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Rethinking Pelvic Typologies and the Human Birth Mechanism[1]

by Dana Walrath

Paleoanthropological reconstructions of childbirth in the genus *Homo* typically rely upon a model incorporating the evolution of a monotypic human birth mechanism. Two features characterize this proposed mechanism or pathway taken by the fetus through the birth canal: fetal rotation and neonate emergence in a position facing away from the mother. The evolution of these two features is said to facilitate birth through the bipedal pelvis but is also taken as evidence of the difficulty of human birth relative to that in other primates and our smaller-brained ancestors. In contrast, the present work takes the position that birth mechanisms vary now and probably did so in the past. The notion of a monotypic birth mechanism has been imported into paleoanthropological discourse from typological thinking in Euro-American biomedical practice and text. The history of anatomical descriptions of pelvic types and associated birth mechanisms shows a trend toward the concept of a singular "normal" birth mechanism in biomedical practice. This paper suggests that biomedically defined pelvic typologies constitute a static definition of human variation in pelvic morphology and that pelvic typology, in turn, has contributed to a static definition of the normal human birth process that has been incorporated into paleoanthropological models.

DANA WALRATH is Assistant Professor in the Department of Medicine at the University of Vermont College of Medicine (Burlington, Vt. 05401, U.S.A. [dana.walrath@uvm.edu]). Born in 1960, she was educated at Barnard College (B.A., 1983) and the University of Pennsylvania (Ph.D., 1997). She has done research in computed tomographic osteometry (1993–96) and archaeological fieldwork in France (1995 and 1996). Her research interests are the biological and social implications of reproductive technology, gender, and human evolution. Her publications include "Decoding the Discourses: Feminism and Science" (*American Anthropologist* 104:327–30) and (with M. M. Glantz) "Sexual Dimorphism in the Pelvic Midplane and Its Relationship to Neanderthal Reproductive Patterns" (*American Journal of Physical Anthropology* 100:89–100). The present paper was submitted 4 II 00 and accepted 29 III 02.

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Because race-based typological thinking was prominent in the physical anthropology of the past (Tylor 1946 [1881], Hooton 1926, Coon 1962), contemporary biological anthropologists work to remove the study of extant human variation from the realm of racial typologies. Biologists and biological anthropologists have in fact made tremendous contributions to the rejection of race as a valid biological category (Brace 1969, Livingstone 1969, Montagu 1969, Lewontin 1972, Gould 1981, Lieberman and Jackson 1995, Marks 1995). However, because of the problems inherent in deducing the nature of variation in the fossil record, paleoanthropologists must regularly contend with the perils of typological thinking. Lieberman and Jackson (1995:239) argue that "static typological definitions of human variation" persist in models of modern human origins and limit the ability of these models to explain the "origins and maintenance of human diversity." This paper will focus on the persistence of a typological approach to human variation in one aspect of the origin of the genus *Homo*: the proposed evolution of a singular human birth mechanism.

"Birth mechanism" refers to the route of passage that the fetus takes through the bony birth canal. Paleoanthropologists have proposed a singular human birth mechanism as an adaptive response to the delivery of large-brained young through the bipedal bony pelvis (Berge 1984, 1993; Tague and Lovejoy 1986; Trevathan 1987, 1988; Rosenberg 1992; Ruff 1995; Rosenberg and Trevathan 1996). This singular birth mechanism is said to appear with the increase in brain size that accompanies the origins of the genus *Homo*.

Two features characterize the proposed birth mechanism: fetal rotation—the sequential rotation of the head and torso as the neonate negotiates the bony birth canal—and the emergence of the newborn from the birth canal in the occiput-anterior position, facing away from its mother. Together, these features are said to allow young humans to be born. In addition, they are used as evidence of the difficulty of human birth compared with that in other primates and our smaller-brained ancestors (Berge 1984, 1993; Tague and Lovejoy 1986; Trevathan 1987, 1988; Rosenberg 1992; Ruff 1995; Rosenberg and Trevathan 1996). Trevathan and Rosenberg suggest that the emergence of the newborn facing away from the mother limits her ability to deliver the infant herself. Thus, the human birth mechanism is said to have been responsible for the evolution of "obligate midwifery" in our species, a selective advantage being conferred on females who seek out assistance at birth. Along with the evolution of secondary altriciality (birth in a relatively immature state) Montagu 1961, Trevathan 1987, Martin and MacLarnon 1990, Rosenberg 1992), the human birth mechanism is said to allow female hominids to bear large-brained young despite a birth-canal space that is constrained by bipedality.

The notion of difficult human childbirth has been a fixture of paleoanthropological discourse since the middle of the 20th century. Schultz (1949) made the first systematic comparisons of human and nonhuman pri-

mate pelves, describing the human birth canal as "shockingly small." Krogman (1951) depicted difficult childbirth as a "scar of evolution," and Washburn (1960) described the inevitable human "obstetrical dilemma." Today, the evolutionary basis of difficult human childbirth is taught in standard anthropological textbooks (Boaz and Almquist 1997, Conroy 1997, Jurmain et al. 1999, Feder 2000, Haviland 2000, Stein and Rowe 2000), often including the evolution of a single-rotational birth mechanism. The evolutionary explanation for human birth difficulty and the monotypic mechanism have even entered the popular literature (Small 1998). Because the social impact of an evolutionary model for human birth difficulty is enormous, the origin and development of this model warrant close examination.

The evolutionary appearance of birthing difficulty is difficult if not impossible to identify in the fossil record. The two most complete pelves from early *Homo*, the Nariokotome adolescent WT15000 (Walker and Ruff 1993) and the Kebara Neandertal (Rak and Arensburg 1987), are both usually classified as male. Fewer than 30 fragmentary specimens constitute the rest of the Pleistocene record up to the Upper Paleolithic transition. No neonatal individual cranial bones, let alone complete neonate fossil crania, exist from this period (Tillier 1992). But even with the most complete fossil record, the birth process itself cannot be preserved. To view the human birth process in action, paleoanthropology has drawn heavily on the biomedical depiction of human childbirth, but in so doing it has borrowed from a medical system imbued with local cultural beliefs rather than from a body of objective scientific knowledge.

Paleoanthropological depictions of human birth and contemporary birth practices in the United States rely upon several shared cultural notions. First is the belief in the inherent danger and difficulty of the human birth process (Jordan 1993 [1978], Davis-Floyd 1992). Second is the depiction of our evolutionary history as driven by the human ability to find cultural solutions to natural problems (Landau 1984, 1991). The representation of human birth as naturally difficult, so that bearing young requires cultural assistance, accords with this framework. Further, as Martin (1987, 1996) emphasizes, social qualities of female gender appear in scientific writing about reproduction. The paleoanthropological characterization of the female human pelvis as ill-suited to the bearing of young could reflect the inferior social position of females rather than an innate obstetrical dilemma. Recognizing social aspects of the construction of scientific knowledge about childbirth entails transcending anthropological boundaries to perceive biomedical practice and paleoanthropological discourse as culturally constructed and not simply scientifically based.

The singular human birth mechanism has been brought into paleoanthropology because of its prominence in contemporary biomedical practice. This birth mechanism is described as "normal" in standard obstetrical texts, though other birth mechanisms are also defined (Benson 1982; Danforth 1982; Pritchard, MacDonald, and Gant 1985; Oxorn-Foote 1986; Cunningham et al. 1997, 2001; Scott et al. 1999). In this context, "normal" may refer more to culturally defined biomedical practices surrounding labor and delivery than to innate, invariable human biology. The so-called normal birth mechanism developed with technology-based descriptions of pelvic morphology within Euro-American biomedical discourse in the first half of the 20th century. These pelvic typologies constituted a static model of human variation in pelvic form. Pelvic typology, in turn, contributed to a static model of the human birth process that has been incorporated into paleoanthropological models.

Euro-American Obstetrics, Anthropology, and the Study of Pelvic Anatomy

The synergy between paleoanthropology and biomedical obstetrics has a long history that can be broken down into three phases. First, the medicalization of the birth process at the beginning of the 20th century relied heavily on anatomical knowledge and related typologies generated by anthropologists. Second, when American childbirth moved from the home into the hospital in the middle of the 20th century, paleoanthropologists began to emphasize the evolutionary basis of difficult human childbirth (Schultz 1949, Krogman 1951, Washburn 1960). According to Krogman (1951:56), for example, "there can be no doubt that many of the obstetrical problems of Mrs. H. Sapiens are due to the combination of a narrower pelvis and a bigger head in the species." In this regard, paleoanthropologists effectively provided a scientific rationale for the medicalization of birth. Obstetric practice then appeared necessary for what evolutionary forces had left undone (Walrath 1997). Finally, with the development of the theory of a monotypic birth mechanism in the 1980s, paleoanthropologists relied on biomedical depictions of normal labor and delivery as solutions for the obstetrical dilemma.

Until anthropologists developed the concept of the obstetrical dilemma, their primary concern with pelvic anatomy related not to the birth process but to the typological depiction of racial difference. According to Hoyme (1957), Verneau allotted 18 pages to describing sexual dimorphism of the pelvis but 82 pages to racial comparisons of pelvic anatomy. While sex differences in vertical and horizontal dimensions were noted, male and female samples were often pooled within race. Pelvic indices developed at the turn of the century (Turner 1885 and Sergi 1899 in Hoyme 1957) were geared toward discrimination of racial types rather than birth mechanisms. It was not until well into the 20th century that physical anthropologists began to focus on the dimorphism of the pelvis, still in terms of racial typology. For example, Howells and Hotelling (1936) ask whether "sex differences in pelves of 'primitive' people were greater or less than those distinguishing the sexes in Europeans." With the work of Washburn (1948; 1949) and Schultz (1949), the functional significance of differences

between the male and the female pelvis received increasing attention in evolutionary anthropology. The increased breadth of the female pelvis began to be interpreted as the result of natural selection working through the mechanical requirements of childbirth (Schultz 1949, Washburn 1948). Though this work marked a shift from the expression of culturally based racial notions in pelvic typology, it still contained elements of cultural shaping. Socially based gender roles are evident in the depiction of the archetypal male and female pelves. The locomotor efficiency of the male pelvis is emphasized in this discourse. By contrast, the inferior social position of women may be reflected in the depiction of the adaptive compromise between the requirements of childbearing and bipedalism. Rather than emphasizing the successful reconciliation of two competing biological requirements, this discourse emphasizes the inefficiency of the female stride and the inevitable obstetric dilemma (Napier 1967, Schultz 1949, Krogman 1951, Washburn 1960).

Though aspects of racial typological depictions ultimately became embedded in the clinical literature, much of the variation in female pelvic shape has been documented by practicing obstetricians and midwives rather than anthropologists. According to Bendixen, "descriptions of the pelvis have been rewritten over the centuries as male physicians gradually took over the practice of midwifery and as changing beliefs regarding sex differences influenced the views of the medical profession" (1995:442). Medical interpretations of morphology derive in part from a vital component of clinical culture: the obstetrical "tool kit." Because clinical and cultural interests are reflected in anatomic descriptions of the pelvis, scientific interpretations of pelvic anatomy and the birth process have changed over time.

A fitting place to begin tracing this history is with Hippocrates (460–370 B.C.), the "father of biomedicine," who asserted incorrectly that the pelvic bones separate at the pubis during labor (Jarcho 1933). Vesalius (1514–64) is often credited with the first accurate depictions of the pelvis (Jarcho 1933). Errors in his original anatomical drawings, which include no sacral curvature and distort the anatomical position of the pelvis, have persisted for centuries and have been retained even in current medical texts (Bendixen 1995). Mauriceau, the author of an important 17th-century obstetrical text, is credited with being the first to challenge the theory of pelvic-bone separation (Jarcho 1933). According to Jarcho, this theory stood in the way of pelvimetric investigation because "fixed measurements of the pelvis were considered of slight importance. Attention was focused on the fancied ability of the pelvis to stretch for the passage of the fetus" (p. 6).

Although pelvic contraction (small or misshapen pelvis) was recognized as early the 16th century, anatomical descriptions of the pelvis in midwifery texts first appeared only in the 18th century (Bendixen 1995). Before this time, midwifery texts concentrated on practical advice (Rothman 1982, Donnison 1988). The inclusion of anatomical descriptions of the pelvis in texts followed the development of instrumentation for the measurement and quantification of the size of the pelvis. The English physician William Smellie (1697–1763) is credited with the invention of the pelvimeter for the measurement of the sagittal diameter of the birth canal (Moir 1946, Moerman 1981). Up to this point, if pelvic capacity was assessed at all it was done manually.

The 18th-century European focus on sagittal diameters reflected the clinical concern with pelvic flattening due to osteomalacia and rickets (fig. 1). These bone disorders, caused by Vitamin D deficiency, were common in northern European cities at that time (Caldwell and Moloy 1933, Moir 1946, Angel 1978, Stuart-Macadam 1989). In a 1718 chapter on difficult deliveries Dionis (quoted in Jarcho 1933:11) states that labor is most difficult in "little" or "crooked" women, elaborating that

> those who had the rickets when young and whose hipbones did not grow hard for a considerable time after they were born are the most of all to be pitied; for the bason in them is ordinarily so straight that 'tis impossible for a child to get over the bar, or open a passage for itself; and we now see that such women after they have been in labor for several days and have suffered most terrible pains, cannot bring forth, but die at last.

The records of several 18th-century "man-midwives" presented by Wilson (1995) illustrate the impact of the rachitic pelvis on obstetrics in this time period. Though Vitamin D supplementation and surgical delivery can avert these difficulties today, osteomalacia, rickets, and other childhood growth disorders still account for obstetrical complications in some populations (Martorell 1989, Akiel et al. 1988, Serenius, Elidrissy, and Dandona 1984). Of course, such birthing difficulties stem from specific pathology rather than from a specieswide obstetrical dilemma.

