“SURVIVAL MOVEMENTS OF HUMAN INFANCY.”

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WHEN we watch closely the limb-movements of human infancy and early childhood, we cannot but be struck with their peculiar purposeless character, and notice how widely they differ not only in form but even in rhythm from the voluntary movements of later date.

These early limb-movements as we see them immediately after birth, are presumably similar to those occurring in utero, though from the nature of the surroundings they necessarily present a greater range.

They are generally known as “Spontaneous” or “Involuntary” movements, sometimes as “Stretching movements.” They steadily diminish in number and in importance till the end of the fourth or sixth month of independent life, by which time many have entirely disappeared, while others survive but in a modified form. In fact, on careful examination, a definite selective process is found to occur among them, by which some become utilized for special purposes, serving mainly for the expression of the various feelings and emotions. These are therefore permanently preserved. Others gradually diminish and tend to disappear, being replaced by the gradually evolving voluntary movements, which appear in successive stages or batches of increasing complexity throughout the early years of childhood. For the early spontaneous movements the writer suggests the term “Survival Movements,” and besides describing their nature, proposes to attempt to give

some explanation of their origin. The full description of the definite stages in which the *voluntary* movements appear, and how they arise from and supplant these early survival movements must be left to another paper.

A careful study of these early infantile movements shows that though they are aimless as far as the individual infant performing them is concerned, they are not necessarily meaningless as regards the development of the race of which the individual infant is but an off-shoot. It is quite possible, indeed we might say probable, that they are vestiges of functions of the limbs which were of prime importance to the members of the race at another and early period of its growth, but began to lose their prime importance, and therefore their full development, when the forelimb gradually acquired other and higher functions. They remain, I believe, as true survival movements from earlier stages of existence, and thus serve to show the order in which the evolution of the human forelimb took place; just as many other bodily structures remain, such as the pineal gland and the vermiform appendix, which denote the existence of functions that are not now in activity.

Preyer,¹ who seems to have made the most thorough investigations into early infantile movements of all classes, divides them into four groups:—

(i.) Impulsive or spontaneous movements:—Comprising the stretching and yawning movements, noticeable as the infant wakes from sleep, also limb movements in the bath, protrusion of the lips in pouting. These are supposed to be due to spontaneous discharges of energy in the motor cells of the nervous system, and not to be due to the action of any external stimulus. As there be no evidence of a *mind* at this stage, they receive the name of “spontaneous” or “impulsive.” It is in this class that most of the survival movements occur.

(ii.) Reflex movements:—Occurring as a result of some external or internal impression, such as stimulus of touch, sight, hearing, or visceral change. They appear at, or very

¹ Preyer, “The Mind of the Child”: English Translation, “The Senses and the Will.” Appleton, New York, p. 195, et. seq.

soon after, birth, and include the movements of breathing, swallowing, reflex movements of the eye in response to light, spreading of the toes in response to stroking or warming the soles of the feet.

(iii.) Instinctive movements:—These also require the stimulus of sense-impression to arouse them, but according to Preyer, differ from the purely reflex in being always preceded and accompanied by a distinct emotion. They are, therefore, accompanied by changes on the psychical plane. They all have a definite aim. He cites as instances:—pecking movements, by which a chick breaks the shell or seizes a fly, running or walking, biting, chewing, and so on; in fact any purposive movement which the individual does not voluntarily acquire for himself, but seems to inherit from his ancestors. Some of them appear at birth; others, such as walking, only at a later stage. We speak of teaching a child to walk as if walking were a purely voluntary and intelligent act, learned by imitation, it is true; but in fact, as we see below, we really here draw out by touch stimulation an instinctive movement. The rhythmical alternate movements of the feet before walking have been noted by Baldwin during the ninth month, *i.e.*, before the child can really balance itself on its feet. By holding a young baby on the palm of my hand, stomach downwards, and supporting the head with the other hand, and allowing the feet and hands to touch the counterpane of the bed, I have elicited alternate movements both in the feet and hands as early as the third day after birth (see fig. 4).

