1968

Formation and maintenance of body image

Joseph Tyson Tim Thomas
University of Nebraska Medical Center

THE FORMATION AND MAINTENANCE

OF

BODY IMAGE

Joseph Tyson Tim Thomas

Submitted in Partial Fulfillment for the Degree of
Doctor of Medicine

College of Medicine, University of Nebraska

January 30, 1968

Omaha, Nebraska

TABLE OF CONTENTS

The formation, maintenance, and alteration of body image is one of the most comprehensive and unifying topics in the field of Neurology. By understanding this topic one gains understanding into the very bases of the inner workings of the "mind" and its relationship through the physical body to the world beyond.

Its study entails the basis of memory and concept formation, that is the psychology, physiology, anatomy, and biochemistry of reception, evaluation, storage, and recall of information. A unified understanding as described above would allow one to recognize, understand, and thereby possibly treat alterations in body image caused by: Environmental, Biochemistral, Psychie, and Epileptic disturbances, as well as Chronic physical illness, Spinal cord injury, amputation, and unclassified disturbances in cortical function.

The overall concept of body image is being constantly formed throughout life. Various percepts and concepts are being built by evaluation of sensory stimuli which are then integrated and stored in the cortical "memory areas". For each individual, the resultant is unique and probably depends to a large extent on an individual's strongest currently active receptors as a function of the stage of development and his basic personality. The basic personality "set" probably serves as a major altering and selecting force prerequisite to the process of integration. These selective factors change relative positions of importance at different stages of growth.

A basic foundation for the structure of the body image has most likely been layed down in the fetal stage of development before the first sensory inputs are recorded. At this stage of development primary sensory inputs are recorded on a level of unawareness with a minimal amount of alteration or evaluation.

An overall concept of body image, once formed, is subjected to continuous change and alteration throughout life as various stimuli, percepts and concepts are fed into the system.

Pathology related to one of these processes for example is as follows: In physical disease that distorts body structure, the psychopathology of the body image distortion depends on the acceptance or recognition of the discrepancy between the structure and image which thwarts the anticipated adult social adaptation which is now not possible. Failure to comprehend the nature of the disease process often leads to paranoid symptoms. Coincident symptoms depend on the nature of the disease process.

It is interesting to note that severe athetosis never develops in adults - i.e. in a trained brain. In infants with brain damage the movements may possibly be encouraged by faulty information reaching the brain body image mechanism.

The magnitude of the overall problem is better appreciated when one considers the former text in light of the following multiple and varied input systems:

1. Proprioceptive receptors
2. Pain, temperature, pressure

3. Visual image

4. Mobility of body part

5. Inputs of space and time

Soon after birth, the neonate has his first experience with "outside" stimuli. Here the first exposure to the concepts of self and non-self are experienced or appreciated. Stimuli from self and non-self must be stored and compared with each other. The inputs most strongly and consistently perceived are those centered around feeding e.g. mouth, head, hands, breast, etc. As the sum total of stimuli becomes less consistant, new percepts begin to form. It is from the many qualities of sensation thus far perceived that form and shape take their earliest beginnings.

There is a correlation between disturbances of the body image and the numerous physical and scholastic problems often encountered in children with cortical disorders when they are called upon to make an effort demanding: 1. exact localization, 2. coordination, 3. pattern integration. Poor knowledge of children's bodies shows itself in an inability to copy the position of different body segments and a tendency for the muscles of a limb to act as a whole and not in groups. Orientation in space is equally affected in various degrees.

The semantics involved in discussing body image is by no means trivial. In this author's review of the literature, there is little consistancy in either the percission of the terms used

or the referants to which they pertain. This section is designed to accomplish the following goals:

1. To present a few representative statements concerning body image, body schema, and perceived body, and to demonstrate the lack of uniformity of definition and overlaping meanings used as referents for these words.
2. To present definitions of words which are well defined but which are not in general usage among non-neuro science readers.
3. Define the terms body image, body schema, perceived body, physical body, and body concept as they will be used in this paper.
4. To present a point of view concerning the nature of the relationship between the sensa, perception, and the physical world.

DEFINITIONS

The following definitions illustrate the ambiguity found in the terms involving body image.

1. The body image is our concept of the shape, the size and the mass of our body and its parts. It allows us to evaluate the space which our body occupies, and thus enables us to move about freely in our environment. The conventional body image usually is not confined to the physical body alone; it normally

includes also the clothes and other objects of daily use, in particular, those connected with and symbolizing professions, clothes and status symbols. e.g. Socially enlarged body image... the experienced driver feels and is always aware of the room he requires for maneuvering his own car. LUKIANOWICZ

2. Body image (body schema; image de soi) refers to the mental idea which an individual possesses as to his own body and its physical and aesthetic attributes. CRITCHLEY

3. The final product of the tests for the appreciation of posture or passive movement rises into consciousness as a measured postural change. For this combined standard against which all subsequent changes or posture are measured before they enter consciousness, they proposed the word Schema. By means of perpetual alterations in position we are always building up a postural modes of ourselves which constantly changes. Every new posture or movement is recorded on this plastic schema. Body schema - a purely physiological mechanism operating outside consciousness and related to the sensory cortex. HEAD and HOLMES

4. Body image is built from all sensory and psychic experiences and is in constant integration in the CNS into a gestalt. This may become modified or distorted by lesions in the CNS or by pathologic conditions in personality. (Gestalt - form, shape, the configuration of separate units into a pattern of shape which by itself seems to function as a unit. The objects

of mind, as immediately presented to direct experience, come as complete unanalyzable wholes or forms which cannot be split up into parts.) SCHILDER

