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THE UPRIGHT POSTURE*

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I. Introduction

A breakdown of physical well-being is alarming; it turns our attention to functions which on good days we take for granted. A healthy person does not ponder about breathing, seeing, walking. Infirmities of breath, sight, or gait, startle us. Among the patients consulting a psychiatrist, there are some who can no longer master the seemingly banal arts of standing and walking. They are not paralyzed; but, under certain conditions, they cannot, or feel as if they cannot, keep themselves upright. They tremble and quiver. Incomprehensible terror takes away their strength. Sometimes a minute change in the physiognomy of the frightful situation may restore their strength. Obviously, upright posture is not confined to the technical problems of locomotion. It contains a psychological element. It is pregnant with a meaning not exhausted by the physiological tasks of meeting the forces of gravity and keeping the equilibrium.

Language has long since taken cognizance of this fact. The term "to be upright" has two connotations: to rise, to get up, and to stand on one's own feet; and the moral implication, not to stoop to anything, to be honest and just, to be true to friends in danger, to stand by one's convictions, and to act accordingly, even at the risk of one's life. We praise an upright man; we admire someone who stands up for his ideas of rectitude. There are good

reasons to assume that the term "upright" in its moral connotation is more than a mere allegory.

The upright posture distinguishes the human genus from other living creatures. To Milton, Adam and Eve appeared as ". . . Two of far nobler shape, erect and tall, God-like erect, with native honor clad. . . ." Some biologists, however, would like to take exception to this praise, and, in slightly more prosaic statements, they indict the upright posture as a cause of hernias and flat feet. However this may be, whether the poet is right or his misanthropic opponents, whether upright posture is an excellence or not, in any case it is a distinction. It does not occur in any species besides man.*

Upright posture, while unique, is also essential. This is no necessary consequence. The exceptional might be nothing but a peculiarity, an accidental caprice of nature. However, there is no doubt that the shape and function of the human body are determined in almost every detail by, and for, the upright posture. The skeleton of the foot, the structure of the ankle, knee, and hip, the curvature of the vertebral column, the proportions of the limbs—all serve the same purpose. This purpose could not be accomplished if the muscles and the nervous system were not built accordingly. While all parts contribute to the upright posture, upright posture in turn permits the development of the forelimbs into the human shoulders, arms, and hands, and of the skull into the human skull and face.

With upright posture, the vertebral column takes on for the first time the architectural function of a column. The skull rests on the articular surfaces of the atlas (which here, indeed, deserves its name) like an architrave on the capitals of columns. This arrangement makes it possible and necessary for the atlanto-occipi-

*F. Weidenreich, in his book *Apes, Giants and Man* (University of Chicago Press, 1946), discusses the relationship between man and his simian ancestors. There he enumerates the main peculiarities which, compared to the condition of the apes, characterize man in his upright posture. The human leg, which he mentions among other things, "is stretched in hip and knee joints to its maximum extent and adduced toward the midline, so that the knees touch each other, while in anthropoids, even if the latter succeed in standing and walking upright, the legs remain bent in hip and knee joints and are held in abduction, so that anthropoids always stand stooped, with their knees crooked and turned outward." In the so-called normal attitude of man, therefore, the lines connecting the centers of hip-, knee-, and ankle-joints are all located in the same frontal plane. The plumb line passes through this plane. Furthermore, the center of the hip joint is, for each leg, vertically above the center of the knee and ankle joints.

tal joint to be moved forward toward the center of the base of the skull, resulting in the typical configuration of the human skull, the extension of the base, and the closing vault, which in turn provides wider space for the orbitae. The skulls of the other primates still show the shape characteristic of other quadrupeds, in which the head does not rest on the vertebral column but hangs down from it. The foramen magnum accordingly is in a more caudal position; the clivus cuts the vertical at a more obtuse angle. The other primates—as it has been said—are built to stand upright but not for upright posture.*

Because upright posture is the "*Leitmotiv*" in the formation of the human organism, an individual who has lost or is deprived of the capacity to get up and keep himself upright depends for his survival completely on the aid of others. Without their help, he is doomed to die. A biologically-oriented psychology must not forget that upright posture is an indispensable condition of man's self-preservation. Upright we are, and we experience ourselves in this specific relation to the world.

Men and mice do not have the same environment, even if they share the same room. Environment is not a stage with the scenery set as one and the same for all actors who make their entrance. Each species has its own environment. There is a mutual interdependence between species and environment. The surrounding world is determined by the organization of the species in a process of selecting what is relevant to the function-circle of action and reaction.[1] Upright posture pre-establishes a definite attitude toward the world; it is a specific mode of being-in-the-world.

Relating the basic forms of human experiencing to man's upright posture may well be called an anthropological approach, if that term is used with its original connotation. It was not until the middle of the nineteenth century that the meaning of "anthropology" was confined to zoological aspects, to a study of man as an

*The comparison of man and other primates is a time-honored topic, widely discussed among pre-Darwinistic zoologists. Most of the characteristic differences enumerated by Weidenreich were known to the anatomists of the eighteenth century, who also considered the possibility of a common origin. Daubenton published, in 1764, a paper about the different positions of the foramen magnum in man and animals (*Mémoires de l'Académie de Paris*, 1764, quoted after Herder). Even the sentence passed on upright posture because of its inherent evils is old enough. Moskati, in 1771, comparing the essential differences of man and animals, came to the conclusion that upright posture disposed heart, circulation and intestines to many defects and diseases (*Vom Koerperlichen Wesentlichen Unterschiede der Thiere und Menschen*, Goettingen, 1771).

animal in his evolution and history as a race. The nineteenth-century view aimed to see man exclusively, and understand him completely, as an animal. It was motivated by an antagonism to theology. Instead of seeing man created in the image of God, it wanted to see man as the descendant of the monkey. This anti-theological view remains theological because of its concern with refutation. However, one can and should consider man in his own right without either theological or anti-theological bias. Anthropology can be developed, indifferent to both the Biblical account and the evolutional theory of genesis.

The writer's interest is in what man is, not in how he supposedly became what he is. Palaeontology tells what man or his ancestors once were, not what man actually is. Even if one concedes to palaeontology that it has discovered the living or extinct ancestors of man, it has little to say as to how the change to modern man came about or as to what its final result was. Looking from man to the hominids* or the other primates, we see what man is no longer. Looking from the other primates to man, we see what the other primates are not yet. Any explanation of the causes of evolution demands a knowledge of both the old and new forms. No designer of an automobile would try to explain its present form and shape by mere reference to its forerunners. It is true that a modern car has some basic traits in common with the old buggy, but just that which gives an automobile its characteristic shape is not learned from the old form. It is the automobile's own function and dynamic structure that determine its shape.

Palaeontologists are inclined to exaggerate their gratitude to the ancestors of humans. In a very illuminating survey of the development of the humerus from fish to man, Gregory[2] states that man has inherited the basic pattern of locomotion from the earliest vertebrates, and that he owes the modeling of a potential humerus and a potential ulna to the crossopterygians of the Devonian age. Still, man's gait and behavior seem slightly remote from the Silurian ostracoderms.

*The early Darwinists were on the search for the "missing link" connecting modern man with the living anthropoids. Today, the opinion prevails that the human branch parted from the modern anthropoids "much earlier than we ever dreamed." Weidenreich believes that this separation occurred in the Miocene period, or not very long afterward. Portman places it in the late Cretaceous period. From there on, a fragmentary line of hominids, documented by fossils in Europe, Asia, and Africa, leads toward modern man. There is also another line, still more hypothetical, leading to the living anthropoids: chimpanzee, gorilla, orangutan.