(iv.) Voluntary and Intelligent movements:—These are not inherited; each individual acquires them for himself. They are preceded by, or caused by, an “idea.” They therefore not only have a definite purpose, but are consciously and intentionally performed. In the process of building up and elaborating of these intelligent movements, some of the most interesting problems in Mental Philosophy are involved. They include the origin of the will and of the intellect. Preyer, Baldwin,¹ and others have shown

¹ Baldwin, “Mental Development in the Child and in the Race,” p. 81.

how important a part imitation and suggestion play in their growth. How many nerve processes occur in them is well shown by Preyer where he says: "In order to imitate, one must first perceive through the senses; secondly, have an idea of what is perceived; thirdly, execute a movement corresponding to the idea." He gives as instances a child making faces, such as pouting at a stranger or a nurse; holding out the arms to show he wants to be lifted up; speaking definite words. He considers walking to be simply an instinctive movement, not an intellectual or ideational one, because a child does not see others walking and then determines to imitate them, but because the parent or other instructor holds the child up by the arms or body, and makes its feet touch the floor, and thus sets in action the instinctive reflex of this mode of progression.

Such as classification of early infantile movements, however helpful to the psychologist, is unsatisfactory to the biologist. By bringing in the terms "consciousness," "intention" and "idea," even when we translate them into terms of their physiological correlatives of higher and lower cerebral and spinal changes, we get no nearer understanding their origin; while the true meaning of the intermediate stages through which the perfected forms of movement have passed, and by which alone they have been rendered possible, is entirely lost. In harmony with the method of enquiry that evolution has introduced, we need to study these movements in their gradual growth to perfection, not only in their ultimate forms.

Evolution of the Human Limbs.

Leaving then, for a while, the study of infantile movements along the lines of their mental accompaniment, *e.g.*, whether they are conscious, volitional, or reflex, let us study them along the lines of their possible evolution. The structure of the limbs in which the movements occur will be our first guide. A study of the limbs of animals shows that their structure varies according to their habits and instincts, and so directly or indirectly with the food the

animal eats or the means by which it is acquired.¹ In this way limbs have been modified according to their use for *locomotion*, in water, land or air; *prehension*, tree and rock climbing; *destruction of prey*, carnivorous animals; or *manipulation*.

In the following paper I have confined myself mainly to the movements of the upper limbs, though movements of head and neck and legs present equally interesting problems.

The Structural Plan of the Human Hand.

In studying the general plan and structure of the human hand and comparing it with that of other animals we notice that while it is most highly developed in function, it is also in some respects the least modified in the general plan of its skeleton. In shape and bones it is more like the primitive amphibian paddle² than is the limb of any other mammal, even including the monkeys, and this fact alone debars us from looking upon the other existing mammals for traces of direct human ancestry.

It is also fully established that the primitive form of organic life, including that of man, was aquatic, and the hand must have existed as a paddle, at the time that gillslits in the neck were in functional activity. Von Bardeleben³ shows the human hand possesses some very interesting traces of such formation. Finally, the method of development of the hand seems to indicate that the palm is originally the more important, and the independence of the fingers is acquired at a later stage of existence.

The more tempting and more varied land dietary, with its greater stored-up energy, must have had some share in alluring our ancestors from the sea and marshes, and in turn have helped in the transition from cold to warm-blooded

¹ For a full discussion of this question as it affects man, see Munro: "Pre-historic Problems," chapter ii., "On the Influence of the Erect Position," being the Presidential Address in Anthropology at the British Association at Nottingham, 1893.

² Romanes, "Darwin, and after Darwin," vol. i., pp. 54, 183.