5. Body image is: a. predetermined by an integrated pattern biologically established by laws of growth and constitutionally fixed. b. Socially recognized and accepted by contact and identification with other physical personalities. c. Constantly modified and reconstructed by the actively integrating nervous system that utilizes all the new experiences of the sensations and the psyche. d. Immediately modified by the body movements and positions. BENDER

6. Body schema - forces within the individual which determine what the subjects reconstruction will be. It is the form in which the individual preserves material. Body schema represents a storehouse in which content is retained while it is being reorganized. It is in a way approximating the notion of the apperceptive mass. BARTLETT

7. Body image - That composite picutre which the individual has of his own body. This picture is a multiply determined continously developing and therefore constantly changing, condensed representation of the individual's current and past experiences of his own body. It has both conscious and unconscious aspects; it is under certain conditions, extensible into space; it is largely a function of ego and through the ego it not

only exerts a profound influence on the individual's behavior but on the perception of his environment as well. GATH AND GLUD

The following terms seem to this author to be the most useful in discussing image especially with regard to its formation and alteration. The following definitions, unless otherwise stated, are paraphrased from writings of J. R. Smythies.

1. Body image describes a visual image, mental or memory "image" of a human body, one's own or someone elses not clearly extended in space. It is not a perceived unity made from outside sensory inputs e.g. tactile, thermal, pain, proprioceptive, position sense.

2. Perceived body - This is the spatially extended field present in direct experience whose head surrounds the observing self and the rest of which is extended in perceptual space below the observing self. It is comprised of the totality of all somatic sense available to inspection in any one spacious present. It has its own distances, and these are also present immediately in experience and belongs to the same observational and spatial system as do the distances of the visual field. If the spatial visual field of direct experience is a certain brain state, then so is the spatial perceived body of direct experience. If the visual field of direct experience lies beyond any physiology of the brain, then so would the perceived body of direct experience. It seems reasonable that the perceived body is not the body image; it is the three dimensional object given inside central

consciousness. It is not clearly extended in space. It possesses a spatial relationship with the actual physical body. The spatial interrelations of parts of the perceived body reproduce those of the physical body BECAUSE there is a system of signaling mechanisms between the two. When this signaling mechanism goes wrong, as in certain brain lesions, mescaline intoxication and in Schizophrenia, the behavior of the perceived body may be quite different from that of the physical body, but follows exactly the state of the "body image in the brain."

The perceived body and the extended visual field are extended structures in central consciousness. Perceptual space is not precisely the same entity as physical space.

The perceived body is made up of actual physical inputs. It is made up of all the sensa except the visual. From this given unity we may abstract by our attention at any instant an individual sensum - but the unity is given. Perceived body is coincident in space with the body image. It is directly experienced inside the central consciousness. The perceived body is the somatic sensory field and should be regarded as being coincident in space with the neurone activity in the brain that makes up the BODY IMAGE in THE BRAIN of the physical body.

Body concept describes the constellation of memories and beliefs which we each possess concerning our own physical bodies. It is not always accurate as it is affected by wishes, pride, etc. It is subject to natural change as experience unfolds. Body concept is a conceptual constellation and depends largely upon the proper function of relevant memory mechanisms. According to Critchley, of the various factors which combine to determine the conception of the body, vision is by far the most important, for it affords knowledge as to the appearance of one's own body and permits comparison with that of others. The body image of those born without sight must therefore be quite unusual.

4. Phantom limb - A special disorder in perception. In this disorder the perceived body may possess a leg which the physical body does not. Yet the person knows he has only one physical leg and his body concept is unaffected though the phantom existance of a limb is puzzling.

5. Body schema - A function of a subconscious mechanism outside central consciousness. Its presence is inferred - not witnessed or experienced. The great system of nerve mechanisms responsible for posture, automatic movements and the coordination of voluntary movement (the activity of which goes on below the "threshold of consciousness" or outside perceptual space, without our knowing any more about it than that our actions are carried out efficiently) also possesses its totality of information about

the state of the physical body and its environment. A man does not know anything about the present state of his physical body except insofar as signals from it alter the state of the body-image in his brain. The terms body schema or body image or body concept have two meanings by general usage. They are employed as explanatory constructs in a restricted sense, to account for certain clinical phenomena such as the phantom limb, impaired position sense or spot localization, finger agnosia, or neglect of one side of the body. They also are used as convenient descriptive terms to refer to the totality of behavioral events having to do with the body.

6. Postural model of the body - This term applies in the first place to the sensa derived from the proprioceptive sensory system and that the sensa derived from the skin sensibility should also be included to describe the totality of the unified system in experience that is the perceived body.

7. Sense-Fields of direct experience is composed of events taking place at one end of an extensive signaling mechanism, the other end of which is directed at the physical world.

8. The Mind (in the sense of conscious mind) - the "self" and all that is within the reach of its direct and immediate experience. The mind is in extended space. The mind is this presented world of direct experience is a spatial world. It is the "world around one" is the private world of each individual's everyday experience located literally inside, spatio-temporally

inside, what is generally known as central consciousness.

9. "Consciousness" - The observing self and the spatially extended world of its immediate experience, its sense, thought, and imagery fields. It is also in a behaviourist and clinical reference to the degree to which we can communicate with the subject.

10. Realism states that there exists a spatio-temporal world of some kind independent of our minds and that we can know something about it.

11. Naive realism - "a simplifying and biologically useful assumption that the relation between sensa and material objects is nothing more complicated than the relation being identical with parts of the surface of or something of the sort." PRICE

12. Physiological realism - "All sensa are identical with parts of the brain and not with the surfaces of external physical objects."

