

## Newborn Stepping and Embryonic Growth-Stepping

The recent article by Thelen and Cooke (DMCN, 29, 380–393) provides substantial evidence for the notion that the independent walking of children is based on the gradual elaboration of simpler patterns of so-called spontaneous stepping observed in the newborn. In the accompanying annotation (pp. 399–404), Cooke and Thelen present a descriptive account of newborn stepping and discuss some findings relating to the problem of what makes the baby step in the first place. Concerning this issue, it might be worthwhile to remind ourselves that all adult functions have their own ontogeny, and that there exists a continuous progression from the early stage of stepping *in utero* to stepping by the newborn, as appreciated by W. Preyer in 1885 (quoted in Prechtl, 1986<sup>1</sup>).

However, with 'stepping *in utero*', one needs to consider not only those obvious, palpable movements of the fetus reliably detected by the mother, and coming more recently under more detailed analysis with ultrasound<sup>2,3</sup>, but also the preceding, slower **growth-movements** of the embryo. Detailed anatomical investigations, based in part on total-reconstructions of a developmental series of human embryos<sup>4–8</sup>, have demonstrated the following positional changes in the embryo's lower limb from the time it first appears as a torus in the inferior part of the ectodermal ring. Initially, as the limb anlage grows in volume, it growth-adducts toward the umbilical cord folding across the embryo's genitofemoral fossa, then it growth-flexes, the bend being the anlage of the knee. Subsequent embryonic events in the development of the lower limb include growth-extension of the knee, growth-flexion in a region which then becomes the ankle, and growth-eversion of the foot<sup>5,7</sup>. These changes of limb position occur over defined periods of time and therefore represent the primordial movements of the human lower limb. In other words, the very growth of the embryonic lower limb is an early stepping, the so-called 'growth-kicking'. This is well-portrayed by reproducing the form and position of the lower limb of human embryos at successive stages, at the same magnification (e.g., Blechschmidt<sup>5</sup>, fig. 9, p. 608; Hinrichsen<sup>9</sup>, slides 9.08, 9.11).

In the early embryonic stages, a significant proportion of the leg's inner tissue consists of nerve fascicles of the lumbar plexus (e.g., Blechschmidt<sup>6</sup>, fig. 14, p. 633). Thus it would appear that the nervous system is participating morphologically, and therefore also, in an incipient way, functionally, in the above growth-movements. Given the improbability that any developmental process is exactly symmetrical, the growth-stepping of one lower limb can be conceived as alternating with changes in position and form of the other limb. In this way, the cyclical patterns of fetal stepping are seen to be triggered by the embryo's earlier growth-movements.

Anatomical evidence, summarized by Blechschmidt and Gasser<sup>10</sup> (pp. 156–179) indicates that initially the ectoderm, through its areal-growth, is the main formative apparatus (*i.e.*, motor) driving growth-stepping. Later, the oriented growth of the pre-cartilaginous and cartilaginous masses in the limb, together with

the taut alignment of the femoral neuro-vascular bundle, also plays a significant rôle in the above growth-movements. On the other hand, the muscles arise initially as the passive elements of the limb's musculoskeletal system, and it is only during late embryonic and early fetal stages that 'spontaneous', more evident, patterns of muscular activity emerge.

In this **kinetic view** of human embryology, the fact that the stepping of infants is a continuous elaboration of the stepping of the newborn is seen to be a consequence of the continuous development of embryonic growth-stepping.

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[published: *Developmental Medicine and Child Neurology*, 1988, 30, 126–129]