With all due respect for the accomplishments of those early ancestors, we should not forget to investigate our own situation. Man is not only the end of a long development; he also represents a new beginning. One may doubt if old rocks will reveal all the secrets of human existence.

II. Human Kinematics

a. *Acquiring Upright Posture*

Upright posture has a delayed beginning in the life of an individual. The heart of the unborn beats in the mother's womb. Breathing starts with the first cry at birth. Upright posture keeps us waiting. Even when the physiological conditions—such as the maturation of fibers, the development of postural reflexes, or, later, the elongation of the legs—are fulfilled, the child will not master upright posture at once. He has to learn it, to conquer it. The acquisition will pass through several phases, which, although not completely separate, are sufficiently distinct. Progress is slow; it takes a number of years. This development will be followed here from the getting up, to standing and finally to walking.

The origin and the beginning of upright posture do not coincide, just as the first cry, the beginning of the functioning of breathing, does not mark the origin of breathing. The conditions surrounding the beginning of a function, whether it be breathing or speaking or standing, do not at all give an account of the structures of breath, speech, upright posture, or of their origins. As long as one speaks about breathing and walking, the distinction appears banal and not worth mentioning. There are, however, situations where the distinction is less obvious but not less true. The writer wonders whether genetic psychologists sometimes actually do confuse beginning and origin?

Upright posture characterizes the human species. Nevertheless, each individual has to struggle in order to make it really his own. Man has to become what he is. The acquisition does not make him an "absentee landlord." While the heart continues to beat, from its fetal beginning to death, without our active intervention, and while breathing neither demands nor tolerates our voluntary interference beyond narrow limits, upright posture remains a task throughout our lives. Before reflection or self-reflection start, but as if they were a prelude to it, work makes its appearance within the realm of the elemental biological functions of

man. In getting up, in reaching the upright posture, man must oppose the forces of gravity. It seems to be his nature to oppose, with natural means, nature in its impersonal, fundamental aspects. However, gravity is never fully overcome; upright posture always maintains its character of counteraction. It calls for our activity and attention.

Automatic regulation alone does not suffice. An old horse may go to sleep standing on its four legs; man has to be awake to keep himself upright. Much as we are part of nature with every breath, with every bite, with every step, we first become our true selves in waking opposition to nature. In sleep, we do not withdraw our interest from the world so much as we surrender ourselves completely to it. We abandon ourselves to the world, relinquishing our individuality. We no longer hold our own in the world, opposed to it. Awakeness and the force of gravity are mutually interdependent. While awakeness is necessary for upright posture, that is, for counteracting gravity, gravity determines waking experiencing. The dreams of one night are not related to the dreams of another night, but days are related to each other. They form a continuum, where every hour, every moment, anticipates the next one and prepares for it. Held back by gravity to a precise point, we can overcome distance only in an orderly sequence. During our waking hours, sequence means consequence. Gravity, which holds us in line, imposes upon waking experience a methodical proceeding. In sleep, when we no longer oppose gravity, in our weightless dreams, or in our lofty fantasies, experiencing becomes kaleidoscopic and finally amorphous. Sequence, then, no longer means consequence. Awakeness is no mere addendum, still less an impediment, to an otherwise happily functioning id. The waking man alone can preserve himself, and he alone can help drives to reach their goal.

In the Hobbesian philosophy, man, hunted by fear of violent death, creates the commonwealth to keep disruptive natural tendencies in check. A permanent, never-resolved, discord ensues between man in state of nature and man as a member of society. Locke, Rousseau, Freud, and many others took up the theme and added to it variations of their own. If only these many descriptions of man's state of nature were more than historical fantasies! Yet, one need not invent prehistory; we can make use of a very concrete experience. We can read man's natural endowment from

his physique. Considering man in his upright posture, we do well to envisage the possibility that, not society, has first brought man into conflict with nature but that man's natural opposition to nature enables him to produce society, history, and conventions.

The direction upward, against gravity, inscribes into space world-regions with spatial-emotional values, such as those expressed in high and low, rise and decline, climbing and falling, superior and inferior, elevated and downcast, looking up to and despising. On Olympus, high, remote, inaccessible, exalted, dwell the Homeric gods. On Mt. Sinai, Moses receives the Ten Commandments. Below in the depths, is Hades and the world of shadows. There, also, is the Inferno. However, such evaluations are not unequivocal. "Base" and "base"—these two words have, in spite of their phonetic resemblance, different etymological roots and opposite meanings. "Base," the adjective, is derived from the Latin root "*bassus*" with the connotation "short" and later "low," while "base," the noun, originated in the Greek root "*baino*"—"walking, stepping." The earth that pulls us downward is also the ground that carries and gives support. The weighty man signifies by his dignified gait that he carries a heavy burden but sustains it well. Upright posture as counteraction cannot lack the forces against which it strives.

b. *Standing*

In getting up, man gains his standing in the world. The parents are not the only ones who greet the child's progress with joy. The child enjoys no less the triumph of his achievement. There is a forceful urge toward the goal of getting up and of resisting, in a state of dangerous balance, the downward-pulling forces. There need not be any other premium, like satisfaction of hunger, attention, or applause. The child certainly does not strive for security. Failure does not discourage him. He enjoys the freedom gained in upright posture, the freedom to stand on his own feet, and the freedom to walk. Upright posture, which we learn in and through falling, remains threatened by falls throughout our lives. The natural stance of man is, therefore, "resistance." A rock reposes in its own weight. The things that surround us appear solid and safe in their quiet resting on the ground, but man's status demands endeavor. It is essentially restless. We are committed to an ever-renewed exertion. Our task is not finished with getting up and

standing. We have to "with-stand." He who is able to accomplish this is called constant, stable.

Language expresses well the psychological meaning of standing, with all its facets. The coupling of the transitive and the intransitive meanings "to stand" and "to stand something" characterizes them as resisting, and therefore enduring against, threat, danger and attack. The etymological root of standing—"*sta*"—is one of the most prolific elements, not only in English, but also in Greek, Latin, French and German. It may suffice to mention only a few derivatives of an almost inexhaustible store. Besides combinations like "standing for," "standing by," "making a stand," there are many words where the root has undergone slight changes but is still recognizable, as in "state," "status," "estate," "statement," "standard," "statute," "institution," "constitution," "substance," "establish," "understand," "assist," "distant." This whole family of words is kept together by one and the same principal meaning. They refer to something that is instituted, erected, constructed, and, in its dangerous equilibrium, threatened by fall and collapse. Falling is not always tragic. Clowns, modern and old, primitive and sublime, all have made use of falling as a reliable trick to stir up laughter.

With upright posture, an unescapable ambivalence penetrates and pervades all human behavior. Upright posture removes us from the ground, keeps us away from things, and holds us aloof from our fellow-men. All of these three distances can be experienced either as gain or as loss.

1. (*Distance from the Ground.*) In getting up, we gain the freedom of motion and enjoy it, but at the same time we have lost secure contact with the supporting ground, with Mother Earth, and we miss it. We stand alone and have to rely on our own strength and capacities. With the acquisition of upright posture, a characteristic change in language occurs. In the early years, when speaking of himself, a child uses his given name. However, when he has reached the age when he can stand firmly on his own feet, he begins to use the pronoun "I" for himself. This change marks a first gaining of independence. Among all words, "I" has a peculiar character. Everyone says "I," but for himself alone. "I" is a most general word. At the same time, it has a unique meaning for every speaker. In using the word "I," I oppose myself to everyone else, who, nevertheless, is my fellow-man.

