequency contour (speech prosody) transmitted the most useful information in the shortest time. The human fetus became increasingly sensitive to the mother's prenatally perceptible voice, heartbeat, footstep, digestion, and movement patterns, reflecting her physical/emotional state. The fetus/infant's *mother schema* became more complex. Linguistic ability and complexity developed by statistical learning in mother/alloparent-infant interactions, building upon prenatal learning and enabled by increasing neural capacity and plasticity. The theory is consistent with different aspects of behavioral modernity including language, music, religion, and consciousness.

1. Cognitive approaches

How and why did human communication become so complex in its arbitrary sound patterns, extensive vocabularies, and hierarchical structures—relative to the poor linguistic abilities of non-human primates? The neurocognitive approach has clarified details but failed to present a complete, coherent account:

> "we do not really know how the Basic Property is actually implemented in neural circuitry. In fact … we don't have a good understanding of the range of possible implementations for any kind of cognitive computation. Our grip on how linguistic knowledge of 'grammars' might actually be implemented in the brain is even sketchier" (Berwick & Chomsky, 2017, p. 157).

Harnad (2008) asked "Where did our brains' selective capacity to learn all and only UG-compliant languages come from?" (p. 524) and emphasized the importance of avoiding circular reasoning (begging the question):

> We were looking for the evolutionary origin of the complex and abstract rules of Universal Grammar (UG). Christiansen and Chater (C&C) say … Don't ask how the UG rules evolved in the brain. The rules are in language, which is another 'organism,' not in the brain. The brain simply helped shape the language, in that the variant languages that were not learnable by the brain simply did not 'survive.' This hypothesis begs the question of why and how the brain acquired an evolved capacity to learn all and only UG-compliant languages in the first place, despite the poverty of the stimulus – which was the hard problem we started out with in the first place!

Regarding the poverty of the stimulus, data-driven statistical learning can achieve more than nativist approaches have assumed (Pullum & Scholz, 2002; Saffran, 2003). Statistical learning has also been observed in non-human primates (Hauser, Newport, & Aslin, 2001). Human infants imitate and participate in gestural-acoustic exchanges in a complex, embodied-interactive sensorimotor process (Tamis-LeMonda et al., 2014) whose fine details involve far more information than a grammatically based cognitive linguistic account.

2. The obstetric dilemma

To avoid circular reasoning, we should look for an independent biological "trigger" that catalyzed genetic and/or cultural changes leading to the emergence of complex, reflective language. The trigger should have nothing to do with language itself or indeed with any other aspect of behavioral modernity (technology, religion, art, music, consciousness) that may have interacted with language during the period when language was probably emerging (say, between 200,000 and 60,000 years ago; Berwick & Chomsky, 2017).

A promising candidate for such a trigger is the obstetric dilemma (Washburn, 1960; Wittman & Wall, 2007). During the past few million years, pre-human infants were gradually born earlier than would otherwise have been the case due to a combination of the mother's bipedal gait and the fetus's increasing brain size. The birth process (parturition) became increasingly difficult, shortening gestation, necessitating social support (midwifery), and rendering infants more helpless. While humans are not the only primates for whom birth is difficult (Leutenegger, 1974), human infants are the least able to cling or crawl. In this account of the origin of language, human infants could only survive if they developed a new kind of attachment with adults (mothers and others: Hrdy, 2009) based on acoustic-gestural communication (proto-motherese).

Approaches of this kind were introduced by Dissanayake (2000a, 2000b, 2003) and Falk (2009). Brown and Dissanayake (2018) explained:

> Such coordinated, dyadic behavior … addressed the "obstetric dilemma" of two million years ago when the anatomical trend toward a narrowed pelvis in fully bipedal *Homo erectus* conflicted at childbirth with a concomitant anatomical trend toward enlarged brains and skulls. Among other adaptations (e.g., separable pubic symphysis in females at parturition, compressible infant skull, extensive postnatal brain growth), the gestation period was significantly reduced, resulting in helpless infants dependent on their caretakers for years, rather than weeks or months as in other primates. A mother's simplification, repetition, elaboration, and exaggeration of affinitive communicative behaviors (e.g., smiling, open eyes, eyebrow flash, head bob, head nod, soft undulant vocalization, touching, patting, kissing) served to reinforce affinitive neural networks in her own brain and, when performed on a shared temporal basis, also set up a means of neural coordination of behavior and of matching of affective change between the pair.

In many species, the risk of death is highest in the first weeks, months, and years of life, which gives the events and constraints of early developmental periods special evolutionary significance. The human obstetric dilemma means that the mortal risk was even higher for early human infants due to their inability to follow or cling to a carer. The best survival strategy in this situation was to maintain the proximity and attention of mothers or alloparents by developing new forms of communication in the context of attachment (Bowlby, 1969).