"When, on a common-sense basis, people talk of the gulf between mind and matter, what they really have in mind is the gulf between a visual or tactual percept and a "thought" - e.g. a memory, a pleasure, etc. But this is a division within the mental world; the percept is as mental as the thought." BERTRAND RUSSELL

13. Projection - NO EXPLANATION HAS EVER BEEN GIVEN AS TO HOW THIS ALLEGED "PROJECTION" OF AN APPROPRIATE SENSUM, TO THE

SITE AT WHICH THE ORIGINAL STIMULUS WAS APPLIED OR THAT FROM WHICH THE ORIGINAL LIGHT OR SOUND WAVE STARTED, IS AFFECTED NOR OF THE PHYSIOLOGICAL PROCESSES INVOLVED.

14. Stimulus - this is a simple afferent input: a flash or light, a tone, a stick of a pin, etc.

15. Percept - based on the occurrence of a temporal and/or spatial arrangement of a series of stimuli, an organization (presumable with an anatomico-physiological and perhaps biochemical basis) is attained. A percept is a "series" of meaningful sensory experiences. One already existing percept undoubtedly influences the formation of others.

16. Concept - one's conscious or unconscious "idea" which has arisen because of the association of a series of percepts which are influenced in their formation by already existing concepts; this again presumably has an anatomico-physiologico-biochemical basis.

THE ORIGIN OF FORM PERCEPTION

Man's ability to perceive the form of objects is innate. It is affected by maturation and learning as demonstrated by the work of R. L. Fautz. He designed a group of experiments which sought to find out how and when infants are able to perceive form in order to confer order and meaning on their environment. The development of this ability is directly related to the ability

of the infants to begin storing percepts with which to build a body image and body schema.

Beginning between ages one and fifteen weeks infants have shown definite preferences for stripes, bull's eyes and checkerboard squares vs crosses, circles, and triangles. This preference changes at age two months. These observations imply two things. One, that there is an inately existing ability for form perception in very young infants and, two, that this form perception is modified by either physiological growth and/or learning.

As the infants developed in time, their acuity of perception increased, demonstrating definite physiological change in perceptual ability. That there is an organized sequential process involved is shown by the effect which learning may have on the development of perception. This is seen when animals are deprived of patterned visual stimuli for a period of time soon after birth. These animals show a definite impairment of visual performance. The longer the period of deprivation, the poorer the perceptual ability and the more time required to achieve normal responses.

A complex interplay of innate ability, maturation, and learning is especially active during the early years of development. The importance of the interaction of these facets of development is clearly seen when one is aware of critical ages at which the development of given visual responses are fused together with mental and motor capacities. At these key ages the organism will either show the response without experience or

will learn it readily. If the response is not filed in the memory by the time the critical age is reached, due to lack of visual stimuli, further development proceeds abnormally without the visual linking component. If the stimuli are present later in the course of development, "being out of proper 'set'", much more training and experience is needed to integrate it into the pattern already laid down so that appropriate responses will be forthcoming. This phase of development is clearly implicated in developmental pathology of the body image as will be discussed in a later section. During the entire procedure one can see an active selection process being applied to sort out meaningful and/or appropriate stimuli as well as to impose order upon the incoming recorded stimuli. This selection process acts with bias to try to insure the future usefulness of the stimuli presented. It is worthy of note that the objects perceived most readily by youngest infants are those which had the types of form that would later aid in object recognition, social responsiveness, and spatial orientation, thus providing a foundation for the accumulation of/and ability to use, knowledge through experience.

PERCEPT INTEGRATION

Once the perception of form and structural objects has become established, the next problems are associated with organizing these percepts into distinct dimensional unities. In

other words, to begin forming relationships, patterns, and associations between and among simple percepts. When the number of perceived stimuli begins to accumulate to a number large enough to allow repetition of stimuli, the organism is in a position in which it must increasingly act to select those stimuli which are more or less useful or meaningful to it. Thus at this point in the young organism's development the environment begins to play a new role in supplying sensory inputs - that is in giving stimuli which can have value responses associated with them.

Bennett presents a view of development of body concept which uses the above stated ideas. He states that there are integral and non-integral parts of body concept. There is a pre-schematic stage in which form is established. This is followed by a schematic stage in which concepts are formed. Then comes the final stage in which these concepts are evaluated as to their validity in representing realistically the body concept. Determinants of the conceptual stage are perception, motivation, language behavior and pre-developed body schema. Primary perceptions of touch, movement, pain, and vision are of major importance in shaping or putting the fine touches on the body concept.

To study the interplay between the stimuli perceived and the degree to which they are accepted and utilized by the

learning infant, Bower and his group used the following method: Some response from the organism's store of responses is selected and a value or a "reinforcing" stimuli is placed on the response chosen. This "reinforcing" stimuli is contingent on the occurrence of that response. If reinforcement is given only in the presence of a certain stimulus, the response soon occurs only in the presence of that rewarded or "conditioned" stimulus. Once these patterns have been established, it is then possible to introduce new stimuli to be discriminated from the conditioned stimuli. It was incidentally noted that any change in surroundings seems to reinforce an infant's responses.

Using the techniques described above, it was established that infants' responses to incoming stimuli are affected by real size of objects and real distance of objects from the observer's eyes. The discriminative portions of stimuli used by these infants are binocular parallax and motion parallax which are available only to a mobile organism viewing a three-dimensional array of objects. The ability to use these stimuli as "cues" is based upon some innate abilities which are modified and elaborated by experience and learning.