Because to get up and stand are so demanding, we enjoy resting, relaxing, yielding, lying down, sinking back. There is the voluptuous gratification of succumbing. Sex remains a form of lying down, or as language says, of lying or sleeping with. Addicts, in their experiencing, behavior, and intention, reveal the double aspect of sinking back and its contrast to being upright. A *symposium* found the ancient Greeks, a *convivium* the Romans, stretched on their couches until, after many libations to Dionysus and Bacchus, they finally sank to the ground. *Symposium* means "drinking together, a drinking party." It could be well translated by the characteristic German word, "*gelage*." Plato's dialogue first helped the word "*symposium*" to reach its modern connotation. The old and new are not so far apart as one might assume. Their relation can also be expressed—Plato clearly indicates this—as the difference between being upright and sinking.

2. (*Distance from Things.*) In upright posture, the immediate contact with things is loosened. A child creeping on his hands and knees not only keeps contact with the ground but is, in his all-fours locomotion, like the quadrupeds, directed toward immediate contact with things. The length-axis of his body coincides with the direction of his motion. With getting up, all this changes. In walking, man moves his body in a parallel transposition, the length-axis of his body at a right angle to the direction of his motion. He finds himself always "confronted" with things. Such remoteness enables him to see things, detached from the immediate contact of grasping and incorporating, in their relation to each other. Seeing is transformed into "looking at." The horizon is widened, removed; the distant becomes momentous, of great import. In the same measure, contact with near things is lost.

Thales, the philosopher and astronomer, while watching the stars, fell into a ditch. A young child is close to the ground; to him the stars are far off. He does not mind picking things up from the ground; but, growing older, he will learn to accept our table manners, which remove even food to a distance. We set the table; we serve the meal; we use spoon and fork. Our feeding is regulated by a ritual, which we like to discard at a picnic. Artificiality and tools interfere with the direct satisfaction of hunger. The mouth is kept away from the plates. The hand lifts the food up to the mouth. Spoon and fork do not create distance; tools can only be invented and used where distance already exists. In the early

months of life, hands hold on to things in a grasping reflex. Not until the immediate contact of grasping is abandoned is the use of tools possible. This development is not simply the result of motor maturation. An imbecile may never learn, a paretic may unlearn, manners, not so much because of failure of the motorium as because of the loss and lack of distance. Pointing likewise presupposes distance. It appears to be a human activity. Animals do not easily, if at all, understand pointing to distant things.* Pathology reveals an antagonistic relationship between grasping and pointing. There are cases where pointing is distorted, while grasping either remains undamaged or is later intensified and becomes forced grasping.**

3. (*Distance from Fellow-men.*) In upright posture, we find ourselves "face to face" with others, distant, aloof—verticals that never meet. On the horizontal plane, parallel lines converge toward a vanishing point. Theoretically, the vanishing point of parallel verticals—to which we are comparable, standing vis-a-vis —is in infinite distance. In the finiteness of seeing, however, parallel verticals do not meet. Therefore, the strict upright posture expresses austerity, inaccessibility, decisiveness, domination, majesty, mercilessness, or unapproachable remoteness, as in catatonic symmetry. Inclination first brings us closer to another. Inclination,† just like leaning, means literally "bending out" from the austere vertical.

The dictators, reviewing their parading troops, tried to show by their rigid poses their imperturbable and unshakable wills. Formalized attitudes, and pantomimic, signifying gestures, follow the pattern set by spontaneous expressions. When we lower our heads or kneel in prayer, when we bow or bend our knees in greeting, the deviation from the vertical reveals the relation to it.

*It is the hunter who understands and interprets the dog's aiming as pointing. The "point" is the natural outgrowth of the dog's pausing previous to springing the game.

**Goldstein, Kurt: *Über Zeigen und Greifen.* der Nervenarzt. 1931. Exerimental ablations of cortical areas indicate that grasping is under the control of Brodmann's Area 6.

†The root is Latin, *clino*, to bend. It is interesting to see how greatly language is shaped in accordance with expressive phenomena. Not only does the English language have two words of the same structure from different roots; but there is the German word "*zuneigung,*" with still another etymological derivation, which, however, expresses the same meaning with the corresponding space-experience. All this points to the fact that metaphors do not simply carry over a meaning from one medium to another. There is a much more intimate relation, that between expressive motion and emotional attitude.

So it is with the expressions of reverence, of asking and granting a request, and many others. The formalization and shortening of social gestures sometimes make it hard to recognize their origin; but even the stiff forms of military greeting may, with a slight courteous bending of the head, be revitalized by spontaneous expression.

There is only one vertical but many deviations from it, each one carrying a specific, expressive meaning. The sailor puts his cap askew and his girl understands well the cocky expression and his "leanings." King Comus at the Mardi Gras may lean backward and his crown may slip off-center. However, even the disciples of informality would be seriously concerned if, on his way to his inauguration, a President should wear his silk hat (the elongation and accentuation of the vertical) aslant. There are no teachers, no textbooks, which instruct in this field. There are no pupils, either, who need instruction. Without ever being taught, we understand the rules governing this and other areas of expression. We understand them, not conceptually, but, it seems, by intuition. This is true for the actor as well as the on-looker.

One may argue that these are cultural patterns with which we grow up and that our final attitudes are the result of many infinitesimal steps. To support this view, one may point to the fact that gestures of greeting were different in the old days from ours, and are different in the Occident and the Orient. Yet, in spite of their divergences, they all are variations of one theme. They are all related to the vertical; they are all modifications of the upright posture. Exceptions only confirm the rule. We give our assent by nodding the head, obviously also a motion that carries the head downward following gravity, away from the vertical. It has been observed that this gesture is not universal, that there are peoples to whom the same vertical motion of nodding means negation or denial. However, these two forms of expression, which indeed resemble each other, are not identical. Our mode of assertion, as well as their negation, consists of a two-phased motion—the motion downward and the movement up and backward. While in assertion the accent is on the downward motion, negation chooses the opposite direction. The head is moved from the position of inclination back to the vertical, expressing inaccessibility and denial.

Cultural patterns do not arbitrarily create forms, but, within

the given framework, formalize a socially-accepted scheme, valid only for its group and period. With upright posture counteracting gravity, the vertical, pointing upward, away from the centers of gravity, becomes a natural determinant. The vertical is a constancy phenomenon. Its apparent position does not change, even if the head is tilted and, therefore, its projection on the retina varies. At an early age, children are able to draw a vertical or a horizontal line, to copy a cross or a square, but they fail when asked to copy the same square presented as a diamond.*

c. *Walking*

With getting up, man is ready for walking. The precarious equilibrium reached in standing has to be risked again. A quadruped rests with relative safety on his four legs, which inscribe an appropriate base on the ground. The center of gravity does not leave its position above this base even when the animal walks or trots. The human situation is different. The center of gravity is elevated high over the small base of support. This provides for greater flexibility and variability of movement, but it increases instability and the danger of falling. Man has to find a hold within himself. Standing and walking, he has to keep himself in suspension.

The legs support the body like columns; in the hip joint, the trunk rests upon the femur bones as upon pillars. At least, it seems to. The appearance is convincing enough for a hysterical person to use it as a model for his astasia-abasia. If one tries, however, to carry through the comparison in detail, one sees immediately the striking contrast to the architectonic principles of column and pillar. Many old temples have collapsed, leaving their columns still standing erect. The stone pillars of a bridge are constructed from the foundation upward. Each lower section really carries the upper one, which can be removed without unbalancing the lower ones. Neither the skeleton nor the legs will stand of their own power. The legs could not do it, even if the muscles could still contract and were not severed from their origin on the pelvis. The legs have to be held in suspension by the counteraction of the trunk muscles and by the counterweight of the trunk.