Up until the 19th century, birth was perceived as a normal process not requiring intervention by a physician (Wertz and Wertz 1977). Rothman (1982) reports that the involvement of men in childbirth was technologically driven and can be traced to the 13th-century guilds of European barber-surgeons. Barber-surgeons invented and controlled instruments such as the traditional sharp hook or crotchet for the removal of stillbirths by embryotomy or cesarean section (Rothman 1982, Martin 1987, Donnison 1988, Jordan 1993 [1978], Wilson 1995). Later the forceps, the vectis, and the fillet were developed by a family of 17th-century barber-surgeons, the Chamberlens, first for stillbirths but later for "delivering a living child by the head" in cases of obstructed labor (Wilson 1995:56). Effective use of these instruments appears to have been limited to the Chamberlen family, and their adoption into routine practice for live births was slow (Wilson 1995). Because instrument-assisted births predated germ theory (see Metchnikoff 1939), the outcome was often poor. Jordan (1993 [1978]) describes how Semmelweiss, a 19th-century physician, was banned from the profession for reporting poor outcomes linked to instrumental birth in the absence of sterile technique.

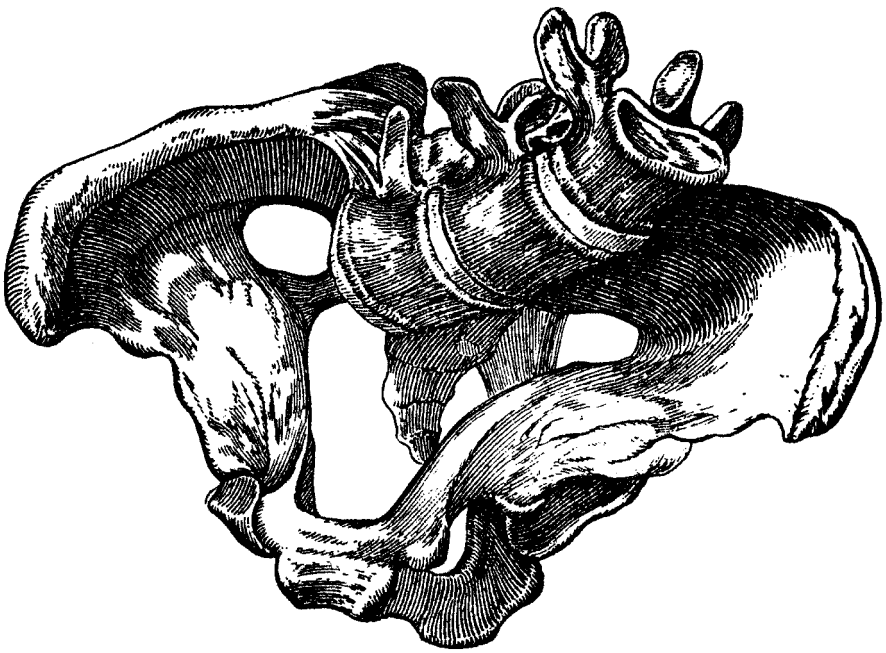

FIG. 1. *Representation of an osteomalacic pelvis* (*Stedman and Garber 1940*).

It was not until the 20th century that hospital birth and its accompanying technology became firmly established in America. According to Rooks, "women left midwives in the early part of this century in order to obtain twilight sleep and, later, general anesthesia, which were only available from physicians" (1997:471). This shift led to another transformation in the medical depiction of pelvic anatomy. With the development of X-ray pelvimetry techniques in the 1920s, an entirely new view of the birth process and pelvic morphology was facilitated by the shift of birth to the hospital. X-ray pelvimetry also provided an opportunity to obtain average values for various pelvic measures on a large scale in living humans. During the 1930s to 1950s, before the dangers of radiation exposure were understood, antenatal pelvimetric X-ray studies were routinely performed to assess the adequacy of the maternal pelvis for childbirth (Caldwell and Moloy 1933, Caldwell, Moloy, and D'Esopo 1934, Ball 1938, Greulich and Thoms 1938, Thoms 1941, Moir 1946, Mengerts 1948, Colcher and Sussman 1949, Steer 1958, Kelly et al. 1975, Stewart, Cowan, and Philpott 1979, Ohlsen 1980). With the advent of X-ray pelvimetry, the obstetric pelvis began to be described in terms of three functional planes: the inlet, the midplane, and the outlet (fig. 2).

After the documentation of the dangers of prenatal X-ray exposure (Ford, Patterson, and Trenting 1959, Polhemus and Koch 1959, Harvey, Honeyman, and Flannery 1985), clinicians reverted to manual assessment of the pelvis, now using gloves with a millimeter scale imprinted on them (Moerman 1981). Also during this time period, "active management of labor," especially the use of hormones to accelerate labor, became more common (Martin 1987, Davis-Floyd 1992, Jordan 1993 [1978], Goer 1995).

The development of computed tomographic (CT) techniques (Hounsfield 1973) brought radiographic pelvimetry back into obstetrical practice. It is worth noting that the Institute of Medicine (1985) described CT as a classic example of a new technology widely incorporated into biomedical practice before its efficacy was established. CT pelvimetry is said to permit a more accurate definition of birth-canal geometry with a lowered level of radiation exposure deemed acceptable by some biomedical practicioners (Federle et al. 1982, Moore and Shearer 1989). In biomedical practice, some physicians use this technology for calculating a "fetal-pelvic index" to determine whether they will allow a woman a trial of labor rather than proceeding to operative delivery (Morgan, Thurnau, and Fishburne 1986, Thurnau, Hales, and Morgan 1992). To compute this index, the transverse diameters of the inlet and the midplane derived from CT images are compared with ultrasound measurements of the fetal biparietal diameter and abdominal circumference. "Abnormal" fetal presentation and suspected fetal-pelvic disproportion are indications for use of the index (Cunningham et al. 1997, 2001). Both of these factors are affected, of course, by definitions of "normal" in biomedical practice.

For example, according to current obstetric practice, the rate of progression of labor is one of the main methods for determining fetal-pelvic disproportion during a trial of labor. A rate of cervical dilatation less than 1–2 cm/hr. meets the criterion for abnormal or "dysfunc-

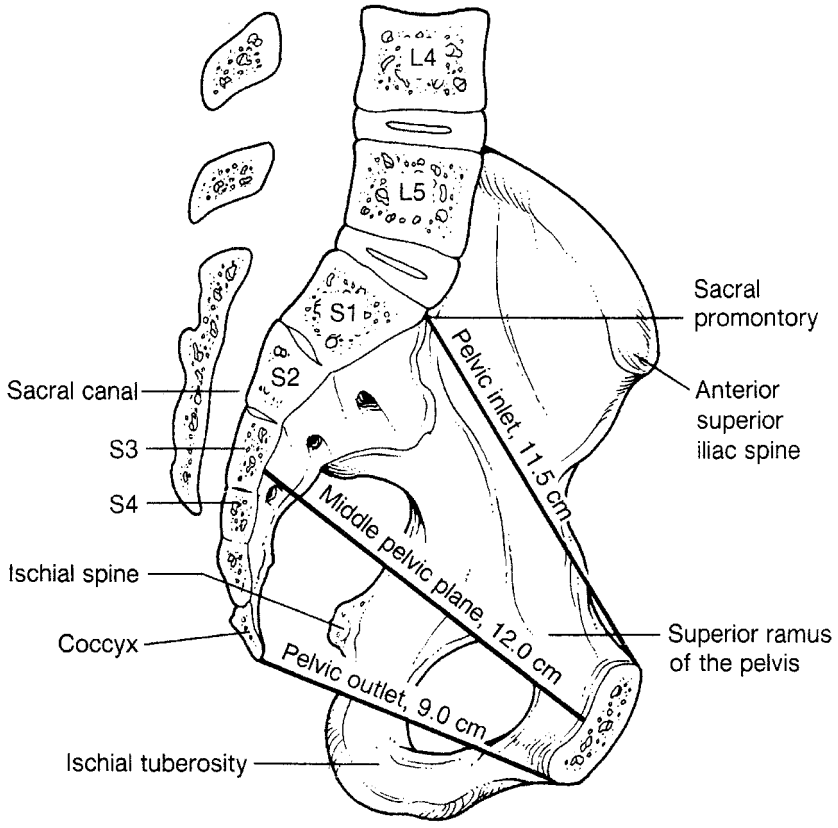

FIG. 2. *The three obstetric planes of the bony pelvis: inlet, midplane, and outlet* (*Scott et al. 1999:chap.3, fig. 2*).

tional" labor. As several scholars have shown, the decrease in medically acceptable duration of labor derives more from changes in medical practices in accordance with cultural values than from changes in the biological process of labor (Rothman 1982, Davis-Floyd 1992). The temporal limits of normal labor have decreased during this century from 24 hours to 14 hours (Rothman 1982). When labor does not proceed according to these guidelines, a diagnosis of fetal-pelvic disproportion is made and surgical delivery usually follows.

As described above, medical descriptions of the pelvis and depiction of the processes of labor and delivery have changed through time in accordance with the clinical concerns and available technology of the period. Because biomedical practices are driven by cultural forces as well as human biology, biomedical depictions of "normal" require contextualization before they can be useful in evolutionary discourse.

Pelvic Typology

Descriptive pelvic typologies were developed in the obstetrical literature during the first half of this century, when X-ray pelvimetry was becoming a standard part of prenatal care. Moerman (1981) notes that because of their relationship to childbirth practice, these typologies were developed with a strong sampling bias. Collectively, the available studies reviewed compare more than 100,000 female pelves with only 200 male pelves derived solely from predominantly white American hospital populations. These new clinical typologies borrowed freely from the existing racial typologies developed from the osteological collections studied by 19th- and early 20th-century physical anthropologists.

Greulich and Thoms (1938) classified the pelvis into four types based on ratios between the transverse and sagittal diameters of the inlet. Their four types, in order of decreasing sagittal diameter, were dolichopellic, mesatipellic, brachypellic, and platypellic. These types were parallel to those defined by Turner in 1886 with one exception; because Turner's interest was in racial differences, he examined only males "to avoid the question of overlap of sexual characters" (Caldwell and Moloy 1933:498).

Greulich and Thom's types correspond closely to the most enduring pelvic typology, that of Caldwell and Moloy (1933). Their system defines four basic pelvic types based on the shape of the inlet: gynecoid, android, anthropoid, and platypelloid (fig. 3). These pelvic types are

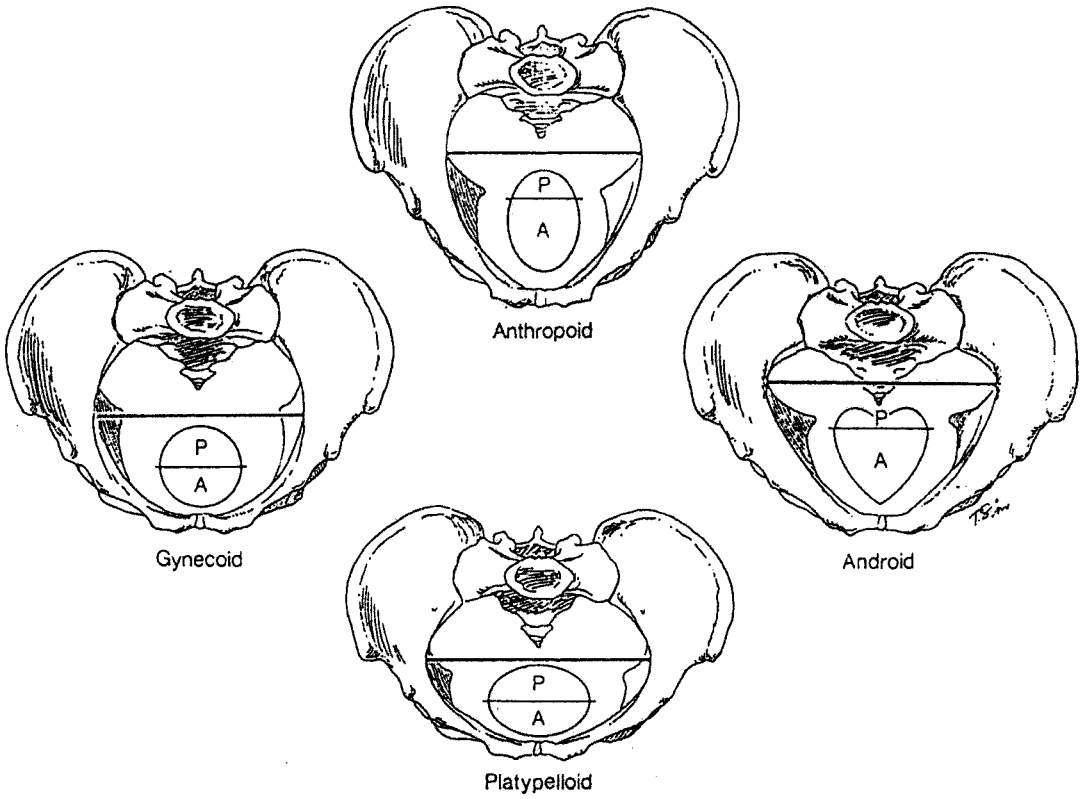

FIG. 3. *Caldwell and Moloy's pelvic types* (*Pritchard, MacDonald, and Gant 1985:fig. 11–9*).

specifically derived from 19th- and early-20th-century racial typologies. Indeed, Caldwell, Moloy, and D'Esopo describe their original publication as "an attempt to make practical use of the anatomic and anthropologic observations since anthropologists have long been cognizant of the four parent types described by us" (1934: 824). They present their work as a typological depiction of anatomical variation "caused by racial, sexual or complex inherited influences rather than by pathologic changes in the bones themselves" (Caldwell and Moloy 1933:479).