³ "Mammalian Hand and Foot," *Proc. Zoolog. Soc.*, London, April, 1894.

life. No doubt, too, the greater stored-up energy in the food helped in the capacity for further variation in structure and growth, and the higher land animals have been divided by Professor Owen into three classes of vegetable feeders: (1) root eaters, (2) plant eaters, (3) fruit eaters; and two classes of carnivorous animals: (1) insect eaters, and (2) flesh eaters. The habit of obtaining and devouring each different kind of food has resulted in the formation and fixation of a specially adapted limb for each purpose.

Darwin says:—"Our progenitors, no doubt, were arboreal in their habits and frequented some warm forest-clad land.¹ . . . At a still earlier period the progenitors of man must have been aquatic in their habits, for morphology plainly tells us that our lungs consist of a modified swim-bladder which once served as a float. The clefts on the neck in the embryo show where the branchiæ once existed. . . . We apparently still retain traces of our primordial birthplace, a shore washed by the tides."

Analysis of Early Infantile Movements.

Let us now turn to the subject with which we are immediately concerned,—the study of the early movements of the human infant—especially those of the hand and arm. We shall see how readily the spontaneous movements group themselves in terms of their value in the racial struggle for existence and survival of the fittest. Limb movements to be of value must be appropriate; (i.) to simple progression, either aquatic, terrestrial, or aerial; (ii.) to prehension, or arboreal existence; (iii.) to manipulation, including the destruction and breaking up of food, or the search for it by digital investigation into nooks and crannies; and finally, to the making and using of tools or weapons.

Limb movements having been once acquired by the race, may persist in the individual in their fully developed form, or may remain only as partially developed rudiments or vestiges.

¹ "Descent of Man," pp. 160, 161.

"Survival Movements" of Locomotion in marshy or aquatic surroundings.

FIG. 1.

Showing primary position of hands and digits. Second month of intra-uterine life. Also position of foot. From His.

FIG. 4.

Drawn from life, eighth day. Showing position of hands and digits, and toes when child suspended his own weight. Left thumb folded forward, but not in use.

If we watch carefully the position of the limbs of an infant either soon after birth or almost any time during the first three or four months, we find them sometimes in the primitive development position, viz.:—folded across the chest, thumb towards the head and with the palm towards the thorax; but much more often the palm is away from the chest-wall, and is directed anteriorly by means of extreme pronation, the dorsum of the hand often lying on or near the shoulder, sometimes an inch or two outside. As the child wakes up the elbows begin to open out and the palm is pushed outwards in a way that would be useful in locomotion, especially in a fluid or semi-fluid medium. In fact, it

FIG. 5.

Drawn from life, eighth day, to show position in which the child was held to draw out reflex movements of progression. Child supported body weight by legs, which showed marked alternate movements. Arms also showed alternate movements, though to a less extent.

is the movement of a paddle. Slow, rhythmical movements of flexion and extension of the fingers occur, which instead of possessing the quick, incisive character of voluntary movements partake of the sluggish rhythm so familiar to the visitor to the tanks of an aquarium. They often occur in a series of three at a time during a quarter of a minute, then follows a pause during which there is apparently an accumulation of energy in the nerve cells. Then another series of spontaneous discharges takes place, to be in its turn followed by another pause. It was this peculiar sluggish rhythm, so unlike that of any other limb movements that first suggested to me that they might be survival movements of aquatic or amphibian life.

The resemblance becomes even greater when we further examine these movements. As the fingers become fully extended, a rotatory movement of the wrist—hyper-pronation—occurs, by which the ulnar border and little finger knuckle are lifted upwards as in raising a cup to the mouth, though the elbow-joint becomes extended instead of being flexed, the hand is thus moved backwards and outwards as a paddle would be used in swimming. The whole of this movement persists throughout life associated with the act of yawning, which act is thus found to be one of the most fundamental limb movements in the human being. It is also frequently met with in the blind where it appropriately serves the sense of touch.