The construction of body schema depends on the power to perceive spatial relationships between objects or parts which make up the body and also objects external to it. The ability to construct a scheme of things outside the body depends on the

power to perceive spatial relations between objects which lie outside the body and objects which compose it. The scheme of the body and the scheme of the world outside are interrelated, not only in the part they play in orientation but also anatomically, the nodal point being in the parietal lobe.

It was demonstrated that infants have a lower processing capacity than adults and that their perceptual systems can handle simultaneously only a fraction of the information they register. This capacity increases with experience so that more than one variable may be processed simultaneously. Implicit in this interaction of sequential growth processes is the foundation of, and mechanism by which, the body image and body schema are formed. It is an often-observed phenomenon that infants will initially misreach, even though it has been demonstrated that they can perceive and evaluate depth. It seems reasonable that the growing infant misreaches because he does not know how long his growing arm is i.e. his body schema or the ability to use the body schema, is yet underdeveloped.

In summation then, infants can register most of the information an adult can register, but they cannot process or evaluate the same amount an adult can. Through maturation of learning and experience they develop requisite volume information-processing capacity. The visual world of the infant may be characterized as overwhelming, but not a meaningless disorientation

of visual blobs.

The infant's reaction to his perceived and conceptualized environment is built up and developed in a step-by-step fashion in much the same manner as his ability to perceive and understand his surroundings. The close similarity of the two processes is shown by the following diagram.

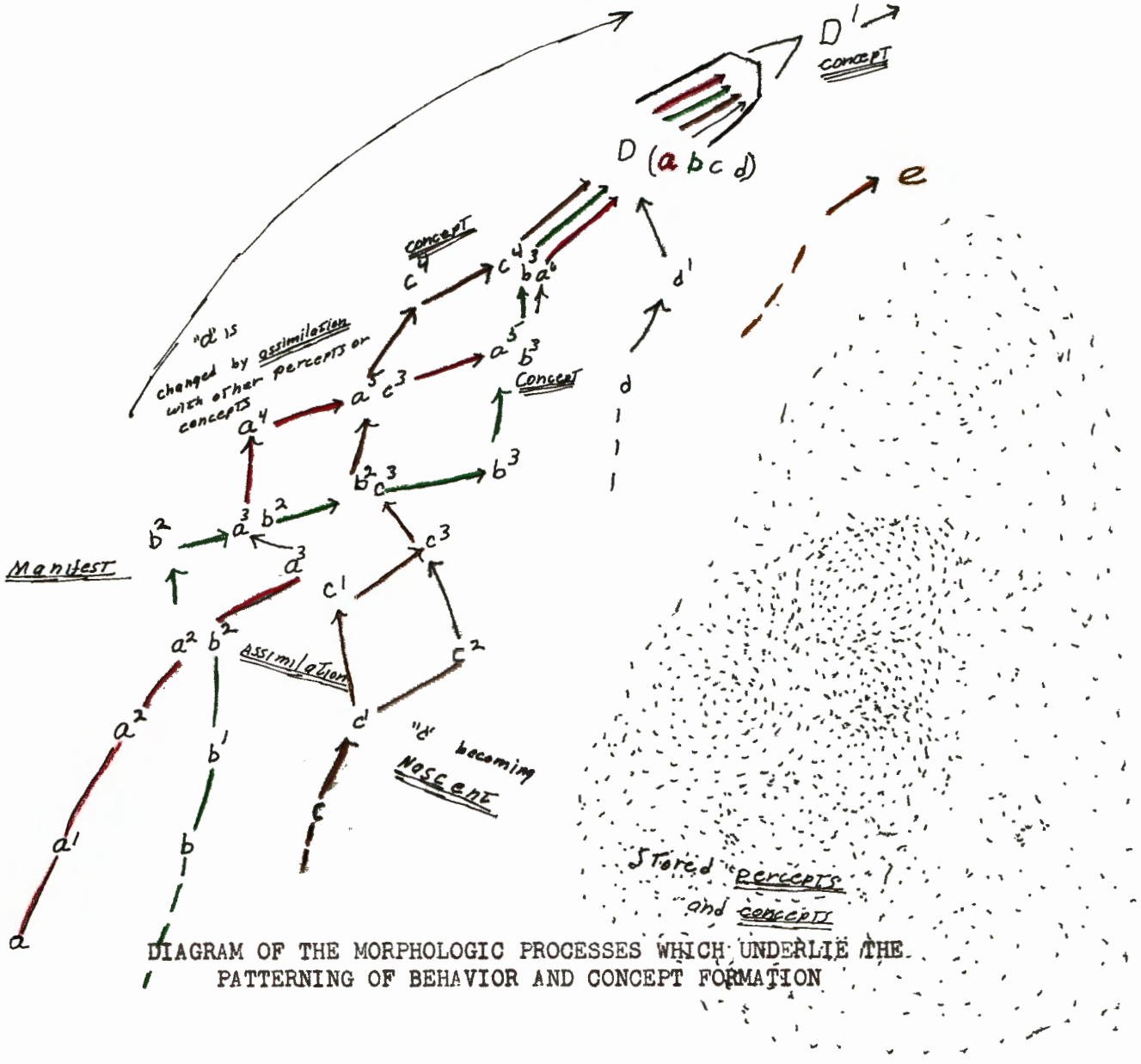


DIAGRAM OF THE MORPHOLOGIC PROCESSES WHICH UNDERLIE THE PATTERNING OF BEHAVIOR AND CONCEPT FORMATION

The shaded area represents the previously stated percepts and concepts.

Broken lines indicate latency, the concept being that the anlage of a concept or response resides in the corpus of behavior and concept formation and is carried along in a potential state until the moment of nascency when a trait, concept, or response begins to develop.

Solid lines within the shaded area represent dormant behavior not ordinarily manifest but present in reserve.