Caldwell and Moloy use anthropological knowledge to illustrate the veracity of the typology they present. They state that although all types can be found in females, it is the gynecoid pelvis, with its large, elliptical inlet, that is ideally suited to childbirth. The android pelvic type is designated when one or more male characteristics are present in the inlet. Obstetric prognosis is described as poor in women with the android type, though improved if the subpubic angle is wide. Caldwell and Moloy point to the 1910 Nubian excavations of Smith and Jones, in which "a number of Nubian pelves which so closely approached the form of the male that the presence of fetal bones within the pelvis alone suggested the sex of the skeletons" (1933:480). They assert that the large sagittal diameters of the anthropoid pelvis (as in the anthropoid primates) make it well suited to childbearing and cite Turner's description of the anthropoid pelvic type, frequent among non-Europeans, as representing the "degraded or animalized arrangement seen in the lower races" (Turner 1886 in Caldwell and Moloy 1933:498). The rare platypelloid type is said to lack this "animal" feature; it is flattened and not well suited to childbirth. Caldwell and Moloy note that Turner thought this form "was characteristic of the more civilized and advanced races of mankind" (1933:498). This pelvic type is even referred to as "ultra-human" (Caldwell and Moloy 1933, Moore 1992), implying a certain unnaturalness of the human birth process.

Evidence of the enduring influence of Turner's racialized approach can be seen even in recent editions of *Gray's Anatomy* (Williams, Bannister et al. 1995) and *Williams Obstetrics* (Cunningham et al. 1997, 2001). Citing Caldwell and Moloy's original study of the Todd osteological collection, they present pelvic types by race. The frequency of the anthropoid pelvic type is reported to be higher in nonwhite women than in white women. The arcane nomenclature of the typology links "animal" with "nonwhite" and "human" with "white." In addition, the "animal-like" anthropoid pelvis is linked with relative ease of birth while the "ultra-human" and white are linked with birthing difficulty. Thus, enduring nomenclature reflects how pelvic typology developed in relation to cultural beliefs about race, sexuality, and re-

production. The typological categories mirror beliefs about who bears young and the position of these individuals with respect to the larger society.

Caldwell and Moloy stress that variable dimensions of the pelvic midplane, outlet, and inlet result in considerable variation among what they call the "four parental pelvic types." They describe this variation in terms of intermediate forms, for example, one with a posterior segment of one pelvic type and an anterior segment of another or with narrowing/funneling that combines a gynecoid inlet with an android outlet. In most present-day obstetrical and anatomy texts, however, the four parental pelvic types are presented as fixed entities (Benson 1982, Pritchard, MacDonald, and Gant 1985, Oxorn-Foote 1986, Moore 1992, Scott et al. 1999). Some movement away from rigid typologies can be seen in the more recent editions of *Williams Obstetrics*, with arrows between the types to indicate the existence of intermediate forms (Cunningham et al. 1997, 2001). A wide range of pelvic variation in shape and size has also been well documented by contemporary biological anthropologists (Novotny 1986, Tague 1992, Bruzek and Ferembach 1992, Bruzek 1996).

Though contemporary biological anthropologists have not embraced the pelvic typologies per se, they have accepted the biomedical depiction of birth developed from practices based on the typological representation of pelvic variation. Caldwell and colleagues developed their typology as a heuristic device to discuss variation in birth mechanisms according to pelvic form (Caldwell, Moloy and D'Esopo 1934, Steer 1959). The so-called normal human birth mechanism corresponds to the gynecoid pelvis, the most common female pelvic type found by Caldwell and colleagues in their study of hospital populations and of the Todd collection (Caldwell and Moloy 1933; Caldwell, Moloy, and D'Esopo 1934, 1939). However, the gynecoid pelvis is found in only slightly less than 50% of women (Cunningham et al. 2001). Paleoanthropologists have accepted the "normal" birth mechanism of the gynecoid pelvis as the only human birth mechanism in making comparisons between humans, other primates, and fossil hominids. These discussions effectively obscure the possibility of significant variation in the human birth process.

The Development of a Singular "Normal"

Clinical tolerance by obstetricians for variation in birth mechanism has steadily declined over time. Today, obstetric texts describe a specific choreography of movements taken by the fetus through a typical gynecoid pelvis as "normal" (fig. 4). Also known as the cardinal movements of labor, the "normal" birth mechanism entails engagement of the fetus in the left-occiput-anterior position, internal rotation of the fetus in the birth canal, and fetal emergence in five steps: descent, flexion, internal rotation, extension, and external restitution. According to this model, fetal rotation occurs because the widest diameter of the gynecoid pelvis is at the pelvic inlet, along the transverse axis, while the widest diameter of the pelvic midplane lies at a 90° angle to that of the inlet. By contrast, the obstetric literature of the mid-20th century stated that birth-mechanism variation depended in large measure upon the precise topology of the individual birth canal. Danforth, one of the leading obstetricians of this period, stated that in light of human pelvic variability, passage of the fetus during parturition followed two rules: (1) the biparietal diameter, being the narrowest fetal dimension, will align with the narrowest pelvic diameter, and (2) the fetal occiput rotates toward the widest portion of the pelvis at each level (Danforth and Ellis 1963, Danforth 1982). Danforth emphasized that "for each pelvis there is an optimum mechanism that may be wholly different from the so-called normal mechanism described" (1982:641). Figure 5, which presents birth mechanisms according to pelvic type, is retained in the most recent edition of the textbook that now bears Danforth's name, though the emphasis of the accompanying text has changed (Scott et al. 1999).

Though other birth mechanisms are described in obstetric texts today, they are generally classified as beginning with fetal presentations defined as "malpositions" rather than as normal variation (Benson 1982; Pritchard, MacDonald, and Gant 1985; Cunningham et al. 1997, 2001; Scott et al. 1999; Chamberlain and Steer 1999). Danforth's notion that birth mechanism varies according to individual fetal-pelvic fit has been lost, though the heuristic typology developed by Caldwell and Moloy remains. In a survey of six standard obstetric texts, Sizer and Nirmal (2000) find that anthropoid and android pelvic shapes constitute the most significant factors thought to be associated with the fetal malposition occiput-posterior. Previously, the occiput-posterior position was considered normal for the anthropoid pelvic type (Caldwell, Moloy, and D'Esopo 1934, Danforth and Ellis 1963, Danforth 1982).

While the "normal" mechanism was being defined, births occurred primarily in hospital settings, under sedation, in a supine position. Thus, the idea of a single "normal" birth mechanism developed in conjunction with other socially determined birth practices. One such practice was the manipulation of fetal descent by the physician's forceps. To prevent fetal damage, physicians were taught variation in birth mechanism in order not to impose a labor mechanism incongruent with bony pelvic morphology (Danforth and Ellis 1963, Danforth 1982). Caldwell and colleagues also linked each of their pelvic types to specific patterns of fetal presentation and descent, with corresponding forceps manipulations (Caldwell and Moloy 1934, Caldwell, Moloy, and D'Esposo 1939, Steer 1959).

The routinization of cesarean delivery has led to the interpretation of fetal presentations in positions deviating from "normal" as indications for operative delivery (Eller and VanDorsten 1993, Gimovsky and Hennigan 1995, Chamberlain and Steer 1999). Clinical definitions of putative "abnormalities" have affected clinical training and practices. For example, Robson, Ramsay, and Chandler (1999) note that since cesarean section has be-

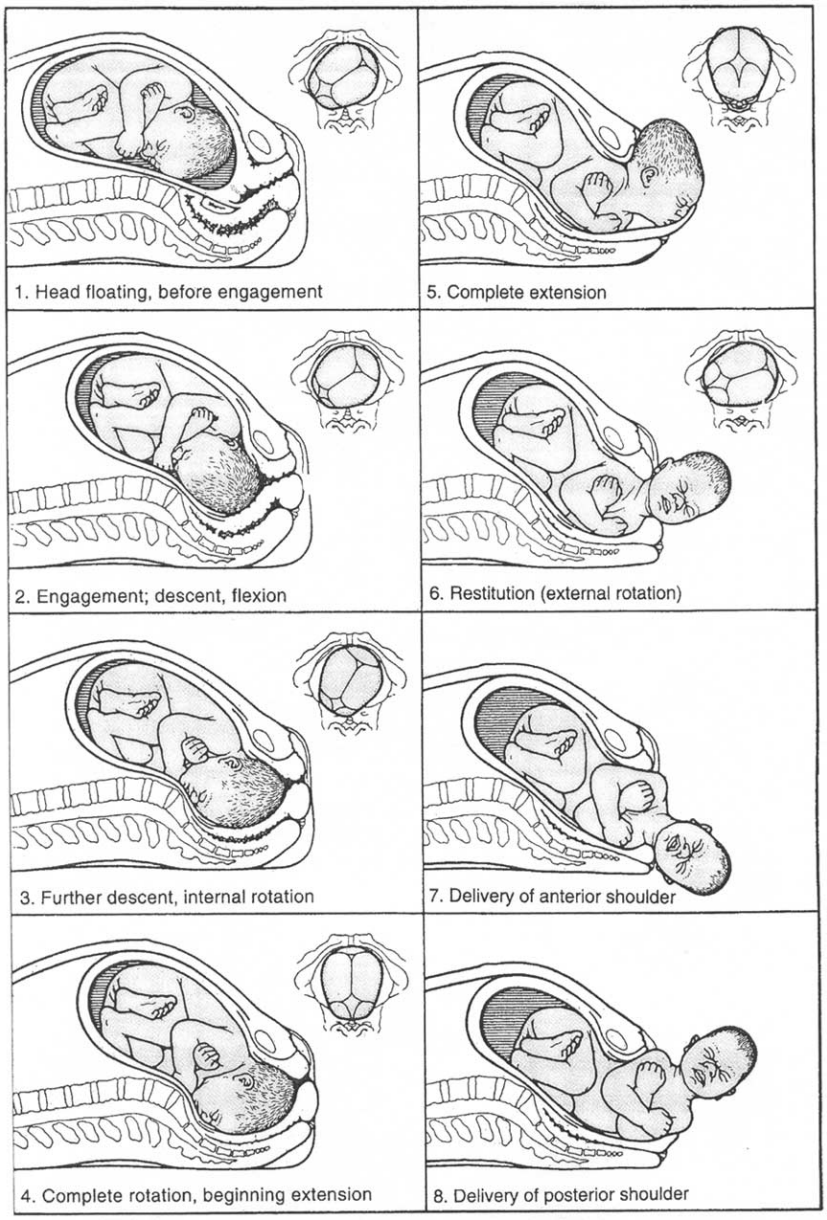

FIG. 4. *The cardinal movements of labor* (*Cunningham et al. 2001:fig. 12–13*).

come standard practice, physicians in training often do not receive adequate instruction for nonsurgical delivery of breech presentation. By contrast, in the past a normal presentation was "one of either pole—the vertex or the breech" (Stedman and Garber 1940). In her comprehensive review of the labor process, Frye (n.d.) says that historical textbooks are packed with clinical details relating to putative abnormalities. These details are missing from contemporary texts because now the "abnormality" is resolved by cesarean delivery.

Similarly, biomedical practices related to the designation of fetal "malpositions" complicate the interpretation of outcome measures in studies designed to assess the danger of delivery in such a position. For example, surgical delivery is frequently used as evidence of the abnormality of the occiput-posterior position. In addition, clinical interventions occurring more frequently in putative abnormalities further influence the likelihood of surgical delivery. According to Sizer and Nirmal, "epidural analgesia and oxytocin augmentation are associated with increased incidence of occipitoposterior position which leads to increased operative intervention for delivery" (2000:749).

Historical analyses provide a window into the effects of clinical interventions on the depiction of "normal" biology. For example, the designation of left-occiput-an-

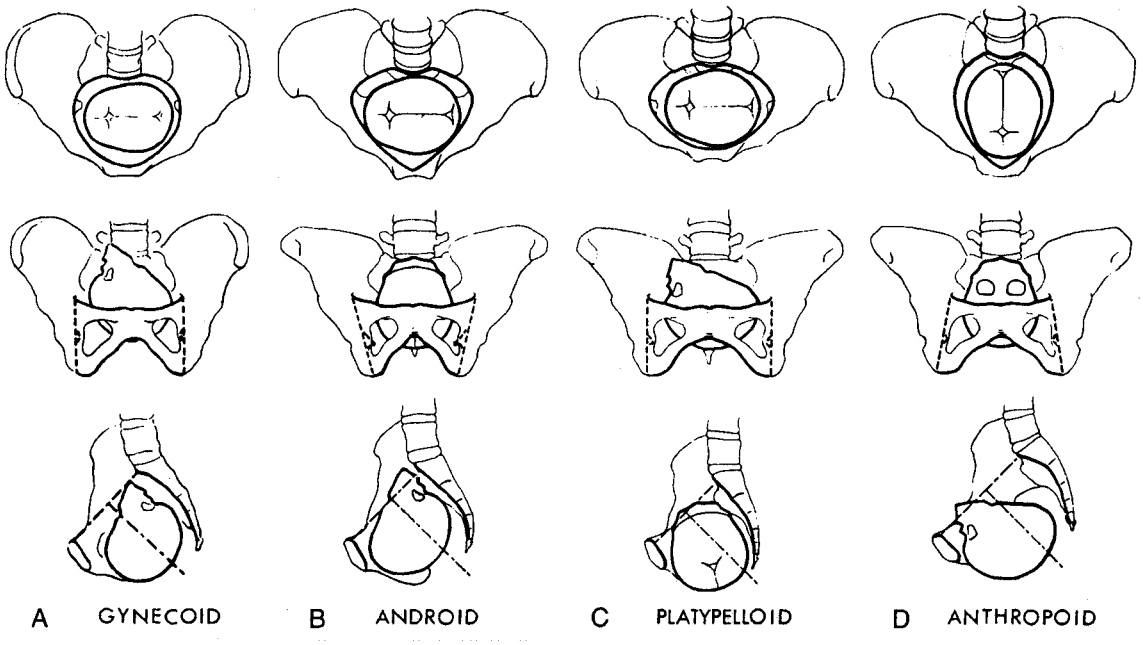

FIG. 5. *Birth mechanism according to pelvic type* (*Scott et al. 1999:chap.7, fig. 4*).

terior fetal head presentation as "normal" has been controversial in the obstetrical literature. Javert and Steele (1942) reviewed the several-hundred-year history of this controversy and showed that the definition of "normal" fetal presentation had changed through time. They suggested that the designation of the oblique left-occiput-anterior position as "normal" derived from a compromise between the previously held notions first that fetal engagement occurred in a direct sagittal orientation and later that it occurred in a direct transverse position. They date this change to the 1887 Ninth International Medical Congress meetings, at which the four oblique positions were "unanimously" defined. Though left-occiput-anterior is currently accepted as normal, these writers report that 63% of the 1,040 vertex deliveries they studied by X-ray pelvimetry were in transverse positions rather than in the "normal" oblique (Steele and Javert 1942). They also describe variation in birth mechanism accompanying variation in fetal presentation.