It may be urged that such a movement or series of movements is not necessarily suggestive of aquatic progression, but may be the remains of a four-footed land progression. That this is not the whole case is proved, I think, by the fact that the movements in the two limbs are not always alternate but often synchronous, though alternative movements are clearly noticed when the child is held face downwards and the palms and soles touch something rough. These movements, moreover, do not take place in an antero-posterior plane, but in an oblique plane half-way between antero-posterior and transverse. Other vestigial movements which are prehensile and truly terrestrial occur in an antero-posterior plane. The movement in the oblique plane can be well studied in water lizards, where the use of the eversion of the ulnar border of the manus is clearly manifest. Lastly, the rhythm is the rhythm of cold-blooded aquatic or amphibian progression, and though perhaps suitable for a purely graminivorous or root-eating animal, is not suitable for one that has to pursue some of its food with any degree of rapidity.

In the discussion of the psychological nature of these early spontaneous movements, Bain¹ showed that they did not depend for their immediate causation upon any reflex stimulation from the outside, nor upon any internal emotion,

¹ "Senses and Intellect," p. 67.

but rather upon an abundance and exuberance of nervo-muscular energy; he suggested that in the greater or less endowment of such spontaneous energy, and in the greater or less sensitiveness to external impression, we have already in infancy some key to the fundamental difference in temperament exhibited by the man of action and the man of feeling.

Other impulsive movements, such as "rolling of the eyes," "twisting of the neck," &c., occur. Perhaps the eversion in some cases of talipes valgus is an instance of the loss of a (racially) late acquired arching and inversion of the foot in infancy, which Huxley considers a vestige of arboreal life. If the above explanation of these early movements, as vestiges of a previous stage is untrue, I do not know how else to explain them. They serve no definite purpose, unless we admit the teleological one, that they exist for the purpose of exercising certain groups of muscles and are thus pleasing to the child, though then we leave unexplained the fact that other series of movements equally simple are not thus exercised at this stage, such as movements of supination. It can hardly be that they are meaningless as well as purposeless. It seems more natural to look upon them as physiological or psychological vestiges whose fuller study will open up some hitherto closed chapters of man's history, and while they excite our curiosity, yet also kindle our wonder at the distance man has travelled in his upward journey.

Reflex and Instinctive Movements.

Let us now consider the movements which Preyer embraces under the terms "Reflex" and "Instinctive." These are, according to him, started by the stimulation of some sense organ from without, and do not arise from any spontaneous discharge of nerve cells from within the organism. They differ from the previous ones also in having a definite aim, while they resemble them in depending for their first manifestation upon an inherited nerve organisation or nexus. The difference between Reflex and

Instinctive movements according to Preyer is that reflex ones are not preceded by consciousness, while the latter are preceded by consciousness in the form of an emotion, though this does not amount to a definite idea. Such a division is not very satisfactory and only applies somewhat loosely, and accordingly the two are in this paper considered together.

The earliest reflex movements that occur naturally after birth are apparently those of respiration. These seem to be set in motion by the stimulus of external cold acting on the skin and mucous membrane of the nose—sneezing. The sense of touch seems the most active and most early in

FIG. 3.

Drawn from life, on eighth day, to show several positions of hand at rest, with eversion of ulnar border and little finger; the last is a position useless for pure terrestrial locomotion. It is an aquatic "displacement position," though adaptable to arboreal life.

calling out reflex and instinctive movements. Then smell and taste, finally hearing and sight. With reference to the movements of the limbs, the sense of touch seems to be the sole avenue by which reflex movements are called into action. As before stated reflex movements of locomotion of both fore and hind limbs can be very early called into action by allowing the palms and the soles to be brought into contact with a rough blanket. These seem to be special applications of the stretching movements, and can only be studied when the child is wide awake. The stretching

movements are best noticed during gradual emergence from sleep.

Survival Movements of Prehension.

On touching or tickling the palm of the hand or sole of the foot, reflex action causes the fingers or toes to contract and to seize the object. If the right moment is chosen and especially if the rest of the body is not securely held, the clutching sometimes becomes so strong that the child can be lifted entirely from its bath or from the ground without any other hold. The grip seems even stronger on the ulnar side than on the radial border. How does such a movement fit in with our Developmental classification of the functions of

FIG. 2.