3. The mother schema

The process may have involved a *mother schema* (Parncutt, 2009) that mirrors the *infant schema* of Lorenz (1943), the two interacting in motherese. Each schema is activated by specific learned or innate sensory patterns, cognitions, emotions, and behavioral interactions. The infant schema of an adult is activated by aspects of an infant's "cuteness" (visual, auditory, behavioral; multimodal). The mother schema of an infant includes its feelings toward the mother or carer and is similarly multimodal. Neither schema is confined to genetic parents or offspring, but may be generalized to other carers and dependents (cooperative breeding, allomaternal care, shared intentionality; Burkart et al., 2009; Hrdy, 2009). A child's mother schema may be activated by exposure to prenatally familiar multimodal perceptual patterns (rocking, lullabies, motherese) or by the behaviors of friendly (caring) versus dangerous (angry, careless) adults. A comparable case (multimodal, mixing "nature" and "nurture") is spontaneous attraction toward a potential sexual partner ("love at first sight")—an aspect of the *relational schemas* of Baldwin (1992).

Both motherese and crying involve vocal learning. First, there is prenatal learning of sound and movement patterns produced within the mother's body (voice, heartbeat, footsteps, digestion; Hepper, 1996; Moon & Fifer, 2000; van

Heteren et al., 2000). All such patterns are related to maternal physical and emotional state and therefore carry information that is existentially relevant for the fetus. Of the available physical signals, fundamental frequency contour (speech prosody) may transmit the most useful information in the shortest time (Coutinho & Dibben, 2013). F_0 contour represents reliable information that is physically unaffected by transmission, absorption, or reflection.

Prenatal learning can explain the extraordinary sensitivity of human newborns to maternal emotional prosody (Mastropieri & Turkewitz, 1999) and the dependence of infant crying patterns on maternal language (Mampe et al., 2009). The Pleistocene pre-human fetus/infant was more likely to survive to reproductive age if it could extract complex meanings from the prosody of its mother and other carers. Linguistic ability and complexity developed gradually between roughly 200,000 and 60,000 years ago in carer-infant interactions, upon which infant survival depended.

4. The origin of language

Simple grammatical functions may have originated as carer and infant—using different combinations of sounds, bodily gestures, and facial expressions (Pascalis et al., 2014)—labeled objects (nouns), processes (verbs), interactions (prepositions), and so on. The infant was motivated to combine these functions (cognitive "merge") because its survival in a dangerous world depended on its ability to communicate with adults. The underlying psychological mechanism was multimodal pattern recognition (Giard & Peronnet, 1999). In this way, the emergence of complex human language can be explained without invoking cognitive theories of abstract, symbolic thinking (cf. Falk, 2009).

In a statistical-learning approach, the complexity and ambiguity of human grammar and vocabulary are consistent with, and explicable by, the complexity of human neural networks (enabled by enlarged cortex) and the repetitiveness of prenatal sound patterns and infant-carer exchanges as they occur in real-world contexts—reflected by music's intrinsic repetitiveness (Margulis, 2014). The fast rate at which the human fetus and infant learn arbitrary sound-meaning relations (cf. Anderson & Thomason, 2013) kick-starts a lifelong process of cultural learning that is characteristic of humans.

The theory assumes that (proto-)motherese was more important for linguistic origins and evolution than inter-adult communication. The reason is both evolutionary and neurological: both mortality rate and neuroplasticity are higher in infancy. Today, avoidable global child mortality (mainly from disease and hunger) is about nine million per year (Black et al., 2010)—still much higher than the adult global death rate due to violence.

5. Music, religion, and consciousness

An approach to human behavioral modernity based on prenatal learning and a complex mother schema can additionally account for complex relations between sound-movement patterns and meanings in music and religion (Parncutt, 2019). It can potentially explain the extraordinarily powerful experiences that both experts and non-experts report in connection with music (Gabrielsson & Bradbury, 2011), monotheistic religion (e.g., Alston, 1993), and shamanism, including spiritual possession (Winkelman, 2004).

Musical and religious rituals may evoke the mother schema by combinations of stimuli that are familiar from prenatal life: muted light and sound, enclosed spaces, melody (reminiscent of the lowpass-filtered mother's voice), rhythm/dance (similar to the mother's heartbeat, footsteps, and associated fetal body movements), and unusual postures (fetal position). Ritual experiences that include vivid illusions of supernatural encounters are explicable if those experiences trigger participants' prenatal mother schemas.

Similarly, the soothing effect of motherese can enable carers to put down infants as they work at other tasks (Falk, 2009). The universal link between rhythm and dance (Richter & Ostovar, 2016) can be understood by considering maternal walk from the perspective of the fetus, which moves rhythmically in time with the sound of footfalls—comparable with entrainment in ensemble performance (Parncutt, 2009).

The theory can also contribute to an understanding of human reflective consciousness and its origins. Reflective consciousness involves theory of mind (Frith & Happé, 1999) and mental time-travel (imagining the past and future; Schacter et al., 2007). Both behaviors are practically unique to humans (Penn & Povinelli, 2007; Suddendorf & Corballis, 2007). The onotogeny and phylogeny of both may involve carer-infant interactions (motherese and mutual self-other consciousness; Trevarthen & Aitken, 2001), as carers and infants anthropomorphize toys and other objects, and carers creatively predict and prevent potentially fatal infant accidents.

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