*Gibson and Mowrer (Determinants of the perceived vertical and horizontal. Psychol. Rev., 45, 1938) assumed that our orientation in space is determined by postural factors, while visual stimulation is of secondary importance. Asche and Witkin, however, in their more recent experiments, came to the opposite conclusion (Studies in space perception. J. Exper. Psychol., 38, 1948).

A column, a pillar, a tower, taper off. Their bases are broader than the top. Human legs also have a conical shape, but the bulk is high. The origin of the muscles, and therefore their main volume, is on top. The muscles extend with their tendons downward from pelvis to knee and again from knee to ankle. Their contraction, however, is directed upward.

With the circumference of the thighs near the hip joint considerably larger than the circumference around the ankle, the leg resembles an inverted obelisk more than a column. This leg-obelisk cannot support itself on its tip. There is a gyrostatic system of balance, holding the legs as much as being carried by them. The old anatomical names of muscles and the traditional signification of their functions are often misleading. The biceps femoris and hamstring muscles, the so-called flexors of the leg, bend the lower leg in one position only, while in another they extend the knee and the hip. The erector trunci and the muscles of the legs co-operate —with gravity as their invisible partner—as synergists, originating in adjacent areas of the ilium and the sacrum. They act upon the pelvis in opposite directions. They turn the pelvis around an axis, connecting the centers of the hip joints. There is a second balancing system between the right and left which keeps the pelvis and trunk in balance in a sagittal plane. From clinical observation of dystrophies and paralyses, we learn what individual muscles—like the gluteus maximus, the iliopsoas, the quadriceps femoris, the sacrospinalis—contribute to upright posture; from physiological experiments, we come to know how they are correlated. Through the combined work, we gain information about the means of locomotion. At this point, a new horizon of problems is opened up, the question of how a being equipped with such a motorium will experience the world—and himself in this world.

Human bipedal gait is a rhythmical movement where, in a sequence of steps, the whole weight of the body rests for a short time upon one leg only. The center of gravity has to be swung forward. It has to be brought from a never-stable equilibrium to a still less stable balance. Support will be denied to it for a moment until the leg brought forward prevents the threatening fall. Human gait is in fact a continuously arrested falling. Therefore, an unforeseen obstacle, a little unevenness of the ground, may precipitate a fall. Human gait is an expansive motion, performed in the expectation that the leg brought forward will ultimately find

solid ground. It is motion on credit. Confidence and timidity, elation and depression, stability and insecurity—all are expressed in gait.

Bipedal gait is in fact a balance alternating from one leg to the other, it permits variations in length, tempo, direction and accent. In a polka step, even the rhythmical sequence of right and left and right and left is interrupted and exchanged. The symmetry of rhythmically alternating locomotor reflexes is thereby broken. Steps, varied in many ways, can be united in a scheme, in a meter. It is not poetry alone that moves on "metrical feet" in an anapaestic, iambic or trochaic meter. In marching, in dancing, we perform a great variety of set patterns. "Per-forming" means that we follow a given form, that we are able to conduct ourselves in accordance with a scheme set beforehand, that we can use our limbs like instruments. Everyone who drives a car uses his legs and feet as tools. No one, however, outdoes the organist, who plays one pedal with his feet. Such an instrumental use of the limbs, obviously not limited to the arms and hands, demands a centralization of functions, demands a dominating hemisphere. For symmetrical alternating movements, bilateral, segmental and suprasegmental structures may suffice. Instrumental use depends on an interruption of symmetry, followed by higher integration.

A breakdown of this integration should result in kinetic apraxia of trunk and legs. There are indeed some cases recorded[3] that confirm this expectation. Their number is small. It probably would be greater if, as Sittig[4] pointed out, more attention were given to this symptom. Even then, it might escape observation for two reasons: first, paresis may cover the apraxia of the legs; and, second, gait and other symmetrical motions may still be found intact, when actions based on less symmetrical motions, like jumping and dancing, have already failed.[5]

III. Upright Posture and the Development of the Human Hand and Arm

a. *The Hand as a Sensory Organ and as a Tool*

In upright posture, the frontal extremities are no longer asked to support and carry the body. Relieved from former duties, they are free for new tasks. The anterior limb develops into the human arm and hand, which acquire multifarious new functions. For this development, upright posture is not only the genetic condition; it continues to dominate the functions of hand and arm.

Opposition of the thumb has been frequently mentioned as the most essential innovation. This statement is not completely true or completely correct. It is not correct because the hands of other than human primates are not entirely lacking in opposition of the thumb.* It is not completely true because one detail is singled out. With the same justification, or lack of it, the index finger has been honored as the specifically human acquisition. Those who say this think, of course, of its function of pointing. The index finger, however, could not point if the hand were not joined to the arm, and if the hand and arm were not related to upright posture.

In upright posture, the hand becomes an organ of active gnostic touching, the epicritic, discriminative instrument par excellence. As such, the hand now ranks with the eye and the ear. Anatomy which describes the eye and the ear as sensory organs, does not grant the same privilege-status to the hand. Anatomy dissects. It divides the hand into different layers and, "in a systematic order," describes the skin as a part of the integument and places the bones in the osteological, the muscles in the myological, the vessels in the cardiovascular systems. Not to call the hand an organ seems strange, in view of the fact that organ originally meant "tool." For Aristotle, the hand was "the tool of tools."[6] Anatomy has good reasons for its procedure; they are not, however, simply of a pragmatical order. The hand is a tool in relation to the living, experiencing being, to the man who stretches out his hand, touches and grasps. The anatomical description that attributes the tissues of the hand to different systems is an analysis of the dead body. The wholes which function as frames of reference differ widely.

The hand as an object of anatomy and the hand experienced as a part of my body—these two hands are not exactly the same object. The moment the anatomist takes up his scalpel he behaves, in regard to his own hand, like anyone who has no knowledge of anatomy. This change of attitude is not simply a relapse into naïve, primitive, pre-scientific behavior, unavoidable as a kind of abbreviating procedure. The anatomist, like everybody else, does not innervate the opponens, the interossei, the flexores digitorum. He does not use *the* hand but *his* hand. The possessive relation expressed by the words "my," "yours," "his," familiar and simple

*The proportions of their hands, however, especially the length of the metacarpus, prevent the formation of the finger-thumb forceps with its characteristic effect. See Revesz, Géza: *Die Menschliche Hand.* Karger. New York and Basle. 1944.

as it appears, contains, in fact, one of the most difficult problems for our understanding. It indicates the transition from physiology to psychology.*

Anatomy and physiology relate the body as a whole, and its parts, to neutral space—as the frame of reference. In experiencing, however, I experience my hand as an organ in relation to the world. The space that surrounds me is not a piece of neutral, extended manifold, determined by a Cartesian system of co-ordinates. Experienced space is action-space; it is my space of action. To it, I am related through my body, my limbs, my hands. The experience of the body as mine is the origin of possessive experience. All other connotations of possessive relations are derived from it. "Mine" is a distinction which has its place only in the experienced relation of myself and the world. Severed from this basic concept of experiencing, psychology will lose its specific theme and content.

Discussion is necessarily discursive. Analysis cannot avoid dividing into parts that which exists as a whole. When the dissection is completed, synthesis sometimes will be found difficult. It depends on the preceding methods of dividing. They may be so radical as to prevent the restitution of the whole. Adding part to part does not give a full reintegration of the whole. The parts have to be understood from the beginning as parts of that specific whole to which they belong. With attention focused on details, the human arm and hand appear as just one other variation in the development of the forelegs. For every part, one can find a homologue in other species. However, "homologue" means difference as well as similarity. If one gives due respect to both, and considers the arm in its entirety within the whole framework of upright posture, one can hardly deny that through the peculiar structure and function of arm and hand, a new relation between the human organism and the world has been established.