Similarly, the depiction of the "normal" birth of the shoulders has changed over time. According to Sutton and Scott, "old midwifery text books tell us that 'the anterior shoulder will be seen first but the posterior shoulder must be born first' while contemporary texts describe the birth of the shoulders in the opposite order" (1996:34). They suggest that this difference reflects the degree of intervention by the birth attendant. When mothers and infants are supported during labor rather than "delivered," the posterior shoulder emerges first. Sutton and Scott suggest that this difference has practical consequences in that "allowing the posterior shoulder to emerge first means that episiotomies are rare and shoulder dystocia can be avoided as long as no one touches the baby's head."

Technological intervention aimed at controlling fetal presentations is not new. In 1745, William Smellie, the inventor of the pelvimeter and "father of scientific obstetrics" (Thurnau, Hales, and Morgan 1992), presented the first report of an instrumental rotation to occiput-anterior position (Phillips and Freeman 1974). In 1865 the rotation was standardized as the Scanzoni maneuver. Phillips and Freeman state that in 1918 occiput-posterior was defined as failure of spontaneous anterior rotation prior to complete dilation, and obstetric practice began to "disallow" progression to the second stage of labor in this position. Phillips and Freeman cite studies by Calkins (1953), Kutcipal (1959), and Chambers (1968) that attempted to show that occiput-posterior presentation might not be a problem in and of itself. They suggest that the poor outcome in occiput-posterior presentations may have been iatrogenic, perhaps related to the hazards of misapplied forceps. Phillips and Freeman state that "if the fetus that is delivered with occiput posterior position is in no greater risk, then premature or unnecessary intervention should be avoided" (1974:175).

In contemporary biomedical practice, based on the avoidance of perceived risk (McClain 1983, Frankenberg 1993), fetal presentation in positions other than "normal" has become a standard indication for surgical delivery (Benson 1982, Pritchard, MacDonald, and Gant 1985, Chamberlain and Steer 1999). Such changes in labor and delivery practices are seemingly based solely upon the perception of risk and so depend upon the experiences and the beliefs of both patients and practi-

tioners (McClain 1983, Frankenberg 1993, Kaufert and O'Neal 1993).

As many scholars have shown, the determination of relative fetal risk is shaped by cultural factors (Shaw 1974, Oakley 1984, Martin 1987, Davis-Floyd 1992, Jordan 1993 [1978], Goer 1995, Davis-Floyd and Sargent 1997, Banks 1998). For example, as electronic fetal monitoring and other technological procedures have become standard obstetric practice, patient and practitioner sensitivity to fetal risk and malpractice litigation has increased. In her extensive review of the medical literature, Goer (1995) has shown that many of these clinical practices related to the perceived risks of childbirth are maintained despite evidence suggesting their inefficiency. The influence of social and technological factors on surgical delivery is even discussed in recent editions of *Williams Obstetrics* (Cunningham et al. 1997, 2001), whose authors link the quadrupling of the cesarean rate since 1965 to reduced parity, older maternal age, electronic fetal monitoring, malpractice litigation, and other socioeconomic/demographic factors.

As fetal presentations that deviated from the cardinal movements of labor were defined as abnormal, these "normal" practices and the accompanying biological descriptions were incorporated into paleoanthropological discourse. The notion of a monotypic birth mechanism derives largely from the medical model that emphasizes the danger of childbirth and advocates specific clinical interventions. Once a part of evolutionary discourse, the model of a singular birth mechanism has taken on the appearance of scientific fact, obscuring the underlying biomedical definitions of normal birth.

"Normal" or "Human"?

As paleoanthropologists incorporated the biomedically defined "normal" birth mechanism into evolutionary discourse, this "human" birth mechanism was said to have appeared with the genus *Homo* (Berge 1984, 1993; Tague and Lovejoy 1986; Trevathan 1987, 1988; Rosenberg 1992; Ruff 1995; Rosenberg and Trevathan 1996). The evolution of the human birth mechanism is depicted as an adaptive response to the bearing of large-brained young. According to Trevathan and Rosenberg, this biological adaptive response has positive social consequences in that the human birth mechanism brings about social cooperation at the time of birth. They suggest that with the hominid neonate emerging in an occiput-anterior position, its mother cannot easily guide it from the birth canal. According to this model, anatomical changes of the pelvis associated with bipedality require changes in the birth mechanism. Trevathan (1997: 82) states:

> The anatomical change more important to my argument here requires that the human infant emerge from the birth canal facing *away* from the mother. This hinders her ability to reach down and clear a breathing passageway for the infant and to remove the cord from around the neck if it interferes with breathing or continued emergence. If she attempts to guide the infant from the birth canal she risks pulling it against the body's angle of flexion, perhaps damaging nerves and muscles in the process.

These writers suggest that the selective advantage of social assistance at birth was great enough that human birth since the origins of the genus *Homo* can be characterized by "obligate midwifery."

Building upon the earlier paleoanthropological depiction of difficult birth as a "scar of human evolution," Trevathan and Rosenberg incorporate the culturally resonant feature of inevitably difficult human childbirth. However, their model departs from the reinforcement between paleoanthropology and biomedical technology in suggesting that women need *human* rather than *technological* assistance at the time of childbirth. According to Trevathan, "the most important service provided by birth attendants is the emotional support for the birthing woman" (1997:83). Yet, when assisted birth is tied to a specific birth mechanism as it is in the obligate-midwifery model, it appears to have biological rather than social origins. Trevathan states that "the practice of having some form of assistance at birth is one of the best candidates for that elusive human phenomenon, the cultural universal" (1987:112). The human birth mechanism, as a solution to the obstetrical dilemma, forms the biological basis of the cultural universal proposed in the obligate-midwifery model.

The depiction of an evolutionary basis for a singular human birth mechanism in paleoanthropological discourse was built upon a single formulation of obstetrical practice. Within biomedicine, birth mechanisms other than the one associated with the gynecoid pelvic type came to be considered pathological. The conflation of "normal" biomedical practice with "normal" biological process has had a dominant influence on the paleoanthropological portrayal of a singular human birth mechanism. Despite the role of cultural factors in the formulation of biomedical birth practices, paleoanthropological discourse uses this model to posit specieswide features of the "human birth mechanism." In the context of the paleoanthropological reconstruction of birth, the singular birth mechanism is cited concurrently as a solution to the human obstetrical dilemma and as evidence of birthing difficulties in humans relative to nonhuman primates. While biomedical models have been employed in the reconstruction of ancestral birth patterns, the argument is made here that no single "normal" process of birth/fetal descent exists.

Evidence of Variation

The notion of a particular birth mechanism characteristic of a human taxon is weakened by the presence of variation in living humans and nonhuman primates. Because nonhuman primates serve as the "other" in evolutionary reconstructions, birth variation across the pri-

mate order is oversimplified to highlight the human-animal dichotomy. Among humans, variation can be found in biological parameters such as pelvic morphology and fetal presentation as well as in the cultural practices surrounding birth.

If pelvic fit determines fetal presentation, birth mechanism could be expected to vary depending upon variability in pelvic morphology, as Danforth suggested. Population variation in metric and nonmetric features has been well documented (Stewart, Cowan, and Philpott 1979, Ohlsen 1980, Meindl et al. 1985, MacLaughlin and Bruce 1986, Rosenberg 1986, Novotny 1986, Akiel et al. 1988, Tague 1992, Bruzek 1996). Though the study of population differences in bony features has a perfidious past, these comparisons are relevant to childbirth. Bony morphology may lead to a birth mechanism that differs from the birth mechanism defined as normal in another population. In this context, it is worth reiterating that Caldwell and colleagues' documentation of racial differences in the frequency of pelvic types (1933, 1934) continues to be included in obstetric and anatomy texts (Cunningham et al. 1997, 2001; Williams, Bannister et al. 1995). By contrast, population variation in birth mechanism is absent from the literature in part because of the biomedical characterization of this variation as abnormal. Acceptance of variation in birth mechanism would constitute an important departure from the static pelvic typology embedded in the notion of a single human birth mechanism.

An examination of pelvic variation at the individual level removes this discussion wholly from the realm of typology. If a singular normal female pelvis existed, little variation in pelvic form would be expected. Instead, pelvic measures have at least as much variation as highly variable metric features such as height or hat size (table 1). Such metric variation indicates variation in the shape of the birth canal and supports variation in birth mechanism.

The fetus can also contribute to variation in birth mechanism. Table 2 illustrates some of the variation of fetal presentation documented in the biomedical literature. Some of this variation derives from methodological differences such as whether fetal position is assessed at presentation or at delivery. Variation also derives from differences between practitioners in their partitioning of the continuum of fetal positions. Calkins (1938), for example, is interested in the etiology of occiput-posterior presentations and chooses to lump transverse presentations with anterior presentations. Finding a frequency of occiput-posterior presentations at 49%, he states, "Occiput posterior presentation is not such a serious complication as we have been led to believe" (p. 621). Other investigators keep transverse presentations separate, find frequencies of over 60%, and argue for their normalcy (Caldwell, Moloy, and D'Esopo 1934, Steele and Javert 1942). In recent studies in which normal is defined as the left-occiput-anterior presentation, transverse presentations are combined with posterior presentations because both are considered abnormal (To and Li 2000). Some recent studies seek to explain the etiology of putative abnormalities. For example, Gardberg and Tupperainen (1994*a*) found that anterior placental location is associated with occiput-posterior presentation. Their finding indicates that soft tissues as well as bony structures contribute to variation in birth mechanism.

While all the early studies discuss variation in birth mechanism according to fetal presentation (Caldwell, Moloy, and D'Esopo 1934, Calkins 1938, Steele and Javert 1942), more recent studies focus on the normalcy of the presentation associated with the singular birth mechanism (Gardberg and Tuppurainen 1994*b*, To and Li 2000, Sizer and Nirmal 2000). It is interesting to note that the frequency of "abnormal" presentations has decreased as these presentations have been pathologized. Collectively, the conflicting reports of the frequency of fetal presentations argue for the influence of obstetrical practice on the categorization of fetal presentation.

The Comparative Perinatal Project (CPP) provides both insight into the range of variation in birth mechanism and evidence of the interplay between medical practices and the understanding of variation (Niswander and Gordon 1972). This large-scale, multisite analysis of pregnancy and labor was undertaken by the National Institute of Neurological Diseases and Stroke to eliminate birth-related neurological disease. It documented variation in human biology as well as obstetrical practice. In nearly 40,000 births recorded by the CPP, fetal presentation was in the "normal" left-occiput-anterior position only 20% of the time. Direct occiput-anterior presentations were the most common at 46%. The "malpositions" accounted for another close to 20% of fetal presentations.

The CPP study also documented variation in the presence of the obstetrical forceps during this time period. Frequency of forceps deliveries ranged from 10% to 90% by site, with an average of 57% for white women. Though Niswander and Gordon noted a statistical association between occiput-posterior and transverse fetal presentation and perinatal morbidity and mortality rates, the unspecified vertex presentation had the highest rates of poor outcomes. This large epidemiological study linked forceps delivery to perinatal morbidity and mortality. However, no link was made between forceps and fetal presentation. Though the notion that poor outcomes could derive from misapplied forceps was not discussed, this study played a significant role in the subsequent management of putative abnormalities by cesarean section.

Several more recent epidemiological studies confirm a relatively substantial frequency of fetal presentations in positions other than "normal" (Gardberg and Tuppurainen 1994*b*, To and Li 2000, Sizer and Nirmal 2000). Again, the outcome of these deliveries is complicated by the biomedical responses to these presentations as abnormal. Gimovsky and Hennigan (1995) call for a reevaluation of the obstetrical management of these presentations in order to reduce the rates of cesarean delivery. Banks (1998) advocates noninvasive delivery of breech births as well. Because biomedical knowledge and practice are disseminated globally, these writers' suggestions

TABLE 1
Anthropometric Variation in Adult Females

	Mean (mm)	Standard Deviation	Coefficient of Variation	Source
Transverse diameter of the pelvic inlet	125.87	9.36	0.074	Walrath (1997)
Transverse diameter of the pelvic midplane	104.31	5.62	0.054	Walrath (1997)
Transverse diameter of the pelvic outlet	127.21	12.06	0.095	Walrath (1997)
Sacral breadth	114.99	7.53	0.065	Walrath (1997)
Pubic symphyseal height	21.51	4.03	0.187	Walrath (1997)
Maximum diameter of the false pelvis	269.80	21.21	0.079	Walrath (1997)
Femoral head diameter	41.86	2.49	0.059	Walrath (1997)
Arm length	540.5	31.8	0.059	Peebles and Norris (1998)
Shoulder breadth	367.2	18.7	0.051	Peebles and Norris (1998)
Head breadth	129.2	6.5	0.046	Peebles and Norris (1998)
Head circumference	549.7	17.0	0.031	Peebles and Norris (1998)
Stature	1,620.0	64.4	0.040	Peebles and Norris (1998)

are particularly apt. For example, To and Li (2000) report a frequency of 14% of occiput-posterior and transverse positions in a study of 17,533 deliveries in a Hong Kong teaching hospital. They note that "malposition" is associated with increased risk of operative delivery. The definition of normal fetal presentation and birth mechanism derived from American hospital populations may contribute to this risk. The international application of biomedical practices described above can provide a window into human variation in a biological process such as the birth mechanism.