Further figures to show position of hand at rest in a child two months old. Power of supination very slight.

a limb into locomotion of varying kinds, viz.:—aquatic and terrestrial; prehension (arboreal locomotion), manipulation (movements involving supination and independence of the thumb, capacity for destruction and division of food, &c.)? They at once fall into the category of prehensile movements, and Dr. Louis Robinson in an article on "Darwinism in the Nursery," in the *Nineteenth Century* for November, 1891,¹ drew some very interesting parallels, and showed that by watching some sixty babies he found out that from the very beginning of their separate existence they possessed sufficient

¹ See also Dr. Robinson's paper on "Infantile Atavism," *B.M.J.*, Dec. 5, 1891, p. 1226.

grip and muscular power to sustain their own weight on a horizontal bar or finger, and even delighted in the process. I have myself frequently tried this experiment, but have had only varying success. I believe, however, that he is right in ascribing such early movements to inherited prehensile power, and that further investigation along these lines will be fruitful of other illustrations of the law of recapitulation.

In November, 1894, the *Nineteenth Century* published an article by S. S. Buckman on "Babies and Monkeys," in which further comparisons were instituted, from which the following extract is taken :—

"In the method of using its hands the baby shows to the full its descent from arboreal ancestors. When it wishes to take hold of anything, like a glass or a flower pot, it does not, like an adult, put the hand round it, or even put a thumb inside to use as a lever. On the contrary, it places all the fingers inside, makes no use of the thumb, and clasps the rim of the flower pot between the fingers and the palm of the hand. This is exactly the action which would be acquired from arboreal ancestors, in going from bough to bough they would take their hands, palm first, and would strike from above downwards, grasping the bough with the fingers. Such is the action of an infant picking up a cup. So little use have some monkeys made of the thumb, that abortion has resulted, and in the most arboreal species of monkeys known, the fingers have grown together, because the whole hand was used merely as a grasping hook."

*Seizing or Clutching Movements, with a Psychological
Accompaniment of Emotion or Idea.*

Preyer discusses the Seizing movements under the class of Instinctive Movements, and says that the first noticed grasping at objects with manifest desire to have them was seen by Sigismund in a boy of nineteen weeks, and by himself in a girl in eighteenth week, and in a boy in seventeenth week. The factors in such an action are evidently very much more complicated than in the mere clutching of a stick. In the observations on my own child I paid more

attention to the method of grasping, and the date of the use of the thumb, and I extract the following from my notebook:—

Development of Independent Action of Thumb and power of opposing it to rest of the hand.

Eleventh week.—Baby distinctly uses his hands as a grasping organ to pull the feeding bottle towards him when very hungry, mainly by pressing ulnar border of palm on it and drawing towards him.

Twelfth week.—Does not use his thumb properly for grasping; when he tries to bring the bottle towards him he tucks the thumb out of the way. For the past fortnight, however, he has been beginning to grasp with his fingers, and will pull his mother's hair or dress if his fingers come in contact (see fig. 6, and refer to footnote).¹

Fourteenth week.—Now moves his hand to press the teat into his mouth, and grasps things with greater vigour. No power of opposing the thumb to the rest of the hand, though it is noticed that the thumb does not get in the way so much as before. The thumb is also occasionally kept outside the fist.

Sixteenth week.—Has been using the thumb more and more since last note now, and never shuts it inside his fist, but always outside. He grasps objects intentionally now, but only for a few seconds. He does not hold out his hand to reach a thing but lets his finger travel over them as they lie on his lap; only after feeling them does he grip them.

Nineteenth week.—Played with a toy for the first time.

Twenty-fifth week.—Spontaneous purposeless movements of fingers now ceased. Movements of putting up and down and of flexion and extension of forearm.