Only in relation to action-space, then, will the hand be understood as a sensory organ. It is true that the microscope does not reveal any tactile receivers specific for the skin of the hands. Meissner's corpuscles and Pacinian bodies are most numerous, but they are also found elsewhere. Their number alone would not

*Sherrington, in an introduction added to the ninth edition of his book, *The Integrative Action of the Nervous System*, emphasizes this gap between physiological and psychological approach and methods. Although he does not directly mention the problems posed by the possessive relation, he obviously is fully aware of them.

justify us in speaking of the hands as sensory organs. There is a better reason for doing so than the mere frequency of corpuscles. It is their distribution over the multiplex, mobile structure of the fingers, which, in their diversity, form a motor-sensoric unit. It is not the individual finger that, in feeling, recognizes, but all the fingers together, combined in a group. It is not the resting finger that feels, but the actively moved digits. Tactile impressions result from motion; nevertheless, we do not experience our motion so much as the quality of the things touched.[7] We feel the smoothness of a surface in letting our fingers glide over it.

While motion is indispensable for tactile impressions, the impression-guided fingers function as a working tool. This intimate interpenetration of sensorium and motorium is well expressed in words like "handling," "fingering," "thumbing," "groping," each of which combines the transitive and intransitive meanings of touching into one. The hand has, it seems, an insight of its own. In an ataxia of the legs, seeing may partially compensate for the sensory deficiencies. However, in a posterior root deficit of the hands, seeing is of little help, neither is it an aid in finger-agnosia and right-left disturbances.

The epicritic-discriminative functioning of the hands depends on still another condition. There is an inner distance necessary, a remoteness experienced in spite of the proximity of contact. A physician, in examining (palpating) a body, is expected to remain a neutral observer. He should be neither attracted nor disgusted by what he observes. His goal is not closeness, is not unification. His action resembles that of a winetaster, who takes a sip but spits it out again, avoiding swallowing and incorporation. The gnostic function of touching depends on the upright posture, which through its permanent distances produces a hiatus in the immediateness of contact.

"Experienced distance"[8] cannot be expressed in geometrical terms. It cannot be defined as the length of a straight line connecting two points in space. The geometrical consideration of distance is completely indifferent to time. The concept of a vector adding direction, and thereby time, to distance would be more adequate. Still, it lacks any conative character. Geometrical distance relates two points in space, both detached from the observer. Experienced distance is that which unfolds between an experiencing being and another person or object. It can be experienced

only by a being who aims at unification or separation. The modes of unification and separation vary. The spatial relation is only one among others. While experienced distance cannot, therefore, be expressed completely in spatial terms, it never lacks a spatial element. The space to which it is related, however, is not the conceptual homogenous space of mathematics but perceptual space, articulated in accordance with the specific corporeal organization of the experiencing person.

The role of distance is not limited to the hand as a sensory organ. It also dominates manual expression, communication, contact. Distance is ambivalent. Sometimes we want to preserve it; sometimes we want to eliminate it. The hand is instrumental in both cases. When our equilibrium is out of balance, is disturbed, the hand grasps for a hold. In darkness, it functions as scout and sentry, warning against collision and searching for contact. Sometimes no hold is found, no contact is made. Searching hands stretch into the void. It is as if emptiness were localized in our hands. Indeed, only the empty hand, like the begger's hand, can receive. Emptiness is the condition by which our hands can be filled. Only because of remoteness can it make contact.

We understand that the phobic patient feels somewhat more comfortable by carrying something in his hand, maybe no more than a cane, an umbrella, a bag. Does not each of us, if he alone is exposed to a group, e. g., as a speaker, an actor, like to put his hands on a chair, a desk, to fiddle with a pencil, with notes? Finally, we may even surprise ourselves with gesticulations which help less to clarify our thoughts than to fill emptiness and cover distance. In such situations, we are only one step ahead of the embarrassed child who pulls his fingers, as if in doing this he could fill his empty hands.

All the variations of the expression of emptiness are related to upright posture. They are, it seems, a universal language. When Darwin prepared his book on expression,[9] he sent questionnaires to missionaries abroad in order to find out the distribution of gestures familiar to us in the western world. He was interested, among other things, in the gesture of shrugging the shoulders, an expression of the incapacity to advise or to help. Here one again meets the empty hands. With the lifting of the shoulders, we also supinate our arms and demonstrate the empty hands. Shrugging the shoulders is an expression of fruitless endeavor.

Darwin learned through his questionnaires that this expression is indigenous everywhere, not imported from other civilizations, not formed by more or less local conventions and customs. Its universality proves it to be autochthonous with the human race. It is a universal and spontaneous gesture of man, wherever and whenever he, with upright posture, experiences a distance from things and fellow-men.

b. *Expansion of the Body Scheme by the Arms*

In upright posture, the arms expand the body scheme. The arm motion circumscribes a sphere which surrounds the body as territorial waters surround the shores of a country. This constitutes a section of space which, like the three-mile zone, belongs to the central body, yet not completely. It is not an indisputable property but a variable possession. My intervening space is a medium between me and the world. As such, it has the greatest social significance; it mediates between the other and me. In this space, which is not completely my own, I can meet the other as the other, join him as my partner, arm in arm, hand in hand, and yet leave him in his integrity. Through this space, I hold the other at arm's length or let him come toward me and receive him with open arms. It is the space of the linking of arms, of embracing,* but also of crossing the arms, a motion in which we keep distance, "circumwalling" ourselves in an attitude of defense, of fortification. It is also the space of handshaking. There are many nuances of handshaking, like warm and strong, or cool and hesitant. There can be spontaneous advance, or a no less spontaneous containment—as by the hand of the schizophrenic. In a farewell, the hands hold each other, press each other, move on together; they will not part. In a handshake sealing a bargain, the hands meet each other halfway in a mutual firm grasp in which the motion is arrested, expressing final agreement. Even the formalized gesture signifies social acceptance. We pass through a reception line, and the hands stretched out toward us tell us that we are welcome and received into the group.

The "three-mile zone" is not static. It is a borderland with fluctuating frontiers. It expands or shrinks. The body-scheme is not so much a concept or image which a person has of his own body as it is an ensemble of directions and demarcations—directions in

*The etymological root of "embrace" is "*brac*," as in "*brachium*," the Latin word for arm.

which we reach out toward the world, and demarcations which we encounter in contact with the world.[10] The body-scheme is also experienced, therefore, as an I-world relation. Corresponding to our conation, space itself loses its static character, opens endlessly before us, expands or represses us. The "de-pressed," with his head bent, his shoulders lowered, his arms fallen to his sides, with his slow, short steps, succumbs to the pressure which pushes him down. The Christian attitude of kneeling in prayer, of bending the head, of interlacing the hands, expresses humility, surrender to a higher power. The hands, withdrawn from the territorial space, joined at the midline in full symmetry—taking no sides—have renounced all action. The Moslem in his pious prostration goes to the extreme of fatalistic submission. The ancient Greek attitude of praying—upright, arms lifted and extended—opened and widened the body space in an enthusiastic gesture—"en-thus-iastic," indeed, because "*en-theos-iastic*" means "to receive the God, to be possessed by him."