Examination of birth outside of a biomedical model provides a more complete picture of variation. However, because it is emphasized primarily in biomedical discourse, the frequency of the cardinal movements of labor has not been the focus of ethnographic analyses. These studies focus instead on the tremendous cross-cultural variation in the practices and beliefs surrounding birth (Kitzinger 1972, Shaw 1974, Cosminsky 1976, Jordan 1993 [1978], Scully 1980, Martin 1987, Davis-Floyd 1992, MacCormack 1994 [1982]). Cross-cultural differences in the handling of breech deliveries are mentioned (MacCormack 1994 [1982]; Jordan 1993 [1978]), but distinctions are not made between occiput-posterior and anterior vertex positions in the ethnographic literature except in biomedical contexts. For example, in American hospital deliveries, Jordan describes how birth mechanism and fetal presentation play a role in "power defining encounters." A laboring woman asks what LOA (left-occiput-anterior) is and the physician replies, "It's loa dear. You know, like in aloha? You ever been to Hawaii?" (Jordan 1993 [1978]: 70).

Cosminsky states that in more than 25 years of ethnographic observations on childbirth, no one ever spoke about face-up (occiput-posterior) presentations, indicating either the infrequency or the normalcy of this pattern of fetal emergence (personal communication). Instead, the widespread cultural practice of assisted birth is used as an indication of the monotypic birth mechanism of the gynecoid pelvis. To support her thesis about the selective advantage of assisted birth, Trevathan (1987) reports that only 24 of the 296 studies she surveyed mentioned unassisted birth as a common practice. Physical and emotional support during birth, however, need not be tied to a singular human birth mechanism.

Some midwifery practices in the United States are informative on the birth process without the influence of biomedical practices. In a series of 1,917 births, 1.7% were in the "abnormal" occiput-posterior position (Gaskins 1990). In these births, the babies experienced no complications from being allowed to emerge in a face-up position rather than maneuvered into the "human" pattern. Face, brow, and breech presentations were also born without complications or instrumental intervention in this sample.

The notion of a monotypic human birth mechanism is based partly on the idea that nonhuman primates experience less difficulty during childbirth because they do not experience rotational birth and the newborn emerges in an occiput-posterior position. Can the rotational birth mechanism by itself be evidence of birthing difficulty? The important recent work of Stoller has challenged the notion that humans are the only species to undergo rotational birth. She documents rotational birth in *Papio* and *Saimiri* (Stoller 1995*a*, *b*), two nonhuman-primate groups long known to have a close fit between maternal pelvic and fetal dimensions (Ankel-Simons 2000), and argues that without a comprehensive understanding of

TABLE 2
Variation in Fetal Position (%)

Source	*n*	Fetal Locus	Fetal Position[a]								
			LOA	ROA	OA	T	LOP	ROP	OP	OP + T	Other[b]
Caldwell, Moloy, and D'Esopo (1939)	200	Engagement	9.5	6.5	5.5	60.0	9.0	9.5	–	–	–
Calkins (1938)	2,002	Presentation	–	–	51.0	–	–	–	49.0	–	–
Steele and Javert (1942)	763	Brim	13.2	9.6	1.8	63.4	3.0	7.3	0.6	–	–
	277	At, above, or below ischial spines	11.9	5.7	2.8	62.8	3.2	11.5	1.8	–	–
Niswander and Gorden (1972)	37,276	Presentation	20.4	13.6	45.9	5.2	2.0	2.9	2.1	–	7.9
Gardberg and Tuppurainen (1994)	3,648	Delivery or last exam before obstetric intervention	–	–	–	–	–	–	4.7	–	–
To and Li (2000)	17,533	Delivery or last exam before obstetric intervention	–	–	–	–	–	–	–	14.0	–
Sizer and Nirmal (2000)	16,781	Delivery or last exam before obstetric intervention	–	–	–	–	–	–	4.6	–	–

[a]OA, occiput-anterior; OP, occiput-posterior; T, transverse; L, left; R, right.
[b]Face, brow, unspecified vertex, transverse, compound, and breech.

the factors that determine birth mechanisms it is premature to define a human pattern. She suggests that the false dichotomy between humans and nonhuman primates has influenced studies of the evolution of birth, adding that "only after a broad theory of labor mechanics has been established will the predictive studies of fossil morphology be justified" (1995*a*:4). Similarly, the statement that nonhuman primate newborn emergence is always in an occiput-posterior position may not stand up to close investigation. In the wild, relatively few nonhuman primate births have been observed. Unfortunately, primate breeding colonies employ cesarean sections for most deliveries, thus obscuring variation in birth mechanism.

The relative rapidity of nonhuman-primate labor and the observation that nonhuman primates give birth alone have been used to support claims about human birthing difficulty (Jolly 1972; Trevathan 1987, 1988), but these factors warrant reexamination. First, not all nonhuman primate births can be described as rapid or easy. Maple (1980) describes a range of variation in terms of maternal behavior, difficulty, and duration for orangutan zoo births. Duration of labor from cervical dilation to birth varied from 15 minutes to 60 hours. Field observations by Kaplan and Rogers indicate that orangutan mothers will stretch and bend in the week before delivery "as if to overcome pain" (2000:51), a pattern that is perhaps indicative of an extended labor pattern.

Galdikas (1982) was the first to report on wild orangutan birth, making observations on a birth by an older mother and the first birth of her adolescent daughter. In both cases the mother's behavior changed before parturition. The younger orangutan's "movements seemed slow and belabored as though she was having difficulty in locomoting" in the days before the birth (p. 503). In the older mother, fluid leakage and vaginal opening were visible in the days before birth. In addition, "she did scratch her stomach more than usual" (p. 506). The births themselves could not be observed at close range because the orangutans retreated to nests high in trees for the final stages of the birth process. However, the younger mother was observed to be in a state of high agitation for about two hours. Galdikas reports (p. 504) that

> at one point she had both her arms wrapped around the tree trunk against which her nest had been made. There was a 1-m-long squirt of heavy fluid (probably amniotic fluid) at the height of the agitation. Approximately 50 min later *Fern* seemed to have calmed down and was observed lying on her back. Birth had probably just occurred. Twenty minutes later she was seen licking her fingers as she lay on her back. Subsequently there was virtually no movement in the nest although occasionally a limb would protrude up.

Though the above account is fascinating, it provides limited information about the "hallmarks" of nonhuman primate birth as contrasted with birth in humans. Orangutans would be expected to give birth alone, as they are solitary creatures. The relative ease and brevity of birth seem open to question. Birth mechanism and newborn emergence pattern are completely unknown from this account.

Fossey (1983) describes variation in gorilla birth but also from a distance. Gorilla births are nocturnal, so inferences about the relative ease of birth are made by examining nests the following morning. Easy births, for experienced mothers, involve one night nest, whereas "females giving birth for the first time or those having nonviable births . . . may build as many as five successive night nests adjacent to the main cluster of their group's nesting site" (p. 175). In all births the night nests are left saturated with blood, and in the case of viable births most of the placenta is consumed. In one difficult nonviable birth Fossey reports an abnormal amount of blood and a trail of blood between four nests.

Human labor is traditionally described as longer than labor in other mammals (Trevathan 1987). However, as Trevathan notes, "although normal labor may be longer in humans than in any other species described, that may be, to some extent, an artifact of the ability of human females to communicate the onset of contractions even though they may not show overt signs of the onset" (p. 97). In a culture in which the danger and difficulty of birth are emphasized, early sensitivity to labor sensations is likely encouraged. Cross-cultural variation in the social patterning of birth has been shown to affect what women say about labor and how physical sensations are perceived (Kitzinger 1972, Shaw 1974, Cosminsky 1976, Jordan 1993 [1978], Scully 1980, Martin 1987, Davis-Floyd 1992, MacCormack 1994 [1982], Davis-Floyd and Sargent 1997).

Nonhuman primate birth is not always solitary. Among baboons, birth often takes place in the midst of the group. Kummer (1995) recounts an interesting social baboon birth originally described by Abegglen and Abegglen. The young birthing mother is accompanied by her mate and another adolescent female. The younger female is observed to investigate the birth by sniffing the vulva of the laboring mother and sniffing the newborn shortly after delivery. During the course of labor the male is observed to mount the female, which Kummer interprets as "a sketchy demonstration of possession" (p. 204), though other interpretations are certainly possible. The young male then tries to catch the infant after it emerges as it is dangling dangerously by its umbilical cord over the edge of a precipice. Trevathan recounts delivery assistance in a pair of captive orangutans and connects it to Jensen's 1967 account of the "Bornean Iban myth that knowledge of midwifery skills was obtained by a man who watched an orangutan assist his mate in delivery" (1987:109).

The examples above call into question the fixed dichotomy between nonhuman primate and human birth that contrasts easy, nonrotational, occiput-posterior, unassisted birth in nonhuman primates with difficult, rotational, occiput-anterior, assisted birth in humans. This dichotomy constitutes the ultimate typological approach in that it reduces all variation to two categories of primate to emphasize the uniqueness of human birth.

Why Change?

The foregoing discussion illustrates the interplay between biomedical and paleoanthropological discourse in the construction of a scientific understanding of the human birth process. Though cultural factors have played a primary role in the formulation of the biomedical birth practices, paleoanthropological discourse has adopted this formulation to posit a specieswide characteristic, the human birth mechanism. This monotypic model is based on the notion of an ideal, gynecoid pelvic type setting the stage for a singular birth mechanism understood and managed by experts. It is derived from a cultural approach to human birth that emphasizes the physiological stress and danger of childbirth and advocates specific mechanical interventions. Based largely on the biomedical/obstetric literature, the singular birth mechanism has been cited by paleoanthropologists as, on one hand, a solution to the human evolutionary obstetrical dilemma and, on the other hand, providing evidence of birthing difficulties in humans. Biomedical models have thus been adapted to the reconstruction of ancestral birth patterns.

The evolutionary discourse not only embodies prevailing cultural beliefs but also frames the types of scientific questions that are asked and the theories developed to account for accepted scientific notions. For example, the original evolutionary discourse on human birthing difficulty led to the development of a theoretical monotypic birth mechanism. With its direct and immediate relationship to reproductive success, childbirth is a powerful process through which evolutionary change can occur. Evidence of successful adaptation to the competing demands of childbirth and bipedalism can be found without recourse to a species-specific birth mechanism and universal birthing difficulty.

Generally, evolutionary studies focus on variation as a way of understanding biological processes. Instead, the birth discourse has tended to remove variation both within and between species in order to emphasize the dichotomy between humans and nonhuman primates. A better understanding of human variation without the constrictions of pelvic typologies and the associated monotypic human birth mechanism can shed light on the evolutionary forces that have shaped the human birth process. Without the influence of a model that emphasizes the uniqueness of human birth, evolutionary reconstructions of reproductive patterns can only improve as new avenues of investigation open.

An alternative model begins with the notion that,

biologically, human birth represents fitness in the Darwinian sense. The continued growth and expansion of human population size can be taken as a measure of the degree to which human reproduction can be considered successful. Humans' reproductive success undoubtedly reflects a previously little-acknowledged adaptive variability inherent in the biomechanical aspects of the birth process. Demographic expansion has been characteristic of ancestral hominids as well. From this point of departure, sexual dimorphism of the pelvis would be viewed as a complete solution to the demands of the bearing of large-brained young rather than the impossible compromise first described by Schultz (1949) and Washburn (1948, 1949). Recent studies document successful adaptation to childbirth through canalization of the pelvic growth process in females (LaVelle 1995) and female-specific scaling between determinants of fetal size and the most constrained dimensions of the birth canal (Walrath and Glantz 1996, Walrath 1997). Hager (1989) ties this notion of adaptation to childbirth to the fossil record, suggesting that pelvic dimorphism begins to appear with the origins of the genus *Homo*.

The notion that humans are well adapted to childbirth opens up other areas of evolutionary thought. For example, paleoanthropological theorists have posited that secondary altriciality evolved in response to obstetric constraint (Montagu 1961, Trevathan 1987, Martin and MacLarnon 1990, Rosenberg 1992, Ruff 1995). In these scenarios, the birth of more helpless neonates is linked with the evolution of human-like culture. An alternative construction, less influenced by the notion of the obstetrical dilemma, is that secondary altriciality appeared with the developmental shift accompanying the origins of bipedalism. Bipedalism may have provided the opportunity for encephalization by providing a developmental shift that allowed for brain expansion. This construction contrasts considerably with the notion that encephalization led inevitably to obstetrical difficulty. The pervasive influence of the obstetrical dilemma and the monotypic birth mechanism has thus colored theories of when and how the human developmental pattern arose.

Evolutionary studies hold an interesting place in anthropological discourse. They draw upon both scientific and narrative traditions while attempting to make universal statements. As a putative characteristic of our species, the notion of a singular human birth mechanism appears to minimize the social underpinnings of the evolutionary narrative. However, the practical consequences of this biological theory are above all social, affecting beliefs and behaviors surrounding birth. A number of implications stem from an alternative understanding that no single "normal" process of birth/fetal descent exists.

The prevailing evolutionary narrative of human birth shapes the way in which American women experience childbirth. The cultural belief in the danger of birth is reinforced in introductory college texts describing the evolutionary basis for human birthing difficulty. The singular birth mechanism is presented as evolutionary fact rather than as a clinical "normal" defined in relation to prevailing medical beliefs and practices. These "facts" are also made available for the general educated reader. One parenting book summarizes the birth process as follows: "and so we have the miracle of modern human birth—a painful, twisted journey that squeezes the infant head like Play-Doh and causes mothers unbelievable pain" (Small 1998:12). As in the descriptions of the singular human birth mechanism found in introductory college texts, the cultural belief in the difficulty and danger of birth is linked with scientific evolutionary studies so that the pain and danger appear natural and inevitable.