The behavior margin of the shaded area represents overt, manifest behavior.

A concept or trait, whether dormant or manifest, typically advances through several changes in maturation:

1. First it is nascent - simple and discrete in character, a veriest beginning.

2. It becomes assimilative - when two or more percepts combine, diverge, interweave.

3. Coordinatint - a behavior pattern of complexity emerges and finally

4. Synergic - (capital letter in the diagram) when all the essential components have been woven together into one strand fully incorporated into a new concept or percept.

Each event is like a timing cue for another event.

Visualized in this way the morphology of behavior and concept formation becomes dynamic. Apparent inconsistencies, reversions, displacements, reappearances, and old patterns in revised forms all become understandable. The growth complex takes on perspective.

INTEGRATION WITH MOTOR FUNCTION

A major factor in the formation of concepts concerning the world and an individual organism's knowledge of his relationship to it is the formation of feedback loops for intermodality integration of new percepts and already established concepts. The mechanism described below is one of the feedback loops that is of utmost importance in the formation of body schema, perceived body and body image. It is worth reiterating here that motor impulses give the final shape to the body image. The utilization of these constructs to allow the organism to maneuver successfully thereby accomplishing planned physical tasks.

This material directly relates to pathological conditions of body image. According to Bychowski the development of the body image is not static, even in adults, since bodily skills acquired modify body image integration. The varied phenomena of regression and disintegration (in the psychoses) are related to the continuous evolution of the body image and the fact that it is represented in brain areas and is affected by peripheral stimulation.

Just as specified cortical defects lead to specific body scheme disturbances, functional distortions of body image have great importance in determining the content of pathologic mental conditions.

Correct perception of space and accurate visually guided action in space are, in the long run, not dependent on unique and permanently fixed optical properties of the paths taken by light rays traveling from object to eye. How can the visual control of spatially coordinated action be stable under normal circumstances and yet sufficiently modifiable to allow recovery from transformation? Recovery takes time and renewed contact with the environment. Adaptation must result from information drawn from this contact with the environment. If the end product of adaptation is recovery of a state of stability of perception, the information on which that recovery is based must be as reliable and unvarying as its end product. The mechanism of perceptual adaptation involves much more than just a change in the way the sensory parts of the CNS process data from eyes and ears. The muscles and motor parts of the nervous system are actively involved in the adaptation. The relation between sensory and motor activities in the adaptive process is illustrated by the observation that humans who undergo sensory or motor deprivation through prolonged isolation or immobilization, perform less well than they normally do on perceptual and motor

tasks. A single mechanism for recovery and adaptation involves three processes:

1. The development of normal sensory-motor control in the young.

2. The maintenance of that control once it has developed.

3. The adaptation to changes or apparent changes in the data reported by the senses of sight and hearing.

Without a mechanism of perceptual and motor integration and feedback which allows the adjustment of the central nervous system to the growth of the body, the establishment of an accurate body schema would require an enormous amount of genetically coded information. Adjustments must be made for the increasing growth of bone and muscles requiring a gradual modification of the efferent or output signals necessary to accomplish a particular movement. Clear evidence for adaptation, rearrangement, and dependence of the young on environmental contact in developing coordination has been found in primates. A key to the operation of this mechanism is the availability of "reafference", which is a neural excitation following sensory stimulation that is systematically dependent on movements initiated by the sensing animal. Its counterpart is "exafference", which is the result of stimulation that is independent of self-produced movement.

It was demonstrated by R. Held and his group that move-

ment alone, in the absence of the opportunity for recognition of error, does not suffice to produce adaptation; it must be self-produced movement. This self-produced movement with its contingent reafferent stimulation is the critical factor in adapting for or compensating for displaced visual images. Misreaching caused by the displacement of visual images by prisms is progressively reduced during repeated efforts. On removal of the prisms the subject who has succeeded in adapting to this displacement will at first misreach in the opposite direction. This observation is no more attributed to error recognition and correction than is the development of an infant's coordination who has, initially, no sense of spatial relation between efforts to move his hand and then visual consequences - yet this is acquired early. Compensation for rearrangement consists of the acquisition of a new mode of coordination that is objectively accurate for the condition of rearrangement but that coexists along with the older and more habitual modes, therefore, a gradual and progressive course of adaptation is found and must be considered the result of slow shift by the subject from the older direction of localization to the newer direction. The close correlation between signals from the motor nervous system, producing active physical movement, and the consequent sensory feedback play an essential role in adaptation. This is demonstrated by experiments varying the environmental inputs and measuring the

rate of adaptation with and without allowance of accompanying motor activity. The closeness of the association results from the fact that the feedback signals are casually related to movement and in a stable environment there is a unique feedback signal for any particular movement. The correlation is reduced by environmental instability. The presence either of objects that themselves move or of passive movements of the body that are produced by external forces act to decrease the accuracy of the responses. Under these conditions more than one feedback signal may accompany any particular movement. It may be noted that self-produced body movement is utilized in this manner for the formation of accurate body schema and to maintain its relation to the external environment. This can be done only by organisms who can recognize and evaluate output signals relative to their own musculature activity, and only these organisms who can perform such movements can detect and factor out the decorrelating effects of both moving objects and externally imposed body movement.