> "Ah, but a man's reach should exceed his grasp,
> "Or what's a heaven for?"[11]

In pointing also, man's reach exceeds his grasp. Upright posture enables us to see things in their distance without any intention of incorporating them. In the totality of this panorama which unfolds in front of us, the pointing finger singles out one detail. The arm constitutes intervening space as a medium which separates and connects. The pointing arm, hand, and finger, share with the intervening space the dynamic functions of separating and connecting. The pointing hand directs the sight of another one to whom I show something; for pointing is a social gesture. I do not point for myself; I indicate something to someone else. To distant things, within the visible horizon, we are related by common experience. As observers, we are directed, although through different perspectives, to one and the same thing, to one and the same world. Distance creates new forms of communication.

The organization of action-space is deeply imprinted on the memory. Even after the loss of a limb, it persists in the "phantom." As long as there is a phantom, there is also intervening space through which the illusive arm stretches to a distant world, with the illusive hand in a terminal position. It is a common experience that the phantom arm shrinks, that the phantom hand

moves closer to the trunk; but it never disappears completely; it is preserved in its terminal position. The loss of the limb reduces the reach. It modifies the intervening space but does not annihilate it altogether.

The human arm owes its specific mobility to upright posture. Many factors contribute to its development and functions, but through all of them, upright posture is at work. First to be mentioned is the change in proportions of the sagittal and transverse diameter of the chest. In quadrupeds, the sagittal diameter is relatively long, the curvature of the ribs flattened, the motions of the humerus in the shoulder joint restricted, the flexibility of the elongated scapula limited. The humerus is kept in close contact with the trunk. The basic function of supporting the trunk prevails and this imprints one definite general mark on the structure of the shoulder girdle, in spite of all the variations to be found in different species. With upright posture, the transverse diameter is increased. This change, together with the corresponding sharp, angular curvature of the ribs, gives to the human thorax its characteristic shape, which in turn permits the development of the shoulder girdle into a kind of superstructure. This superstructure, which tailors like to emphasize, moves the root of the arm upward very high and markedly to the side. Far from supporting the human body, the arm and the shoulder are themselves supported, or better, held in position by muscle action, especially by that of the trapezius. The arm, separated from the trunk in its full length, can swing from its elevated hub with the widest angle of excursions in the greatest variety of motions.

The arm, not designed for one specific task, has acquired the potentiality of a wide range of performance. The principle of growing indetermination, one of Hughlings Jackson's criteria of functional evolution, is applicable to the comparative anatomy of the shoulder girdle.* One should not forget that the human arm

*The highest centers of the brain are, according to Jackson, the least organized, the most complex, and the most voluntary. Evolution is a passage from the most to the least organized, from the simple to the most complex, from the most automatic to the most voluntary (Jackson, H.: Selected Writings. Vol. 2, p. 46 ff. London. 1932.). The highest centers were not, or were little, accessible to direct experimentation in Jackson's time. Their functions were found by inference, reasoning backward from the observation of peripheral performances. The diverse functions of finger, hand, arm, and shoulder, would tell something about the organization of the corresponding highest centers. Complexity of the brain centers must have and does have its exact counterpart in the organization of the limbs.

neither supports the trunk nor has to hold up the body, a function still assigned to the forelimb of the tree-inhabiting primates. Small but still significant changes ensue, in the shape and position of scapula and clavicle, in the origin and insertion of the shoulder muscles, in the configuration of the acromio-clavicular and the sterno-clavicular joints. All this together provides for a maximum flexibility of the arm, aiding the display of the mechanisms of the scapulo-humeral articulation, where, because of the looseness of the capsule and the shallowness of the glenoid cavity, the humerus can move with great ease in all directions. In the hip joints, on the contrary, the head of the femur is deeply set in the socket of the acetabular cavity, the capsule is tight and reinforced by strong ligaments. While the primarily tectonic formation of the neck of the femur also somewhat extends the range of excursions, the emphasis in the hip is on stability, in the shoulder, on flexibility.

Language, obviously inspired by phenomenological observation, takes the arm as the protoype of the articulation of a limb and of its motions from the joint, for the root of the word "arm" is "$\sqrt{\text{ar}}$" with the meaning "to fit, to join," the same root from which the Greek "*ar-thros*" and the Latin "*ar-ticulatio*" stem.*

Within the totality of the new spatial dimensions acquired with upright posture, lateral space is perhaps the most important one. Through the mobility and action of arm and hand, lateral space becomes accessible and relevant for man. In this sector, most of the human crafts originated. Hammer and axe, scythe and sickle, the carpenter's saw, the weaver's shuttle, the potter's wheel, the mason's trowel, the painter's brush—they all relate to lateral space. This list could be extended *ad libitum* but probably would never come to an end, for lateral space is the matrix of primitive and sophisticated skills: of spinning and sewing, stirring and ironing, sowing and husking, soldering and welding, fiddling and golfing, batting and discus-throwing.

The crafts of peace are followed, accompanied, or preceded, by the techniques and weapons of war: club, sword, spear, bow, sling,

*In this paper, the writer has made frequent use of etymology, although it is not customary to introduce "linguistic evidence" in a biological discussion. However, because the history of a word represents the sedimentation of general psychological experience, it appears to the writer to be justified to refer to etymology as an auxiliary discipline.

boomerang, to mention some elemental forms only. Lateral space makes action at a distance possible, as David proved successfully to Goliath.* Superiority has not always belonged to the light forces. Even so, the importance of action at a distance, for which throwing is the primordial and perennial model, remains undiminished, and with it, the importance of lateral space.

The development of primitive and elaborate weapons makes one wonder whether "arm," the limb, and "arms," the weapon, may have the same etymological root. To this question, the linguists answer both "yes" and "no." Their answer is "no" because arms, arming, armament, are historically related to the Latin root "*arma*." The Romans' word for "arm," the limb, is "*brachium*," with another derivation and meaning. However, the root for "*arma*," weapon, is also "$\sqrt{ar}$."

In considering the phenomenon of throwing, one cannot pass over the remarkable difference in the manner of throwing of the two sexes. It seems the manifestation of a biological, not an acquired, difference. Gesell[12] illustrates the familiar facts with some good photographs. They show little girls of five and six and two boys of the same age, throwing a ball. The girl of five does not make any use of lateral space. She does not stretch her arm sideward; she does not twist her trunk; she does not move her legs, which remain side by side. All she does in preparation for throwing is to lift her right arm forward to the horizontal and to bend the forearm backward in a pronate position. In the final motion, action is limited to the triceps and flexors of the hand. The excursion of her motion in the elbow joint does not exceed an angle of about 90°. The length of the lever from the fulcrum at the el-

*In this Biblical legend, a situation permanently repeating itself is told as a unique event. The Bible takes great pains to describe Goliath's heavy armor (I Sam. 17). It also tells that Saul offered David his own sword, a "helmet of brass," and a "coat of mail." However, David, not trained in the use of these weapons, laid them down. We may not go far wrong if we assume that the Bible, in a poetical condensation, describes as a duel what is really a conflict of two civilizations and of two types of military tactics. Goliath, the Philistine, belonged to a settled, seafaring nation, advanced in the techniques of metal forgery; David, described as a shepherd, belonged to a small nomadic tribe which invaded the Philistine territory from the interior. The conflict of the two co-existent types of military tactics is this: Goliath, heavily armed—the Philistine "Maginot Line"—almost immobilized by the weight of his armor—someone has to carry his shield before him—can move only directly forward to a close fight, while David, a kind of guerilla fighter, finds his advantage in mobility, in dodging, and in sudden attacks. This conflict between fortified defense and mobile attack is found in all military history up to our own time.

bow to the palm of the hand coincides with the length of the forearm. The ball is released without force, speed, or accurate aiming. It enters almost immediately the descending branch of a steep parabola. At the age of six, the girl tilts her right shoulder slightly, moves the left foot forward one small step, but shows no further progress. A boy of the same age, when preparing to throw, stretches his right arm sidewards and backwards, supinates the forearm,* twists, turns and bends his trunk, and moves his right foot backward. From this stance, he can support his throwing almost with the full strength of his total motorium. The excursion of his final motion reaches an angle of 180°. It moves around the left standing leg as its central axis. The radius of this semi-circle exceeds by far the full length of the arm. The ball leaves the hand with considerable acceleration; it moves toward its goal in a long flat curve.