As women have learned that their fear of the birth process has an evolutionary basis, obstetrical intervention may have become a self-fulfilling prophecy. Fear can delay the labor process (Rothman 1982, Rooks 1997, Davis-Floyd 1992, Jordan 1993 [1978], Goer 1995), and in biomedical practice such delays lead to surgical obstetrical intervention (Benson 1982; Chamberlain and Steer 1999; Cunningham et al. 1997, 2001). In contexts where normal variation is incorrectly labeled as an abnormality, the impact of fear on the process of labor will be particularly strong. Conversely, an anthropological discourse that emphasizes successful birth in humans over evolutionary time might be expected to have positive social consequences. A more optimistic and variable model of the evolution of human birth could lessen the fear surrounding childbirth and lead to easier deliveries for American women.

The medicalization of birth and reproductive phenomena represent the production and control of reproductive knowledge via the universal scientific framework (Ginsburg and Rapp 1991). Ginsburg and Rapp emphasize that "no aspect of women's reproduction is a universal or unified experience, nor can such phenomena be understood apart from the larger social context that frames them" (p. 330). The biomedical depiction of "normal" birth was defined within a social framework that developed practices consonant with prevailing cultural beliefs. In this light, the "normal" birth mechanism derived from biomedicine is not equivalent to a single natural pattern established by evolutionary forces. Furthermore, evolutionary models about nature generally favor diversity rather than a monotype.

Progression beyond typological models of human birth to incorporate the full range of human variability will improve our understanding of the evolution of human reproductive biology. Ultimately, our reconstructions of reproductive biology and behavior will benefit from a better understanding of the beliefs that influence them. Better models about the evolution of human childbirth also have the potential to improve the birth experience for women and babies.

Comments

SHEILA COSMINSKY
Department of Sociology, Anthropology, and Criminal Justice, Rutgers University, Camden, 311 N. 5th St., Camden, N.J. 08102, U.S.A. (*cosminsk@camden.rutgers.edu*). 27 IX 02

Walrath's paper contributes a valuable perspective to anthropology. In the process of analyzing the historical interaction between physical anthropology and biomedicine with regard to human birth, Walrath demonstrates the cultural construction of the definition of "normality." According to the evolutionary model proposed by Trevathan (1987, 1999), the rotation of the fetus and the occiput-anterior position of delivery represent an adaptive compromise to bipedalism, the shape of the human pelvis, and a larger-brained infant, which results in a painful and difficult birth process that limits a woman's ability to deliver the infant herself.

Walrath questions both the assumption of the difficulty of human childbirth and the corollary of necessary assistance. She points out the impossibility of inferring information about the birth process from the fossil record, and our knowledge and observations of primate birth that would substantiate this claim are very few. She uses data from historical obstetrical sources and from the recent Comparative Perinatal Project to argue that no single "normal" process of birth exists.

Although midwives or other women assist at a birth in the majority of societies, the ethnographic evidence includes cases of unassisted birth, including several cultures in which solitary delivery is highly valued. Sargent (1989) reports solitary delivery for Bariba women in Benin, who value stoicism and not expressing pain. Biesele (1997) mentions this as an ideal among the Kalahari Ju/'hoansi. Shostak (1981:179) quotes a San or Ju/hoan woman as saying, "You don't worry if you feel pain: pain is the sign of the child's existence." Trevathan says that although the Kung San have an cultural ideal of unassisted birth, most have older women with or near them when they give birth in case of complications. However, Biesele quotes a Ju/hoan woman as saying, "How should I fear childbirth? Isn't it just a thing you do, just quietly give birth alone and then sit up and carry the child in a sling?"

O'Neil and Kaufert (1990) report that there was no one model of traditional birthing among the Inuit. Although many births were assisted, some women managed births alone and claimed that childbirth was relatively easy. Unassisted birth was a source of pride and a sign of virtue. Murphy-Lawless (1998) reports that in the Bolivian Andes, while a woman usually seeks the assistance of a midwife for a first pregnancy, subsequent births may be unassisted because the woman feels she knows what to do and may choose to be alone. Solitary birth has also been reported for various groups in the Southern Highlands of Papua New Guinea. For example, Angal Heneng-speaking women are expected to deliver alone because of beliefs about the danger of contact with women's blood (Alto, Albi, and Irabo 1991). In some cases, women may deliver alone not out of preference but because no one is available to assist them. One of the midwives I worked with in Guatemala reported that the first child she had delivered had been her own fifth child, no midwife having been available. Her first four deliveries had been assisted by a midwife, but for the following seven she managed alone. In the numerous instances in the United States and elsewhere of baby dumping, abandonment, and neonaticide, births generally take place silently and unassisted (Jon'a Meyer, personal communication).

Biomedicine assumes that the woman is incompetent and lacks the knowledge to deliver unassisted, whereas in these cases the woman assumes that she is competent, highlighting the cultural construction rather than the scientific basis of the assumption of the difficulty of the birth process. The medicalization of birth is a global process. Midwifery training programs around the world are based on this biomedical model and emphasize the dangers and risks of birth. The cultural construction of this model includes not only pelvic type and birth mechanism but also other aspects of the birth process such as the duration of labor (Murphy-Lawless 1998). Birth that has been considered within the locally defined range of normal variation is now defined as pathological or abnormal and thus referred not only to the hospital but for cesarean delivery as well. The rate of cesarean sections has risen sharply in many parts of the world. Although various ethnographic studies have examined management of breech and transverse births, especially the use of external version (Jordan 1984), little information exists concerning the frequencies, difficulties, and management of variations in face presentation. I hope that this article will stimulate future research in this direction.

ALISON JOLLY
School of Biological Sciences, Sussex University, Brighton BN1 9QG, U.K. (*ajolly@biols.susx.ac.uk*). 22 VIII 02

Walrath has made a bold and very useful leap in combining three ideas usually left separate. The first is typological thinking, which defines the "most frequent" category as the "normal" one and swiftly moves on to the idea of the "only" normal one. Applied to human birth this means defining the child's entering and leaving the birth canal with occiput anterior and face toward the mother's back as "normal" and all other possibilities as "abnormal." The second idea is that the change from primate birth to human birth involves pain and danger, with the typical human birth presentation being a makeshift adaptation forced by the shape of the bipedal pelvis. The third is the decision of contemporary American medical practice that cesarean section is preferable to "abnormal" birth.

To start with the first idea, we should all applaud at-

tacks on typological thinking. If there were one curriculum change that might be promoted in primary school, it would be elementary statistics, with some understanding that an average does not describe a distribution. Then even a fourth grader could read a proposition such as "Boys are more mathematically gifted than girls" as describing broadly overlapping distributions, not "all boys" versus "all girls," and be able to argue rationally about how much, or why, or whether it is true. Similarly, reading "80% of birth presentations in the 37,000-strong Comparative Perinatal Study were occiput-anterior" should immediately bring to mind that 20% of births were otherwise.

On the evolutionary idea, I am fully convinced by Walrath's conclusion that human childbirth is a triumph, reconciling the needs of big-brained babies and bipedal mothers. I am less convinced by the way in which she has reached that conclusion. It remains true that the vast majority of human infants are born occiput-anterior, the vast majority of nonhuman primates the other way round. In nonhuman primates, visible contractions during labor generally last less than two hours; in humans, they generally last much longer. Further, there is a strong bias in reports of wild nonhuman-primate births. Births in most diurnal species occur at night. (This is statistically true also for uncomplicated human births, and even with straightforward human births labor is longer in the daytime.) Daytime nonhuman-primate births are more likely to be seen and also more likely to be complicated and long, which means that the difference between humans and nonhuman primates is even greater than reported. If length is correlated with subjective pain, this suggests that human births are indeed more painful. Thus, although human birth is a triumph, it has a cost. Trevathan's idea that midwifery matters to human mothers' and infants' survival still stands, though midwifery is not obligate in the typological all-or-none sense, for even modern humans can and do deliver alone when necessary (Jolly 1972, 1999).

Finally, on idea three, anything that can be done to individualize, indeed, to humanize, American childbirth is all to the good. Let us hope that Walrath's careful matching of pelvic shapes and optimal presentations can convince both women and their doctors that the unusual is not necessarily abnormal. Perhaps the baby, not the doctor, sees the world the right way round.

SONIA RAGIR
Department of Anthropology, CUNY College of Staten Island, Staten Island, N.Y. 10314, U.S.A. (*ragir@mail.csi.cuny.edu*). 22 X 02

I am in complete agreement with Walrath's argument that the existence of variation in human pelvic morphology and birth mechanisms is evidence of a well-established, successful adaptation to the competing demands of childbirth and bipedalism; indeed, her refutation of the "medical model" of female reproductive frailty and a singular, uniquely dangerous human birth mechanism is long overdue. Walrath's claim that human birth is no more dangerous than that of other primates is supported by the comparative studies of the duration of labor in Indian langurs and in American hospital births by Lindberg and Hazell (1972; Lindberg 1982). Because wild primate births were difficult to observe, these researchers timed only the last phase of the labor—i.e., that which was marked by panting, distinctive postures, and other behavioral changes—and used hospital records of the duration of the same phase of labor in humans. They found that "heavy labor" lasted about two hours in both humans and langurs, and their study provided no evidence that this phase, during which the fetus passed through the mid-plane and outlet of the birth canal, took longer in humans than in other primates.

Furthermore, in a comparative study of sexual dimorphism in mammals, Wood and Chamberlain (1986) argued that the maternal/neonatal mass ratio was the only trait significantly correlated with female pelvic dimorphism; they found no correlation between the size of the neonate's head and sexual dimorphism in the pelvis. Significant increases in the average hominid body size occurred during the transition from early *Homo* (sp.?) to *Homo erectus*, but body-size dimorphism did not decrease until later; the reconstructions of fossil body dimensions suggest that modern levels of sexual dimorphism appear only with the transition to archaic *H. sapiens*. Ruff (1995) argued that the increases in height and robusticity in *H. erectus* were accompanied by proportionate increases in the transverse but not in the anterior-posterior dimensions of the pelvis until the appearance of archaic *sapiens*; thus, the pelvic morphology became relatively narrower from front to back (platypelloid) as females increased in overall size and produced larger infants. The passage of these larger infants through a relatively narrower birth canal would have selected for increased neonate flexibility or expansion in the diameter of the birth canal or both.

The argument that human encephalization created unique dangers during childbirth has never been logically compelling; three-quarters of the increase in cranial volume in modern humans occurs after birth and before the bony plates in the cranium fuse. Whereas the adult human cranial volume is some 400% larger than that of an adult ape of comparable body mass, the human neonatal cranial volume is only 15–20% larger than those of ape neonates; at the same time, newborn humans weigh anywhere from 200 to 300% more than newborn apes. From the point of view of birth mechanisms, the increase in brain volume is insignificant compared with the increase in neonatal body size. Our obsession with human brain size has blinded us to the impact that changes in pelvic morphology might have had on the timing of fetal as well as postnatal development.

I have proposed elsewhere (Ragir 2000*a*, *b*, 2001) that this reorganization of the bony birth canal is likely to have been accompanied by a variety of adaptive responses not only in the process of birth but also in the timing of developmental transitions. The shift of the bony pelvic midplane and outlet to a position perpen-

dicular to the spine would have made the navigation of a birth channel's twists and turns more difficult for a fetus with a rigid rather than a flexible skeleton. A delay in the transition from one phase of fetal development to the next would have permitted a larger number of cell divisions to occur between transitions and resulted in a larger fetus, a less mature skeletal and nervous system, prolonged postnatal development, and encephalization (Little 1989). Selection for skeletal immaturity would have resulted in a large, flexible neonate that was capable of squeezing relatively quickly through a birth canal with variously constricted inlets, midplanes, and outlets (Ragir 2000*a*, *b*, 2001).

KAREN ROSENBERG
Department of Anthropology, University of Delaware, Newark, Del. 19716, U.S.A. (*krr@udel.edu*). 16 IX 02

I am more optimistic than Walrath about our ability to learn something about how human ancestors gave birth from their fossilized morphology. She asserts that, even with a complete fossil record, the birth process itself cannot be preserved and that paleoanthropological depictions of birth stem from an acceptance of modern Western medical ideas about childbirth and the application of those ideas to our ancestors. It is, of course, true that processes do not fossilize directly. However, it is precisely because of the "tight fit" between the maternal pelvis and the infant cranium that we can draw conclusions about the birth process from skeletal anatomy. Tague and Lovejoy (1986:238) argued that because "the shape of the maternal pelvis directs fetal movements during parturition, variations in pelvic morphology imply dissimilarities in patterns of birth. This is true not only between nonhominids and hominids, but interspecifically within the Hominidae." Although such reconstructions of "paleo-obstetrics" are based on a number of very important assumptions, perhaps most notably infant head size at birth, it is reasonable to infer from the size and shape of birth canal and the size and shape of the infant's head and body the way in which the infant usually negotiates the passage. Although reconstructions of birth in our ancestors have generally focused on the head as the greatest constraint, the wide shoulders that hominids share with our great-ape relatives also represent a significant constraint in many living humans and probably did in the past as well (Trevathan 1988, Trevathan and Rosenberg 2000).

Walrath is persuasive in her argument that in looking at the birth process practitioners of modern Euro-American medicine have generally viewed variants from the "normal" mechanism as pathological. Indeed, what is "normal" has changed through time and with cultural context, as she shows. This means that women who give birth in ways not conforming to obstetrical expectations experience more medical intervention and that physicians are not generally trained to handle "nonnormal" situations without recourse to such intervention. Clearly, this has significant implications for the ways in which modern medical obstetrics is practiced. It also means, as she observes, that modern medical settings do not provide an easy opportunity to test hypotheses about how selection is acting on modern women and infants during childbirth. For example, if breech births are routinely delivered by cesarean section, we can learn little from them about the outcome of breech births in the absence of that intervention.