Twenty-eighth week.—Grasping movements much more perfect, though he still does not pick up things between the tip of his thumb and finger. He occasionally grasps a thing

¹ On a Possible Obsolete Function of the Axillary and Pubic Hair Tufts, *Journal of Anatomy and Phys.*, 1892, p. 254.

between the bent last joint of thumb and the fingers. In stretching out for a thing he often grips it between second and third finger, this especially if the fingers so slip round

FIG. 6.

Drawn from life, four months after birth, to show prehensile use of fingers, before the movements of the thumb are fully called out. The ball of the thumb in centre figure is used as a support. Inter-digital clutching movements of right hand figure illustrates a method of grasping objects of support which would be called into play in Dr. L. Robinson's theory of the use of axillary and pubic hair tufts (see reference in paper).

FIG. 7.

Eleven months. To show full development of powers of the thumb, of supination, and also the searching movements of index finger—digital investigation.

the object. In grasping small flat objects, such as a domino on the table, he grips between the tips of the fingers and the base of the palm, often bringing the ball of the thumb to

steady from the side. He now tries to pull things to pieces, such as a piece of paper (first appearance of purposive supination). The fingers are becoming more and more independent and have considerable power. Toes very rarely used for grasping, though they have not entirely lost that power. The thumb has been growing in importance and in variety of action very rapidly during the last week.

The reason I have quoted these notes in such full detail is to show how deeply rooted these inherited movements are, and by how slow a process those that do not survive disappear.

It is often six months or more before the more elaborate movements of manipulation possessed by the human being are rendered possible by the development of the capabilities of the thumb, and the power of purposive supination.

Survival Movements of Digital Investigation.

FIG. 8.

Drawn from a child twenty months old. To show full development of searching movements of index finger, a key in a shoe, and the hole in the head of a stethoscope.

Another survival movement presents itself prominently before our notice, namely, the way in which a child points and pokes at any object with its index finger. My wife and I noticed this digital exploration vaguely manifest about the seventh week, and it still persisted vigorously at the sixteenth month, though in a highly special and voluntary form. It is

the method by which not only the form, but the resistance, the consistency, and texture of a thing are determined. The movement may have originated during arboreal life for burrowing into nooks and crannies, and to have owed its survival to the great knowledge it gives about food through the sense of touch. It has also very conveniently adapted itself to gesture language in pointing. A still more ultimate analysis may show it to be a specialised form of the stretching movements of aquatic life. In watching its early appearance, my own child at first indiscriminately used the second, third, or even fourth digit occasionally for this purpose, but finally rejected them all in favour of the index digit.

Lastly, I have frequently watched a child stroking the floor, the table, or other surface, and asked myself whether this originated as a movement of progression. In the movement of crawling the palms are flat downwards, fingers directly forwards. In this stroking movement the hands are pushed outwards away from the middle line, not inwards towards the centre, though when voluntary movements are performed there may be a to-and-fro movement. This may or may not be a survival from movement of aquatic locomotion, but its very early appearance suggests it to belong to the inherited movements and not to those voluntarily acquired.

In conclusion, I should like to urge the importance of further study of these early infantile movements, and to plead for their inclusion in any complete study of the development of the nervous system. Child Study is very young amongst us, but such a line of enquiry as I have suggested offers fruitful reward. Whatever the rightful explanation, there is certainly a gradual selection and a gradual supersedence of involuntary movements by voluntary ones, and these appear in a definite order, each successive batch being more complicated than its predecessor. The independent use of the thumb and the power of supination seem altogether voluntary and are of late appearance, and deserve separate consideration under the group of "manipulation." Medicine teaches us how these late arrivals are early departures, not only does the

power of supination and of opposing the thumb become early lost in various poisonings; but even the gait of the infant acquiring the art of walking reminds us irresistibly of that of the ataxic drunkard, whose alcohol has made him temporarily lose the complete co-ordination necessary for normal progression. While, however, a study of the processes of degradation and decay is apt to leave a feeling of depression and even despair, the study of the opening powers of the infantile mind fills us rather with joy and hope.