As this difference appears in early childhood, it cannot result from the development of the female breast. While the legendary Amazons had the right breast removed to allow the use of bow and spear,** it seems certain that Nausicaa and all her companions threw a ball just like our Bettys, and Marys and Susans. How can we explain the difference? The little girl has no more difficulty in keeping her equilibrium than the boy. It is true that she is weaker in muscle power; but, therefore, one should expect her to compensate for this lack of strength with added preparatory excursion. Instead, we find her avoiding the turn into lateral space. Maybe the masculine way of throwing corresponds to masculine "eccentricity," while the feminine attitude reveals a deep-seated restraint and an inclination to circle around one's own center. The difference, then, would belong to the area of expression; it would not be a difference of strength and build but of general psychological attitude in relation to the world and to space.

Thus far, lateral space has been discussed as if it were a unit, a single whole. Indeed, in many motions, we lift our arms symmetrically in surrounding space. However, even simultaneous movements need not be actually symmetrical. They appear symmetrical; they are not so in their intention. The arms can be stretched, the hands can point, in opposite directions, to the right

*Supination reaches its fullest and freest excursion with the horizontal abduction of the arm.

**Amazon means "*a-mazos*," without breast.

and to the left, at the same time. It is this contrast of directions which divides, articulates, and organizes lateral space, producing heteronymous, unequal parts. These can be reunited into an ordered whole where one half dominates the other. Spatial syntax cannot deviate from the general principle of taxis, which always demands a leading part to which the others are subordinated. The pair, right-left, is the true embodiment of unity, unfolding itself into opposites, or, if we begin with the opposites, the unity of a contrasting manifold. Both aspects belong together. Practical discrimination between, and co-ordination of, right and left precede their conceptual distinction. The amazing cases of autotopagnosia demonstrates to what an extent the organization of the body-scheme, as a manifold of directions, dominates recognition. In the Gerstmann syndrome, we find (a) finger-agnosia, (b) agraphia, and (c) acalculia, besides a right-left disturbance. Searching for a common denominator, we may find it in the loss of the capacity to organize opposite directions into one or to break the unit into opposite directions:

(a) The fingers of the hand repeat, so to speak, the right-left scheme for one side. Thumb and little finger point in opposite directions. This maximum of divergency (the direct opposition) sets the pattern for the intermediary positions.

(b) Writing, the spatial construction of letters, presupposes the same capacity to differentiate a scheme of varying directions and to establish them simultaneously in advance. The shape of the printed letters "b" and "d" illustrates this well.

(c) Numbers follow the same principle. The "2," the model of all numbers, is a unit of 1 plus 1, which, while they become united, remain separate: 1 and 1, or 2. The figure "one" is unity, the "two" a unit. It should therefore not be surprising that a child learns cardinal numbers a considerable time after mastering the ordinals. While he knows the series of numerals and enumerates the fingers of one hand, he is not able to sum them up into one unit of 5.—When he has reached the age when he can conceive of cardinal numbers, he is usually able to distinguish right and left.

c. *Neurophysiological Considerations*

The highest skills are contingent upon the unification of opposites, the co-ordination of relatively independent parts which are not bound together by symmetry, homology or synergy. A good

violinist in a fast spiccato-run co-ordinates the motions of his left hand and fingers with those of his right shoulder and arm. He has to combine into one pattern the action of distal muscles on one side with that of proximal ones on the other. His movements should be speedy, accurate, well-timed in tempo and rhythm, with the appropriate accentuation and phrasing. Playing from parts, his motions will be directed by seeing, and controlled by hearing. Here, "seeing" does not mean simply response to optical stimuli but comprehension of symbols, which express pitch, time proportions, dynamics; "hearing" is not merely the reception of acoustical stimuli but the anticipation and perception of sounds ordered in the various aspects of music. The necessary flexibility and versatility of motion of the upper limbs could not be accomplished without the compensatory movements of the trunk and leg: in other words, postural adjustments are continually necessary, and—perhaps not yet satisfied with all this—we may have to allow our artist to tap the basic meter with his foot, in this way setting one, mechanical, repetitive motion against all the variations. Finally, a concert recital will vigorously activate the autonomic system.

A performance like this, which involves the functions of the whole body, depends on the capacities of the nervous system for differentiation and integration. The highest forms of integration are proportionate to the available divisions of labor. Lateral space, the development of handedness, has brought about the highest forms of integration. While considerable knowledge has been accumulated relative to the co-operating parts, the organization of the whole is still inadequately understood. Neuroanatomy and neurophysiology have rarely envisaged the diverse mechanisms related to lateral space as one functional unit. In a short survey, one may enumerate its major components, their connections and ways of interaction.

Clinical experience, more than experimental observation, points to the inferior parietal lobule (gyrus supramarginalis and angularis) as the highest level of integration concerned here. It has been found involved in cases of right-left disturbances, finger-agnosia, agraphia, alexia, and constructive apraxia. As the highest level of co-ordination, it should be supplied with tactile impulses, both exteroceptive and proprioceptive, with acoustical and optical stimuli. If neighborhood relations mean anything, the in-

ferior parietal lobule may well be looked upon as a center, surrounded by and connected with the somesthetic areas of the postcentral gyrus, the optical areas of the occipital lobe, the receptive acoustical areas of the temporal lobe. It is not to be expected that any motor activity would start from here but that motions would be integrated, directed, and controlled from this area. Neighborhood relations also indicate that the inferior parietal lobule receives impulses from Brodmann's area 22, the acoustical adversive field, and from area 19, the occipital eye field, both areas serving adaptation of the body to events in lateral space. The superior parietal gyrus, Brodmann's area 7, has not yet been mentioned. Foerster[13] believes it to be an extrapyramidal field, more important than precentral area 6 with its subdivisions. Like areas 19 and 22, area 7 is also supposed to be in the service of motions related to lateral space. It closes the circle of the areas surrounding the inferior parietal lobule, which, therefore, is in close relation to an extrapyramidal field, initiating synergistic motions, and to the central gyri with their specified focal organization. If areas 39 and 40 function as a field of integration, bilateral representation of sensorium and motorium is indispensable. Commissural and association fibers, which, it seems, provide the main connections, could well serve this purpose. With the commissural connections of corresponding areas, a time differential may become effective through which the minor hemisphere may be subordinated to the dominant one.

Action in lateral space is to a great extent directed and controlled by vision. The oculomotor apparatus on all its levels from the periphery to the cortical eye fields, no less than the central optical pathways, is intimately related to motion in lateral space. The homonymous division of visual fields and retina which cuts through the macula is a most appropriate device for the control of lateral-space, perhaps even more so than for binocular frontal vision. In lower vertebrates, all retinal fibers cross. The reason may be, as Ramon y Cajal assumed, that in the absence of crossing, the optical projection would be completely incongruent with the visible objects. The new acquisition in mammals with overlapping visual fields is that the temporal fibers remain uncrossed. The twofold cortical representation of lateral eye movements demonstrates their great importance. The frontal eye field probably regulates

voluntary movements of the eyes; the occipital field controls lateral gaze induced by the sight of moving objects.

