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INFANTS' MOVEMENTS.

In an earlier article,[1] I had occasion to speak of certain phenomena of the infant's muscular development — the phenomena which illustrate the principle of suggestion. A brief survey of certain general characters of these early movements may now be made.

From the outset, movement is the infant's natural response to all influences. And, more than this, Bain and Preyer seem to have made out their case, that from the outset there are movements which are spontaneous, due to unsolicited discharge of the motor centres. At any rate, no observation made after birth can decide the question one way or the other. It remains for the embryologists to continue their work, and this is where Preyer's results get their principal value.

In regard to movements more properly reflex and responsive, I may record a few detached observations on my child. Carefully planned experiments with her, made in the ninth month, showed the native, walking reflex — alternative movement of the legs — very strongly marked. I held her by the body, having made the legs quite free, in a position which allowed the bare feet to rest lightly upon a smooth table. The reflex seemed to come somewhat suddenly, for up to the middle of the eighth month I could not discover more than a single alternation; and this I had determined not to take as evidence, since it could well arise by chance. But, in the ninth month, I observed as many as three and four well regulated alternations in succession. At first most of these movements were the reverse of the natural walking movements, being oftenest such as would carry the child backward. This, however, passed away. I have the following note on June 13, 1890 (the child being one day short of nine months old): "Walking movements, 3 to 4 alternations, backwards oftenest, but tending rapidly to forward movements; later, 2 experiments, each showing 3 to 4 alternations forwards very plainly;" and on June 19: "Fine activity in walking — good alternations, but more backwards than forwards — clearly reflex, from stimulus to the soles." It is easy to see that this backward alternation might be due to some accident of stimulation or discharge when the reflex was first called out; a tendency which early efforts at creeping would soon correct. Yet in H.'s case, it was so marked that for a period she preferred to creep backward.

A few observations were made also upon bilateral reflexes. A gentle touch with finger or feather on the cheek, or beside the nose, or upon the ear, when H. was sleeping quietly upon her back, called out always the hand on the same side. After two or three such irritations, her sleep became troubled and she turned upon the bed, or used both hands to rub the place stimulated. Tickling of the sole of the foot also, besides causing a reaction in the same foot, tended to bring about a movement of the hand on the same side. These observations, not a large number, were made in the sixth, seventh, and eighth months.

A reference has already been made to the late rise of real phenomena of imitation. In support of the assertion, that imitation is rather late in its rise, the following experiences may be reported. As a necessary caution, the rule was made that no single performance should be considered real imitation unless it could be brought out again under similar circumstances. It is probable that cases of imitation recorded as happening as early as the third month are merely coincidences. For example, I recorded an apparent imitation by H., of closing the hand, on May 22 (beginning of the ninth month), but on the following day I wrote, "experiment not confirmed with repeated trials running through four succeeding days." H.'s first clear imitation was (May 24) in knocking a bunch of keys against a vase, as she saw me do it, in order to produce the bell like sound. This she repeated again and again, and imitated it a second time a week later when, from lapse of time, she had forgotten how to use the keys herself. But on the same day (May 24), other efforts to bring out imitation failed signally, i.e., more or less articulate sounds, movements of the lips (Preyer's experiments), and opening and closing of the hands. Ten days later, however, she imitated closing the hand on three different occasions. And yet a week afterward, she imitated movements of the lips and certain sounds, as *pa*, *ma*, etc.[1] From this time forward the phenomenon seemed extended to a very wide range of activities, and began to assume the immense importance which it always comes to have in the life of the young child. It may be noted that H.'s first clear imitation plainly involved a complex voluntary muscular performance; and as far as a single instance is of value, it shows that the will may get control of certain muscular combinations before they are called out to a great extent involuntarily. In this respect, also, my observations confirm Egger's.[2]

In order to test the growth of voluntary control over the muscles of the hand and fingers, I determined to observe the phenomena of H.'s attempts at drawing and writing, for which she showed great fondness as soon as imitation was well fixed. Selecting a few objects well differentiated in outline — animals which she had already learned to recognize and name after a fashion — I drew them one by one on paper and let her imitate the "copy." The results I have in a series of "drawings" of hers, extending from the 7th of last April (the last week of her nineteenth month) to the present (middle of the twenty-seventh month). The results show that, with this child, up to the beginning of the twenty-seventh month there was no connection apparent between a mental picture in consciousness and the movements made by

[1] Science, xvii., 1891, p. 113.

[1] Egger notices this late development of vocal imitation, "L'Intelligence et Langage chez les Enfants," p. 18.

[2] Loc. cit., p. 18-20. Yet I cannot hold with Egger that imitation always involves "intelligence."

the hand and fingers in attempting to draw it. The "drawing" was simply the vaguest and most general imitation of the teacher's movements, not the tracing of a mental picture. And the attempt was no better when a "copy" was made by myself on the paper—a rough outline drawing of a man, etc. There was no semblance of conformity between the child's drawing and the copy. Farther, while she could identify the copy and name the animal, she could not identify her own effort, except so far as she remembered what object she set out to make.