ATTENTION AND AROUSAL

At this point appropriate questions would be: What turns the mechanisms on which are responsible for the formation and utilization of body image and concept? What moderates or governs (i.e. increases or decreases the quantitative activity) of these processes? The answer to these questions can be spoken to be a

discussion of conflict and arousal stimuli. Berlyne and his group have demonstrated that arousal involves a heightening of attentiveness that motivates individuals to act and learn. They have also demonstrated that the inner conflicts caused by ambiguous, surprising, or complex stimuli help to cause or increase arousal in an individual. An extremely strange phenomenon, especially if it consists of a mixture of familiar and unfamiliar elements can induce fear and flight. Moderate amounts of unpredicatable change are sought out and welcomed. Attention and curiosity are "turned on" or increased by novel stimuli vs familiar stimuli which attract less inspection. More complex or more incongruous pictures attract more sustained interest than more common pictures. These stimuli have one thing in common, they all give rise to conflict. These stimuli from the environment do not bring one predominant reaction immediately. They initiate discordant and mutually interfering processes in the CNS as demonstrated by EEG. Perceptual and thought processes impose order on the percepts from the external world by classifying, interrelating, interpreting, and organizing the information that comes in through sense organs thus preventing a chaotic mêlée of separate responses, each prevented by its competitors from reaching fruition; therefore making organized and relevant behavior responses possible.

If the incoming information is not enough to complete a concept, further information may be sought through exploratory behavior - depending on the level of motivation caused by the conflict.

At this point, a great unknown quantity is making itself manifest by its presense and development. The Goddess of fascination and frustrations - "Curiosity". Curiosity and other motivational effects of conflict act to produce a state of "Disequilibrium" arising from inconsistency and lack of certainty in judgment. This in turn, is the main force which maintains a state of progression toward logical ways of organizing perceptions and later construction of thoughts. This is manifest in three ways:

1. Activation of the organism as a whole thus making responses more vigorous and causing an intensification of trial-and-error behavior.
2. It directs or guides the motivated organism in a direction that will resolve the situation producing the state of disequilibrium (e.g. activation).
3. It enhances appropriate responses by making the organism particularly sensitive to appropriate reinforcing events.

It has been demonstrated that the level of "activation" i.e. sorting and directive influence, fluctuates from moment to moment and is manifested by changes in almost every system of the body. The reticular formation of the brainstem is thought to play a major role in the function of this system as it interacts with incoming stimuli as well as other brain structures, especially the

hypothalmus and cerebral cortex. It should also be noted that when arousal becomes excessive in magnitude, performance is impaired. This liability of performance to arousal and/or activation is a major function of developmental age and maturity.

In studying localized anatomic and biochemical pathology, it must be remembered different centers in the brainstem control different types of activation as a function of their sensitivity to particular stimuli or patterns of stimuli. These localized brainstem centers are also influenced by reinforcement of responses previously found "successful" in reacting to these similar or stimuli patterns.

There is a close relation between the level and type of activation responses and the exploratory activities produced by complex, ambiguous or "novel" stimuli as exemplified by the facets of an orientation reaction. The level of activation is also closely related to conflict and collative stimuli. EEG responses to stimuli of high level complexity or incongruous stimuli show significantly longer-lasting desynchronizations than lower-level stimuli of these types. This fact is fundamental information when forming hypothesis of biochemical and physiologic mechanisms of brain function.

Once the anatomic and biochemical systems have been established, the organism is now capable of receiving a steady inflow of sensory material, storing it, forming percepts and

concepts. The concepts which are formed are constantly being subjected to alteration both on a conscious and unconscious level.

To summarize then: Thought products in general are the result of the organization of previous perceptual inpressions. These impressions are provided either by original perceptual content (primary perception) or by relationship extracted from other perceptual contents (secondary perception) and they are moulded by motivational factors which gather together those experiences which are relevant as will be related later.

PHYSIOLOGICAL MECHANISM

1. Memory The next step in discussing the formation of body concepts is a discussion of Memory. This is most relevant to the terms. It has been demonstrated that there are two memory mechanisms, one for short term memory and one for long term memory. L. Peterson and his group describe an activity mechanism in which a single experience gives rise to activity among neurons. This activity soon dies out if the experience is not repeated. ~~This~~ will be further discussed on a biochemical level later in this paper. A second mechanism is discussed in which actual permanent structural change in neuronal components serves to record long term memory. This second mechanism is activated with repetitions of an experience with time lapse between stimuli. The two mechanisms are thought to be related in that the activity

mechanism presumably assists in the production of the structural change.

Dr. Hebb and his group at McGill University have inferred that something more than transient neural activity results from a single presentation and test by the following experiments. If a single presentation caused nothing but transient neural activity, succeeding sequences would obliterate the activity, thus the memory. It was found, however, that occasional repetition of a given sequence amid several others produced improvement in recall. Therefore, even a single presentation must have caused some type of structural change.

In experiments in which delays were introduced between presentation and recall Peterson demonstrated that rapid forgetting occurs after a single presentation. He proposed that this forgetting is caused by spontaneous decay as well as competition or interference from similar messages. In short term memory the effect of competing messages is so strong that it usually obscures any evidence of decay thus serving as the prime source of forgetting. His experiments have demonstrated that there must be two definite and distinct recording mechanisms operating to record short term vs long term memory. One storage system which dominates recall from stimuli presentations without subsequent reinforcement or exposure to the same stimuli, and another storage system operating to store information presented

with spaced intervals of presentation and implying that this long term effect of the first presentation has time to consolidate and become more "fixed" during the spacing interval.

Time is a major factor in the relation between short term and long term memory along with the number of intervening events which occur between successive presentations. This is demonstrated by a declining recall followed by increasing recall. It is entirely possible that the act of recall itself is a disrupting process which interfers with storage, therefore, the passage of time could allow some consolidation of information to take place so that the memory is less easily disrupted.