In the brain stem, the cortical nuclear fibers reach the pontine center of conjugated lateral gaze, which is also influenced by acoustical and vestibular stimuli. The final section of this pathway has not yet been fully established. The cortico-nuclear connections add conscious and voluntary control to the mesencephalic automatic regulations of gaze and posture. In this group, the Moro reflex has special significance for the present problem. The functions of the superior colliculi seem limited, in man, to the control of vertical movements; while the wide cortical eye fields chiefly direct rotation of the eyes to the contralateral side. Some tracts descending from the mid-brain and ending in the cervical cord integrate the functions of the accessorius, of neck and shoulder muscles, into the complex sensory motor system in control of lateral space. On the most peripheral level, the plexus formation seems to serve the co-ordination of proximal and distal muscles.

IV. Upright Posture and the Formation of the Human Head

Upright posture has lifted eye and ear from the ground. In the family of senses, smell has lost the right of the first-born. Seeing and hearing have assumed dominion. Now, these really function as senses of distance. In every species, eye and ear respond to stimuli from remote objects, but the interest of animals is limited to the proximate. Their attention is caught by that which is within the confines of reaching or approaching. The relation of sight and bite distinguishes the human face from those of lower animals. Animal jaws, snoot, trunk, beak—all of them organs acting in the direct contact of grasping and gripping—are placed in the "visor-line" of the eyes. With upright posture, with the development of the arm, the mouth is no longer needed for catching and carrying, for attacking and defending. It sinks down from the "visor-line" of the eyes, which now can be turned directly in a piercing, open look toward distant things and rest fully upon them, viewing them with the detached interest of wondering. Bite has become subordinated to sight.

Language expresses this relation in signifying the whole, the face, through its dominating part, the eyes, as in the English and French word "visage," in the German "*gesicht*," and in the Greek "*prosopon*." While the origin of the Latin word "*facies*"—and therefore, also, of the English noun "face"—is uncertain, the verb

"to face" re-assumes, in a remarkable twist, the original phenomenological meaning: to look at things straight ahead and to withstand their thrust. Eyes that lead jaws and fangs to the prey are always charmed and spellbound by nearness. To eyes looking straight forward, to the gaze of upright posture, things reveal themselves in their own nature. Sight penetrates depth; sight becomes insight.

Animals move in the direction of their digestive axis. Their bodies are expanded between mouth and anus as between an entrance and an exit, a beginning and an ending. The spatial orientation of the human body is different throughout. The mouth is still an inlet, but no longer a beginning, the anus an outlet, but no longer the tail end. Man in upright posture, his feet on the ground, his head uplifted, does not move in the line of his digestive axis; he moves in the direction of his vision. He is surrounded by a world-panorama, by a space divided into world-regions joined together in the totality of the universe. Around him, the horizons retreat in an evergrowing radius. Galaxy and diluvium, the infinite and the eternal, enter into the orbit of human interests.

The transformation of the animal jaws into the human mouth is an extensive remodeling: mandible, maxilla, teeth, are not the only parts recast. The mark of the jaws is brute force. The muscles which close the jaws, especially the masseter, are built for simple, powerful motions. Huge ridges and crests, which provide the chewing muscles with an origin appropriate to the development of power, encompass the skull of the gorilla. They disappear when the jaws are transformed into the mouth. The removal of these pinnacles permits the increase of the brain case, while at the same time the reduction of the mighty chewing muscles permits the development of the subtle mimic and phonetic muscles.

The transformation of jaws into the mouth is a prerequisite for the development of language, but only one of them. There are many other factors involved. In upright posture, the ear is no longer limited to the perception of noises—rustling, crackling, hissing, bellowing, roaring—as indicators of actual events, like warnings, threats, lures. The external ear loses its mobility. While the ear muscles are preserved, their function of adapting the ear to the actuality ceases. Detached from actuality, the ear can comprehend sounds in the sounds' own shape, in their musical or phonetic pattern. This capacity to separate the acoustical gestalt

from the acoustical material makes it possible to produce purposely, and to "re-produce" intentionally, sounds articulated according to a preconceived scheme.

Just as the speaker produces his words, articulated sounds, which function as symbols, as carriers of meanings, these should be received and understood by the listener in exactly the same way. The articulated sound, the phoneme, has an obligatory shape. The phoneme itself is a universal. The relation which connects speech and speaker can be held in abeyance that speech as such can be abstracted, written down, preserved and repeated. Speech, while connecting speaker and listener, keeps them at the same time at a distance. The most intimate conversation is bound to common, strict rules of phonetics, grammar and intended meanings. A spontaneous cry can never be wrong. The pronunciation of a word, or the production of the phoneme, is either right or wrong. The virtuosity acquired by the average person in expressing himself personally and individually in the general medium of language hides the true character of linguistic communication. It is rediscovered by reflection when disturbances of any kind interfere with the easy and prompt use of language, or when the immediateness of contact does not tolerate linguistic distance and the word dies in an angry cry, in tender babble, or in gloomy silence.

In conversation, we talk with one another about something. Conversation, therefore, demands distance in three directions: from the acoustical signs so that the phoneme can be perceived in its pure form; from things, so that they can be the object of common discourse; from the other person, so that speech can mediate between the speaker and listener. Upright posture produces such distances. It lifts us from the ground, puts us opposite to things, and confronts us with each other.

The sensory organs cannot change without a corresponding change in the central nervous system. No part could be altered alone. With upright posture, there is a transformation of sensorium and motorium, of periphery and center, of form and function. While upright posture permits the formation of the human skull,* and thereby of the human brain, the maintenance of upright posture demands the development of the human nervous system. Who can say what comes first and what comes last, what is cause and what is effect? All these alterations are related to upright posture as their basic theme. "In man, everything converges into the

*Note the introduction to the present paper, paragraphs 4 and 5.

form which he has now. In his history, everything is understandable through it, nothing without it."[14]

The phenomenon of upright posture should not be neglected in favor of the lying man, or the man on the couch. To do this, is to ignore facts which are obvious and undebatable, accessible without labyrinthine detours of interpretation, facts which exact consideration and permit proof and demonstration. It is true that sleep and rest, lying down and lying with someone, are essential functions; it is no less true that man is built for upright posture and gait, that upright posture, which is as original as any drive, determines his mode of being-in-the-world.

"The upright gait of man is the only natural one to him, nay, it is the organization for every performance of his species and his distinguishing character."[15] Human physique reveals human nature.

V. Summary

The wound cut by the Cartesian dichotomy of mind and body is covered over, but not yet healed, by mere reference to the mind-body unity. This term is useful only if it is filled with definite meaning and classified in its pre-suppositions as well as in its consequences. The idea of a mind-body unit demands first of all a revision of those traditional concepts of psychology which are shaped in accordance with a theory of a mind-body dichotomy. Experience can no longer be interpreted as a train, accumulation, or integration, of sensations, percepts, thoughts, ideas, volitions, occurring in the soul, the mind, the consciousness, or the unconscious for that matter. In experiencing, man finds himself always within the world, directed toward it, acting and suffering.

This study discusses the mind-body relation from one well-defined point of view. In analyzing upright posture, it points out in detail the correspondence between human physique and the basic traits of human experience and behavior. It also sets forth how some expressive attitudes of man are related to his basic orientation in the world as an upright creature.

Upright posture, which dominates human existence in its unity, makes us see that no right exists for claiming any kind of priority for the drives. The "Rationale" is as genuine a part of human nature as the "Animal."

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