But in the next week (early in the twenty-seventh month) a change came. I drew a rough human figure, naming the parts in succession as they were made: she suddenly seemed to catch the idea of tracing each part, and she now for the first time began to make figures with vertical and horizontal proportion; i.e., she followed the order she saw me take: head (circle), body (ellipse) below, legs (two straight lines) further below, hands (two lines) at the sides of the body. It is all done in the crudest fashion, but that is due to the lack of muscular co-ordination. With the simplification of the figure by breaking it up into parts came also the idea of *tracery imitation*, and its imperfect execution.

As yet, however, it is limited to two or three copies — objects which she sees me make. That it is not now simply imitation of my movements is evident from the fact that she does not imitate my movements: she looks intently upon the figure which I make, not at my movements, and then strives to imitate the figure with movements of her own very different from mine. But she has not generalized the idea away from particular figures, for she can not trace at all an altogether new figure in right lines. Further, she traces these particular figures just as well without written copies before her: *here, therefore, is the rise of the tracery imitation of her own mental picture* — a fact of great theoretical interest.

This illustrates again the point so strangely overlooked by writers on the rise of volition that the earliest voluntary acts are not voluntary movements. The thing pictured and willed here is not a movement, it is a figure — man, bird, dog. This figure suggests (stimulates) its motor associates. It is only later that the muscular movement becomes conscious end.

In the nature of the movements which the child has made in this series of drawings there is a marked change and development. There is growth from angular straight lines to curves, from movements one way exclusively to reverse movements, and an increasing tendency to complex intricate figures, which last probably results from greatly increased ease, variety, and rapidity of movement. At first she made only sweeping "arm-movements," then began to flex the wrist somewhat, and now, with no teaching, she manipulates the pencil with her fingers considerably. This seems to give support to the opinion of professional writing-teachers that the "arm-movement" is most natural and effective for purposes of penmanship.

Further, all her curves are made by movements from left to right going upward and from right to left downward. This is the method of our usual writing as contrasted with "backhand." She also prefers lateral to vertical movements on the paper. Her most frequent and easy "drawing" consists of a series of rapid right-and-left strokes almost parallel to one another.

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A FEW CHARACTERISTICS OF THE AVIAN BRAIN.[1]

WHEN we compare the brain of a crow or a titmouse with the brain of a snake or a turtle, it is no longer a marvel that birds bear towards their reptilian cousins the relation of intellectual giants to intellectual dwarfs. The cranium of reptiles is small, while the brain-cavity of birds is large, and, what is more pertinent, the whole of that cavity is filled with a compact brain mass. Not only that, but the cerebrum, the seat of the intellectual faculties, constitutes the major portion of that mass.

The cerebrum is composed of two lateral halves or hemispheres, which are so situated that they form a compact heart-shaped mass. The apex of this heart is directed towards the bill of the bird, while the notch is directed towards the tail. These hemispheres are unconvoluted, but the borders of some of the superficial lobes approach almost to the dignity of convolutions. Furthermore, a microscopic study of the brain reveals the fact that occasionally there occurs a blind convolution; i.e., an internal projection of gray matter without a concomitant surface convolution.

A microscopic study of the bird brain does not reveal a cerebral cortex similar to that of the human cerebrum. Here the cerebral cortex is represented by a thin hull containing several loosely aggregated cell-clusters. These cell clusters are constant and are homologous to corresponding clusters in the lizard brain.

Next in size to the cerebrum comes the cerebellum. Not only is it transversely convoluted, not only is it a cover for the medulla, but it is also partly wedged into the notch between the two halves of the cerebrum. This high development of the cerebellum of birds, coupled with the corresponding high development of the cerebellum of fishes, is a strong argument in favor of the hypothesis that the cerebellum functions as a co-ordinating centre for muscular movements.

Neurologically considered, birds are pre-eminently seeing animals, and all parts that appertain to vision are highly developed. The optic nerve is the largest cranial nerve, and the optic lobes are completely differentiated bodies. Even the third, fourth, and sixth cranial nerves, although quite small, are relatively larger than the corresponding nerves of the mammalian brain.

An extraordinary development of one set of organs is never accomplished but at the expense of some other set. In this case the organs of the sense of smell have been the martyrs. Although in the lower avian types the olfactory lobes are paired and conspicuous, yet in the highest types of birds they have been reduced to a small unpaired body which is partly imbedded in the base of the cerebrum.

These two facts lend support to the view that birds of prey find their food more by aid of the sense of sight than by aid of the sense of smell. The birds of prey are far from the lower end of the scale, and in all cases examined the olfactory lobes have been relatively smaller than the corresponding lobes of chickens, geese, turkeys, etc. I have not yet examined a buzzard's brain; but, judging by the figures of A. Bumm,[2] they have small, inconspicuous olfactory lobes.

From the above statements, we see that economy of space is evidenced in all parts of the avian brain. Indeed "progressive compactness" has played so important a part in the evolution of birds that there is a vast difference between the

[1] This is but a brief abstract of a portion of my paper upon the "Morphology of the Avian Brain," Journal of Comparative Neurology, vol. I., pp. 39-92, 107-134, 265-286, pl. V.-VIII., XIV.-XVI., XVIII.

[2] Das Groshirn der Vögel, Zeitschrift f. Wiss. Zoologie, Bd. xxxviii., 1883.