However, the implications of focusing on a "typical" mechanism of human birth are different for anthropologists than for medical professionals. Walrath believes that, as do medical professionals, paleoanthropologists regard the modern human birth process as invariant and accept the "normal" birth mechanism as the only one. Scholars of the evolution of human birth have indeed focused on a single mechanism of birth in modern humans. This is not, however, because they fail to recognize the significance of variation but because they are focusing on what is *by far* the most common mechanism of birth today (see Walrath's table 2). Indeed, the very fact that the occiput-anterior presentation is so frequently observed for modern infants at delivery may reflect the intense selection that it has been under in the past. If most women give birth to infants this way and if those women benefit on the average from the presence of an assistant as Trevathan's "obligate midwifery" hypothesis suggests, then selection will favor the behavior of seeking assistance, whether or not it improves obstetric outcome in every case and whether or not women who give birth to infants in other ways experience difficulty in every case. The hypothesis, like all hypotheses that invoke selection, is based on probabilistic phenomena rather than all-or-nothing scenarios.

Walrath argues that "the prevailing evolutionary narrative of human birth shapes how American women experience childbirth." I suspect that she overstates the impact of the paleoanthropological or cross-cultural literature on thinking within modern medical practice. However, Trevathan has suggested that an understanding of cross-cultural variation coupled with the evolutionary history of childbirth *could* provide a context in which women and physicians might benefit from understanding the importance of many types of assistance.

Walrath's work points to a number of significant areas for future research. Her point that we know very little about variation in nonhuman-primate birth beyond the pioneering study of Stoller is well taken. Similarly, a systematic study of correlations between pelvic morphology and birth mechanism in a population of humans without significant medical intervention would be extremely useful if ethically problematic and difficult to conduct.

Finally, Walrath argues that paleoanthropological studies have depicted the "female human pelvis as ill-equipped to bear young" and that "this could reflect the inferior social position of females rather than an innate obstetrical dilemma." While I applaud her efforts to focus attention on how our interpretations of the fossil record might be influenced by assumptions we carry from our own culture, I do not find this argument com-

pelling. The phrase "ill-equipped" is her interpretation of statements made by paleoanthropologists to the effect that the maternal pelvis has been under selection as a result of increasing infant head size in the past 2 million years of human evolution. However, the presence of selective forces is hardly an indication of inadequacy. Indeed, as Walrath points out, there is a great deal of demographic evidence for the success of the human birth adaptation!

PAMELA K. STONE
Department of Anthropology, Western Michigan University, Kalamazoo, Mich. 49008, U.S.A. (*pstone@wmich.edu*). 11 X 02

I applaud Walrath for her examination and deconstruction of the rigid structures that underlie anthropologists' discussion of the mechanisms of childbirth. She contextualizes the historical forces that have shaped the treatment of childbirth as a monotypic process and the ways in which laboring women's bodies are framed by cultural practices and ideas of medicine. Her work adds to and complements the cultural critiques of birth by Jordan (1993 [1978]) and Martin (1987), in which culture supports varied responses to childbirth. Walrath offers an additional line to thinking about the variability of childbirth from a biological perspective, one in which female biological processes are as variable as women themselves.

Clearly the study of birth is rooted in both biological and cultural constructions, but there is a distinct lack of a dialogue around the variability of the birthing process from a biological standpoint, and this paucity of information needs to be understood and evaluated. As a biocultural anthropologist interested in how biology and culture intersect and define this most basic human process, I am intrigued by Walrath's discussion of the way in which the Euro-American biomedical establishment has dictated a singular "normal" birth mechanism, in which the ascent and rotation of the neonate in labor follow one definitive course through a rigid bony birth canal. This typological approach was constructed by an early eugenic school of thought promoting the idea that white women, whose labors were presented as more difficult, were more evolved then women of racial "types" who were presumed to give birth more easily. However, the cultural practices surrounding parturition were never examined. Today we know that birthing position and the environment in which birth takes place can enable a positive outcome without intervention and give the appearance of an "easier birth." In addition, with all the work done in the past 20 years on rethinking racial typologies, I am amazed that the ways in which we discuss reproduction, both as an evolutionary process and in clinical settings, perpetuate this static perception of pelvic architecture and birth mechanism. In fact, this narrow thinking has a direct impact on the numbers of unnecessary surgical interventions in the delivery room. In turn, this perpetuates the model of birthing women as passive and in fact pathologizes the birth process instead of embracing it as an individual and variable event.

With little else to use, paleoanthropologists have been forced to adopt the static models of birth mechanisms and pelvic architecture that are presented as the standards in obstetrical texts, thus reinforcing the typological approach to the understanding of birth processes in the past. As Walrath points out, the "evolutionary narrative" and the continued use of terms such as "obstetrical dilemma" and "scar of evolution" make it clear that static definitions are embedded in the language of birth and continue to sideline discussions of the variability inherent in childbirth. The idea that birth is dangerous and problematic and should be managed creates a culture of fear which results in problematic parturition and potential complications. Thus anthropological discourse around birth reinforces and strengthens the biomedical misunderstanding.

This paper challenges anthropologists interested in understanding the birth process to examine it as a biocultural phenomenon that is variable both in terms of the cultural constraints on pregnancy and parturition and in terms of the birth mechanism itself. In fact, Walrath is asking for a new ethos of anthropological inquiry, much like Wood and Powell's (1993) archaeological one, that moves away from a "singular norm" and embraces the mosaic of variability in the birth process that can in turn facilitate a better and more positive birth experience for women and babies today.

ROBERT G. TAGUE
Department of Geography and Anthropology, Louisiana State University, Baton Rouge, La. 70803-4105, U.S.A. (*rtague@lsu.edu*). 4 X 02

Walrath suggests that the words "normal" and "abnormal" in obstetrics have consequences in maternal choice about birth and maternal morbidity (e.g., sequelae of surgical delivery) and that these words also influence paleoanthropologists in their theories of human evolution. She presents a fine historical argument that the standards for "normal" anatomy and birth are culturally influenced and challenges the obstetrical and anthropological communities to consider the "abnormal" simply a variant of the "normal." The idea of returning authority in decisions on birth to the mother rather than the medical establishment is welcome. However, there are two problems with her argument. First, her own interpretation of "normal" is monotypic. Second, paleoanthropologists do not assume a single, monotypic birth mechanism in their theory of human evolution.

"Normal" has several meanings. An incomplete list includes "approximating the average," "typical," and "occurring naturally." "Abnormal" is a deviation from the "normal," though it can also mean "inferior to the normal." Walrath implies that obstetricians regard "normal" as singularly meaning "biologically natural" and the "abnormal" requires medical remedy. For example, two chapters in *Williams Obstetrics* (Cunningham et al.

2001) are entitled "Normal Labor and Delivery" and "Abnormal Labor." Cunningham et al. (2001) do not discuss management of "normal" labor, but they do discuss methods to manage "abnormal" labor. By inference, the former will be naturally successful, whereas the latter may require medical intervention to be successful. However, the obstetric literature is not uniform in this use of "normal." I provide two contrasting examples, the first illustrating "normal" as "natural" and the second "normal" as "average." (1) "Many authors . . . believe that the *curved sacrum is the normal* one and that *variations are abnormal*" (Posner, Bloch, and Posner 1955:1021). (2) "The Caesarian section rate . . . [is] striking, in view of the near *normal size* of the pelvis. . . . This . . . rate . . . is seen even if the pelvis was above *average in size*" (Russell and Richards 1971:782). Therefore, a reader must interpret a writer's intent in the use of "normal." *Contra* Walrath, "normal" is not used monotypically in the obstetric literature.

Walrath states that "paleoanthropologists have proposed a singular human birth mechanism" characterized by "fetal rotation . . . [and] newborn emerg[ence] from the birth canal in the occiput-anterior position." With regard to the latter, Trevathan has argued that evolution of the occiput-anterior position was accompanied by the need for an attendant to assist the mother in delivery. However, Walrath does not demonstrate meaningful variation in these two aspects of birth. First, although she argues that an occiput-posterior orientation at emergence is a "normal" (i.e., biologically natural) variant and does not necessitate a birth attendant, she cites only a single study on this issue, and it shows that an occiput-posterior orientation at delivery occurs with a frequency of only 1.7% (Gaskins 1990). The only other fetal orientation would be occiput-transverse, but according to King (1957) this position occurs only with the rare combination of an unusually small head and an ample pelvis. Therefore, though one may disagree with Trevathan's theory about birth attendants, Walrath documents that the occiput-anterior orientation at emergence is "normal" (i.e., typical). Second, she presents no data on the incidence of fetal rotation within the birth canal, but one can infer it. As shown above, the fetus emerges from the birth canal "normally" with an occiput-anterior orientation; an occiput-posterior orientation occurs less frequently. With these two positions of emergence, a fetus must rotate in the birth canal if it enters the pelvis in a position other than occiput-anterior or -posterior. In table 2, Walrath shows that the combined percentage of occiput-anterior and -posterior at the pelvic inlet is less than 50%. (Calkins's [1939] results are not relevant because he evidently simplified his assessment of fetal orientation.) Therefore, if the fetus typically enters the pelvis with an orientation other than occiput-anterior or -posterior but typically emerges in an occiput-anterior or -posterior orientation, then rotation within the birth canal must have occurred—that is, fetal rotation is "normal." Admittedly, studies on the birth process are based primarily on mothers who deliver in North American and European hospitals. This "normal" birth process may be an artifact of the supine birth position used in these hospitals. Comparative data with other birthing postures are needed.

WENDA TREVATHAN
Department of Sociology and Anthropology, New Mexico State University, Las Cruces, N.M. 88003-0001, U.S.A. (*wtrevath@nmsu.edu*). 9 IX 02

This article highlights the limitations of applying a model of childbirth derived from Western biomedicine to the human fossil record and paleoanthropological reconstructions. Assuming that the Western model characterizes all contemporary human populations is also fraught with difficulty. Indeed, anecdotal evidence suggests that posterior presentations of the neonate may be far more common in some non-Western populations than they are in the United States and Western Europe. Most likely, dietary, overall health, posture, and activity-level variations contribute to different pelvic morphologies in adult females (Abitbol 1996). Clearly, the amount of variation in the human birth mechanism is much greater than that depicted in obstetrical texts. Our task now is to investigate and document that variation.

Certainly the terms selected to describe the variation seen in pelvic inlet shapes have proved problematic. "Android" (manlike) and "anthropoid" (money-like) were not likely value-free at the time they were first used and are certainly value-laden today. At the very least, such terminology could be replaced with phrases such as "narrow anterior portion," "narrow midplane," or "narrow transverse plane."

As Walrath notes, the information about posterior presentations in the literature does not always indicate whether these were presentations at the onset of labor or at delivery. By definition, an occiput-posterior delivery occurs when the infant emerges with its face toward the mother's pubic bones. Although many neonates enter the birth canal in the occiput-posterior position, most rotate to emerge in the anterior position. For example, the figure of 49% occiput-posterior presentations that Calkins (1939) cites refers to position at the inlet; in a later paper he notes that, of this number, "complete anterior rotation failed to occur in 4 per cent of occiput anterior presentations . . . [and] . . . the comparable figure for occiput posterior presentations was 6 per cent" (Calkins 1953:469). It is now known that any of the following is possible: occiput-anterior at onset of labor with delivery occiput-anterior; occiput-anterior at onset with rotation to occiput-posterior; occiput-posterior at onset with rotation to occiput-anterior; and occiput-posterior at onset with delivery occiput-posterior (Gardberg, Laakkonen, and Sälevaara 1998). The argument for obligate midwifery is based on presentation at delivery. I have summarized the available data on occiput-posterior presentation at delivery in table 1.

Two primary concerns are raised in clinical practice related to occiput-posterior presentation: the progress of labor when the infant engages in the occiput-posterior

TABLE 1
Occiput-Posterior Presentation at Delivery (percentage)

Population	*N*	Occiput-Posterior at Delivery (%)	Source
United Kingdom, nulliparas	16,781	4.6	Sizer and Nirmal (2000)
U.S.A. (Dallas, Tex.)	12,488	2.6	Haynes (1954)
Finland	408	5.1	Gardberg, Laakonen, and Sälevaara (1998)
U.S.A. (Atlanta, Ga., African-American)	7,044	6.0	Phillips and Freeman (1974)
U.S.A. (Atlanta, Ga., "white")	1,585	4.7	Phillips and Freeman (1974)
U.S.A. (Michigan)	5,396	9.2	Kutcipal (1959)
Hong Kong (Chinese)	17,533	14[a]	To and Li (2000)
U.S.A. (Kansas)	2,002	6–10	Calkins (1939)
U.S.A. (Kansas)	2,119	7.4	Calkins (1953)
Israel	32,811	0.97	Neri et al. (1995)
El Paso, Tex./Juárez, Mexico	1,222	0.5	Trevathan (unpublished)

[a]Includes occipital-transverse, estimated by authors to be as common as occiput-posterior at delivery in their sample.

position and the challenge of delivery when the infant emerges from the birth canal in that position. Engagement in that position is common enough that it seems inappropriate to call it a malposition, although labor, particularly in the lower back, is reportedly more stressful. As Walrath has pointed out, telling a laboring woman that she has a "malpositioned fetus" is likely to contribute negatively to the progress of labor. The head presents in whatever position is the best fit with the pelvis, and if that happens to be occiput-posterior then that is the "normal" presentation for that pelvis (Chamberlain and Steer 1999).

It is also worth considering that most of the deliveries discussed in the obstetric literature probably occurred with the woman lying on her back. Perhaps squatting or standing makes a difference in both the way in which the fetal head engages at the onset of labor and the way it emerges from the birth canal. Cross-cultural evidence suggests that women more commonly walk during labor and are seated or squat during delivery. Using ethnographic analogy, it seems reasonable to argue that these two positions were more common in the past than the supine position.