Retrograde amnesia has been studied to learn more about the problem of consolidation or long term memory. An example is Korsako's syndrome in which recent memories are lost while old memories are preserved. The loss of memory may gradually extend backward to obliterate the memory of progressively more distant episodes. This type of memory loss may occur in head injury, CCT, cerebral anoxia, CO poisoning, etc. This implies a continuum of long term memory. It is of note that if loss of memory function occurs, the least recent memories return first regardless of the importance of the memory to the organism. There appear to be "degrees of magnitude" of memory change (storage) which may vary a function of time of storage e.g. some process is set in motion by the act of registration which increases with time. In an

amnesic event some biochemical abnormality prevents the "memory change" from carrying out its usual function, thus negating the effect of the "memory change" but leaving the physical "memory change" intact.

It has been demonstrated that stimulants applied to the organism both before and within a short time after a learning trial significantly improve the short term memory recall where disruptive stimuli applied immediately after a learning trial impairs recall, thus adding further evidence for a process of consolidation of "fixing" which occurs immediately after a learning trial. These experiments would speak to short term memory storage and recall systems. Their effect on the mechanism for long term memory and recall cannot be inferred from the data reported.

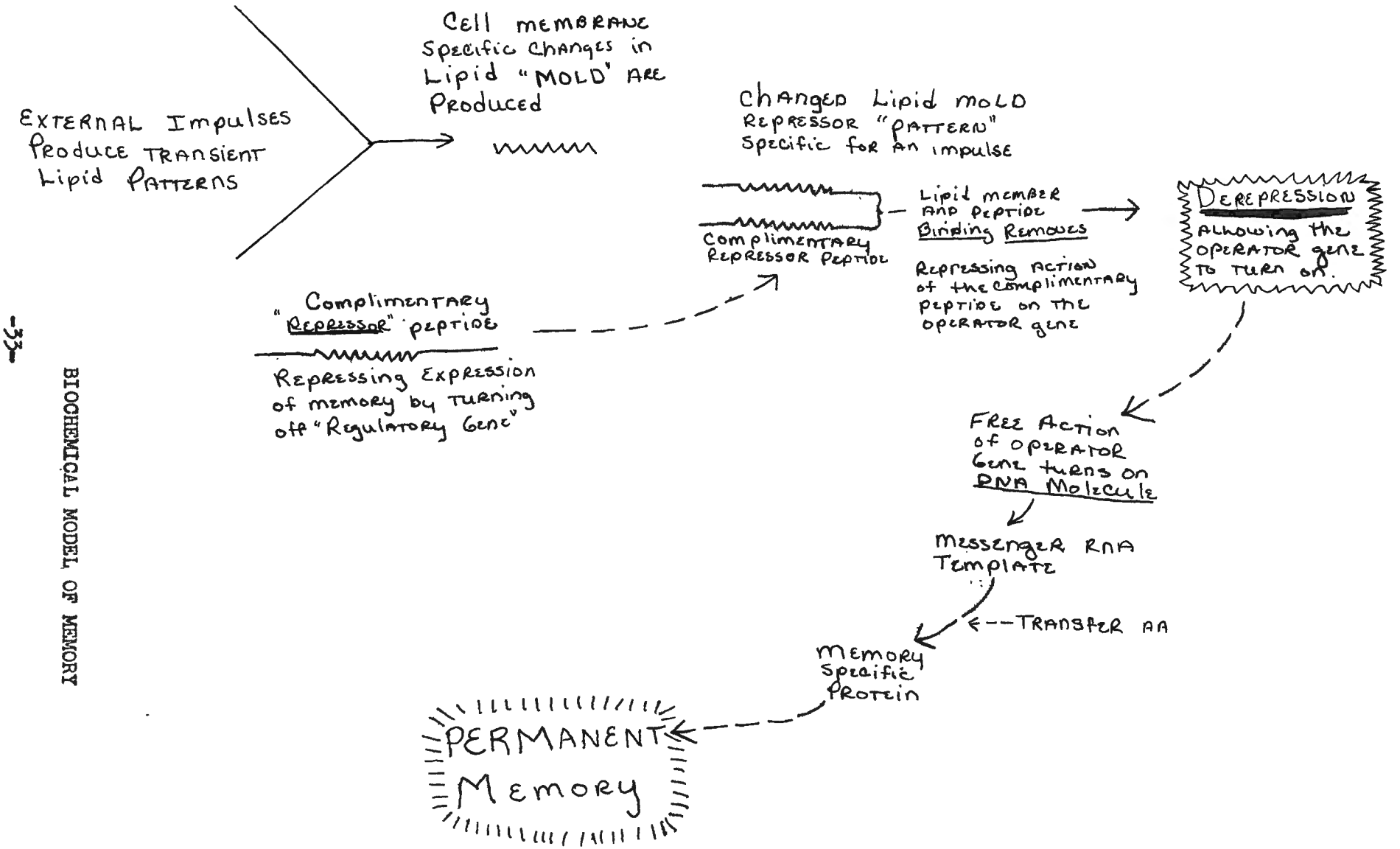
Evidence for the type of function involved in long term memory is presented by Merrell who demonstrated that mirror foci would be set up in corresponding areas of the opposite hemisphere in epileptics. After a given period of time these secondary regions become permanent and will discharge independently even though the primary focus has been obliterated. This implies permanent learning has taken place. A chemical alteration at the site of the secondary focus was shown to consist of abnormally high concentrations of RNA in these cells. After activity of these cells a lesser amount of RNA is found inside these cells

surrounding the neurons. Glambos feels that these glia perform the function of organizing and programing neuron activity. A change in the excitability of a cell would not be permanent unless there was some change in the genetic information in the cell.

