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## The Establishment of Certain Reflex Arcs in Foetal Sheep.

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Sheep embryos first respond to mechanical and electrical stimuli applied to them between the 33rd and 35th day after insemination. At this time movements may be elicited by tapping on the unopened amniotic sac or by faradic currents applied to the spinal cord or to the face. The movements appear to be due to the localized contraction of the muscles in the neck, the fore or the hind limbs. The actual neural elements concerned in the production of the movements of the limbs are not definitely known, but it is clear that these movements themselves are not as yet a part of a total mass reaction.[1]

If the movements of the limbs in these embryos could be shown to involve at least a primary sensory neuron and a motor neuron, the observations would lend support to the general thesis that behavior has its genesis in individual reflexes which are later associated into reaction patterns. We have, therefore, sought to produce isolated movements of the type observed in the sheep embryos under conditions in which we were certain a primary afferent neuron was stimulated as the first element in a reflex arc.

Mechanical stimuli such as stroking the forelimb with a glass rod or flipping it do not induce either flexion or extension movements in sheep fetuses until 44-47 days after insemination. Reflexes in the hind legs cannot be elicited in these ways until 3 or 4 days later. There remains in these cases the possibility that the stimuli were not adequate in younger embryos to produce reflexes in the limbs.

Fortunately fetuses 42 days old and slightly younger are large enough to be manipulated and dissected. We have found it possible to dissect out and to section the median nerve and also the lateral popliteal. Faradic currents could then be applied to their central ends. No movements in the ipsilateral limb or any other part of the body have ever followed faradization of the central end of the median nerve in fetuses younger than 44 days old, though movements can always be produced in older fetuses under similar conditions. Likewise no movements have been produced in the ipsilateral hind leg when the central end of the lateral popliteal nerve was stimulated in fetuses younger than 47 days. In fetuses 47

[1] Barcroft, J., Barron, D. H., and Windle, W. F., *J. Phys.*, 1936, **87**, 73.

days old and over, movements of the ipsilateral leg are quite readily obtained when the central end of the lateral popliteal nerve is stimulated with currents of moderate strength.

However, faradization of the peripheral end of either the median nerve or the lateral popliteal nerve produced muscle contraction with currents of the same strength as those applied to the central ends in each of the fetuses.

These observations suggest that prior to this time (44 days for the fore leg and 47 days for the hind) the primary afferent neurons distributed to the limbs have not made functional connections with the anterior horn cells supplying the limb musculature. Histological studies of the neurofibrillar development of the spinal cords of a series of sheep embryos demonstrate, however, that sensory collaterals reach the gray matter as early as the 32nd day after insemination. The first appearance of collaterals in the gray matter, therefore, does not appear to be directly related to the time at which reflexes may be elicited. Further, it would appear that the stimuli inducing the movements seen in sheep embryos 33 to 35 days old did not excite the anterior horn cells *via* the primary afferent neurons distributed to the limbs. These movements cannot, therefore, be regarded as true reflexes. The implication is that behavior does not appear first in the form of isolated reflexes which are later collected and organized into reaction patterns.