Although most paleoanthropological models for childbirth derive from medical texts, my own model is based on observations made while I worked as a midwife in the El Paso/Juárez area in the late 1970s. Our clients were primarily women of Mexican origin, and they certainly did not fit the description of the well-nourished Euro-American woman on whom most biomedical obstetrical models are based. Despite this, occiput-posterior presentations were rare. Only 6 of 1,222 deliveries between January 1978 and May 1980 were occiput-posterior at delivery, and an incidence of 1% occiput-posterior at delivery is reported today. Most of these women are ambulatory in labor and deliver in a seated position.

As Walrath notes, we need more detailed naturalistic observations of birth in nonhuman primates and ethnographic descriptions of human births. As more fossil evidence and information on contemporary childbirth accumulates, competing or alternative models can be tested against new information, resulting in both a more complete view of childbirth in contemporary human populations and a better perspective on what is "normal" in birth.

Reply

DANA WALRATH
Burlington, Vt., U.S.A. 24 X 02

I thank the commentators for their thoughtful responses to my article and appreciate the opportunity to share in a constructive dialogue about evolutionary models of human childbirth and the human birth mechanism. It is very gratifying to find scholars from diverse anthropological subfields commenting here. Though they differ on particular points, several commonalities emerge. First, as would be expected from a group of anthropologists, typological approaches are uniformly viewed as problematic. Second, there is a call for more information on variability in birth mechanism in humans and nonhuman primates to counter the oversimplifications embedded in typological structures. Third, it is recognized that biomedical models of childbirth provide limited insight into biological processes; there is a concerted call for "humanization" in biomedical childbirth practices. Points of divergence involve the following questions: Is the prevailing evolutionary discourse on birth mechanism typological? What can be known about the evolution of human birth from the fossil record? Is birth really more difficult in humans than in other species, or is that impression an artifact of the way in which our culture approaches childbirth? To what extent does the prevailing evolutionary model influence the contemporary view and conduct of birth? While revisiting these

key themes, I will also discuss future research directions that grow out of this dialogue.

Many commentators engage with the question whether defining a typical human birth mechanism in evolutionary discourse constitutes a typological approach. Cosminsky, Stone, and Ragir fully accept the analyses of the historical interaction between physical anthropology and biomedicine as evidence of a continued typological legacy. Jolly supports all efforts to remove persisting typologies. Trevathan suggests that at the very least we should eliminate the value-laden nomenclature that persists in the literature.

Other commentators propose that contemporary evolutionary models are free of typology—that a "typical" human birth mechanism is defined to facilitate the interspecific comparisons that constitute the core of evolutionary analyses. Although Trevathan, Rosenberg, Tague, and Jolly recognize the presence of some degree of variation in human birth mechanism, they counter that because the "vast majority" of births normally occur via particular mechanisms in particular groups the simplification is warranted to permit interspecific comparisons. These commentators suggest that in this context "normal" refers only to the average or typical mechanisms and is in no way linked to the biomedical "normal," which generally signifies the opposite of "pathological."

Jolly cautions that when continuous features are classified into types the most frequent category quickly becomes first the "normal" and then the "only" one. Cosminsky states that this approach demonstrates the cultural construction of the definition of "normality." Jolly makes the delightful suggestion that mass education in elementary statistics could overcome this confusion by teaching that "an average does not describe a distribution." Her call for more statistical literacy for a society whose health practices and social policies are increasingly governed by large epidemiological studies is very well taken.

In his discussion of normality, Tague makes the very subtle point that I have oversimplified the way in which biomedicine uses the term "normal," recognizing only its opposition to "abnormal" and not its use to mean "typical." I agree with him that both uses of the word "normal" exist in biomedical discourse. Ideally, the usage varies according to whether the subject is biological process or biomedical practice.

Biomedicine describes many continuous biological characteristics in terms of ranges of normal variation. This is as true for biochemical markers such as hematocrit level, DNA repeat sequence number, and cholesterol level as it is for phenotypic features such as weight, height, and transverse diameter of the pelvic midplane. In these contexts, "normal" signifies "average." However, once specific biomedical interventions come into play, what might have been "normal" variation may quickly become "pathological." For example, when growth hormone treatments are prescribed to correct the short stature of an adolescent male in the third percentile for height, his size has been classified as abnormal rather than as an acceptable expression of the normal range of human variation. The shared values of patients and practitioners become visible through medical interventions that reflect collective notions of normality and abnormality.

A key way to demonstrate that "normal" signifies the typical or average rather than the "only" is to document variation. I appreciate Trevathan's suggestion that our task now with respect to birth mechanism is to investigate and document variation. Her table 1, showing the incidence of occiput-posterior presentation at delivery, contributes toward this endeavor. Gaskins's (1990) sample, which included 1.7% occiput-posterior presentation, should be added to these data, along with the frequency of breech and other presentations. These tables indicate considerable variation between geographical loci and presumably between populations in terms of the frequency of occiput-posterior presentation. Cosminsky hopes that future ethnographic work on childbirth will document variation in the frequency, difficulty, and management of face-up fetal presentation, because, as Trevathan, Rosenberg, Tague, and Stone point out, studying variation through the lens of biomedical practice will not provide a complete picture. Further, as Cosminsky says, the medicalization of birth is a global process, and locally defined ranges of normal variation are increasingly being defined as pathological or abnormal.

How much variation in birth mechanism is significant? Tague says that I have not documented sufficient variation in birth mechanism, taking particular issue with one of the studies I cited in which the frequency of occiput-posterior presentation is 1.7% (Gaskins 1990). Perhaps we should adopt the convention that is used by evolutionary biologists, who when looking at genetic polymorphisms consider an allele polymorphic if alternate alleles are found at a frequency of at least 1% (Jurmain et al. 1999). Of course, for continuous phenotypic traits and variable biological processes such as the birth mechanism multiple genes are certainly involved. Because of this, the presence of variation even at low levels is significant.

If one accepts the notion that evolutionary scholars refer to typical patterns to facilitate comparisons, the issue then becomes what ideas are embedded and implicit in the comparison and what the consequences of this comparison are as this knowledge is disseminated. The typical human birth mechanism is cited to illustrate the difficulty of human birth compared with that in other primates and our smaller-brained ancestors. The implicit difficulty of the human birth canal is evident in the following description of the pelves of several archaic *H. sapiens*: "These specimens all have the twisted pelvic openings characteristic of modern humans, which suggests that their large-brained babies would most likely have to rotate the head and shoulders within the birth canal and would thus have emerged facing away from the mother—a major challenge that human mothers face in delivering their babies safely" (Rosenberg and Trevathan 2001:77). Just as biomedical practice disallows birth mechanisms that deviate from the normal, the ev-

olutionary discourse emphasizes a single mechanism because it is the particulars of the mechanism—occiput-anterior fetal emergence—that provide evidence of human birthing difficulty.

Do we have enough data to say that human birth is more dangerous and difficult than that in other species? We can look to the contemporary birth process in humans and nonhuman primates, the behaviors surrounding birth, and the fossil record. Although Rosenberg is optimistic about reconstructing the birth process from the fossil record, I consider the complete lack of neonates in the fossil record a serious limitation. Rosenberg suggests that, left with only a handful of specimens that preserve pelvic anatomy, we can reconstruct birth because of the "tight fit" between the maternal pelvis and infant cranium. In this regard, it is interesting to quote, as Rosenberg does, the article by Tague and Lovejoy that began the tradition of reconstructing birth mechanism from fossil pelvic specimens: "The shape of the maternal pelvis directs fetal movements during parturition; variations in pelvic morphology imply dissimilarities in patterns of birth. This is true not only between non-hominids and hominids but inter-specifically within the Hominidae" (Tague and Lovejoy 1986:238). I find it ironic that pelvic anatomy is a tool for assessing birth mechanisms when making interspecific comparisons while the vast majority of human pelves and the offspring that travel through them are considered uniform enough to posit a singular mechanism. I suggest that it is our affinity for the cultural model of dangerous and difficult birth and the behavioral pattern of assistance at childbirth that informs this reconstruction from sparse fossil evidence.

Cosminsky's commentary provides numerous excellent examples of solitary birth in a variety of cultures. These successful deliveries indicate that women can deliver without assistance by choice as well as (as Jolly points out) by necessity. As Trevathan and Rosenberg state, assistance at birth may satisfy social and emotional needs rather than biomechanical ones. In this regard, the typical human birth mechanism is used to demonstrate one part of the alleged "triple challenge of big-brained infants, a pelvis designed for walking upright, and rotational delivery in which the baby emerges facing backward" (Rosenberg and Trevathan 2001:77). Biological bases imply that cultural shaping is limited, particularly when the biology is depicted as singular.

Observations on birth in nonhuman primates provide insight into the human birth process. Jolly's findings on the timing of the birth process are fascinating and compelling, particularly with regard to the sampling bias in observed nonhuman primate births. However, because of the difficulties inherent in assessing labor through observation, I am less convinced by the correlation of labor length with subjective pain. Ragir cites interesting comparative studies of labor duration in humans and langurs that found the last phase of labor (the only phase that could be accurately assessed) similar in the two species. Further study of nonhuman birthing patterns may well reveal other similarities rather than reinforcing the human-animal dichotomy.

Rosenberg questions my assertion that evolutionary scenarios depict the female pelvis as ill-equipped to bear young and my suggestion that the evolutionary depictions of childbirth derive more from the social construction of gender than from biological characteristics. In contrast, Ragir joins me in contesting the evolutionary model of "female reproductive frailty" and Stone and Cosminsky assert that biomedical models assume female incompetence and passivity. Rosenberg suggests that I have misinterpreted statements about natural selection's acting through childbirth as an indication of inadequacy. In this connection it is useful to examine anthropologists' presentation of the birth process for public consumption. For example, Sarah Blaffer Hrdy's popular book *Mother Nature: Maternal Instincts and How they Shape the Human Species* includes the following reference to birth and pelvic anatomy as a caption to a classic figure comparing head size with pelvic size in a variety of primates (1999:165):

> This diagram of the size of the neonate's head (the black oval) relative to the pelvic outlet in monkeys and apes illustrates why delivering babies is so much tougher for women compared with other apes. Labor in a gorilla is short, on the order of twenty minutes, and enviably easy. By contrast, human births take far longer, and range from easy to extraordinarily difficult. It took sixty-four contractions (occurring an hour apart at first and then gradually occurring every two to four minutes) over an eight-hour period to deliver my third baby, and all present regarded it as an "easy" birth. For such ordeals women can thank the engineering demands of a pelvis that allows upright walking. Quite simply, my baby's cranium was larger than the anterior-posterior dimensions of my pelvic outlet, requiring my son's head to enter the outlet facing sideways. Evolution of larger brains around 1.5 million years ago unquestionably played a role in this tortuous process. In contrast to apes, but more like humans, monkeys also undergo a tight squeeze. It's obvious that giving birth hurts; the parturient monkey strains and may yelp. But she does not require special obstetrical assistance.

This passage emphasizes the same unhappy compromise between bipedalism and the bearing of large-brained young outlined by Krogman, Washburn, and Schultz in the middle of the last century. The value-laden phrases used by these scholars with regard to the costs of human childbirth due to bipedalism are worth repeating. Schultz (1949) characterized the human birth canal as "shockingly small." Krogman (1951) described difficult human birth as a "scar of evolution." Washburn (1960) formulated the notion of a "human obstetrical dilemma." Similarly, an account of the strained compromise imposed on the female pelvis appears in Rosenberg and Trevathan's (2001) *Scientific American* article on the evolu-

tion of human birth. Like Krogman's article in the same journal a half-century earlier, this piece brings anthropological theories to the general educated public.

While Stone agrees that the evolutionary discourse surrounding birth reinforces the biomedical model and that biomedicine overemphasizes the hazards of birth, Rosenberg suggests that I have overstated the impact of evolutionary models on the biomedical assumption of hazardous birth and on popular consciousness of the dangers of birth. Perhaps we biological anthropologists are not the best judges of our sphere of influence. The authority of scientific knowledge in our society, particularly with regard to reproduction, has been well documented by a number of scholars (Jordan 1993[1978], Martin 1987, Ginsburg and Rapp 1992, Davis-Floyd 1992, Davis-Floyd and Sargeant 1997). Imbued as they are with implications of genetic determinism, assertions concerning the evolutionary basis of specific behaviors carry a heavy weight, and in today's genetics-minded American society they can easily be construed as setting limits on what is possible for individuals.

So comfortable are we with the notion of flawed female biology and a cultural intervention—assisted birth—to facilitate a biologically challenged birth process that we have not paid much attention to other aspects of the birth process as an adaptive success. Ragir brings an additional biomechanical perspective to this set of potential solutions to the human obstetrical dilemma. As have Montagu (1961) and others, Ragir focuses on the advantages of bearing an immature newborn. She proposes that the slowed rate of development characteristic of humans results in a large but immature and therefore flexible neonate and that selection would have favored this flexibility. Evolutionary forces other than selection could account for aspects of the human birthing. At this point we do not have sufficient data to favor any one particular evolutionary scenario. Meanwhile, the speculative nature of evolutionary theorizing requires particular vigilance for cultural influences on the adaptive tales we tell.

Theories of the evolution of human birth have certainly not been a major justification for biomedical practices, and the latter have not been the only source of observations contributing to evolutionary reconstructions of human birth. Rather, both are products of a shared cultural perspective that emphasizes danger in human childbirth. While it behooves paleoanthropologists to reconstruct ancestral behavior from the fossil record, we must do this with a keen awareness of cultural assumptions. Martin (1996:40) suggests that "making ourselves more aware of when we are projecting cultural imagery onto what we study will improve our ability to investigate and understand nature." Anthropologists, because of our emphasis on a complete, holistic view of the humans, are in a unique position to examine variation in both the culture and the biology of reproduction.

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