The study of retrograde amnesia has also led to a proposed mechanism for short term memory by Dison. He proposes memory and thought involve permanent patterns impressed on the macromolecular fabric of the neurone.

The membranes at the surface of the cell and of its organelles are composed of bimolecular films of orientated lipids covered on either side by adherent films of protein. In the neurone this pattern of orientated lipid is enriched and variegated by the presence of complex gangliosides in substantial amounts in addition to the membrane lipids of other cells. This mosaic of membrane lipids, along with specifically aligned peptide patterns in the adherent protein, may be directly complementary to various patterns of electrical activity. External impulses may thus generate transient lipid patterns which can in turn re-create patterns of electrical activity. But the internal surface of the lipid membrane patterns is also in contact with the continuously changing peptide patterns of the cell. When a lipid pattern is generated, which is complementary to any specific peptide pattern already present in the cell, then this peptide pattern may become specifically aligned and adsorbed on its reciprocal lipid pattern.

BIOCHEMICAL MODEL OF MEMORY



Probably the lipid patterns are continuously remoulded by active peptide patterns in the cell cytoplasm. Thus the patterns of repetitive electrical activity derive their permanence from the underlying peptide patterns in the neurone.

These patterns are themselves basically determined by heredity and each must have its own counterpart among the coding sequences present in the nuclear genome. Many potential peptide patterns or proteins represented by these genomic codes are believed to be repressed by the action of regulator genes. Some of the effectors which bring about this repression may be uncommitted or unutilised protein molecules which, in very small amount, can suppress the formation by the genome of the specific messenger R.N.A. individually determining their own synthesis. As soon as a specific peptide pattern is removed by alignment and specific adsorption on a complementary lipid membrane pattern, then its repressor effect on the nucleus may be abolished so that its own synthesis by formation and release of specific messenger R.N.A. is evoked and selected. Thus participation of an individual pep tide pattern in alignment with a membrane lipid may evoke the synthesis of this identical peptide pattern. When this newly fabricated peptide pattern reaches the cell membrane, it may later promote rearrangement of lipid molecules so that they align specifically into the complementary lipid membrane pattern and so regenerate the original electrical patterns.

Thus, if a membrane lipid pattern, originally moulded by an external impression, can find a complementary counterpart (even in minute amount) among the inherited potential peptide patterns of the cell, then this peptide pattern is specifically removed and its fabrication and that of the lipid membrane pattern are both stimulated: these patterns then become established as functional as opposed to potential components of the membrane mosaic. In this manner environmental experiences become crystallised into thought and memory, provided that they can evoke the fabrication of corresponding inherited peptide patterns by genomic activation through this type of resonance.

Work done using chronically implanted electrodes suggests that memory is a set of processes which define a state rather than a "bit" in a place. It is apparent that descrete loci participate in memory phenomena and when lesions occur which abolish these loci, the process is altered, the state is not abolished. It has been shown that after massive bilateral lesions of the reticular formation EEG and behavioral arousal can be demonstrated. However, the level of intensity with which stimuli are required to be applied is altered.

Consolidation of information occurs immediately after a stimulus is presented to the memory mechanism for storage. Generalized desynchronization of EEGs after presentation of stimuli are interpreted as demonstrating this consolidation.

Underneath this apparent chaotic activity the processes which produce consolidation are probably proceeding at maximum rate. An analogy would be the so-called "resting stage" of the cell in which metabolic activity and organization processes are taking place. The consolidation of biochemical mechanisma may be the originators of this activity.

It has been proposed that three factors may account for an apparent reversal of consolidation which occurs with the process of differentiation.

Differentiation - a process in which there is a generalized tendency to respond to stimuli other than a conditioned stimulus is selectively inhibited by nonreinforcement of the differential stimulus (internal inhibition). An EEG manifestation of such inhibition might be expected in the form of slow waves.

Beritoff, Kogan, and Roybak propose that the essential mechanism of internal inhibition involves axodendritic processes which cause negativity of the apical dendrites of cortical pyramidal nourons. These influences are presumed to originate in the thalamic reticular formation.

1. Rebound effects from interactions between these reciprocally inhibitory systems as positive and negative stimuli are presented.

2. A differential discrimination may require that a stimulus be compared with a representation of past experience,

in contrast to an existential discrimination which may be based on the presence or absence of the stimulus. Evidence does exist for such representational systems.

3. During differentiation and extinction, performance of the conditioned response elicits nonreinforcement - which is unique and not predictable.

Excitatory sequelae to this nonreinforcement as well as inhibitory influences on the unreinforced process, may be the source of the "superficially" paradoxical events of both hypersynchronous slow waves and desynchronization or increased evoked potentials during this process. This may provide a mechanism by which the organism's "personality set" or "stage of growth" selects appropriate and useful stimuli as noted earlier.

A brief summary of some of the connections suggested for conditioned responses will be of use in regarding later sections of this paper on the disconnection syndromes. The brainstem reticular formation plays a central role in conditioned response elaboration. Its role being involvement in initial stages of connection formation is suggested by Yoshii-Gestaut. Yoshii and Gastaut feel that the general desynchronization produced by conditioned responses early in conditioning suggests function of the mesencephalic reticular formation while the subsequent local desynchronization in later stages of conditioning indicates function of the thalamic reticular formation. Maeno suggests

that internal inhibition results from suppression of the reticular activating system.

Grastyan proposes that reticular formation repression described above arises via hippocampal activation. Yoshii agrees and further suggests that these hippocampal influences which are mediated by the thalamic reticular formation may exert their final inhibitory effects via a corticoreticular projection.

In summation it can be proposed that during initial presentation of a novel stimulus, both excitatory and inhibitory effects are wide-spread throughout the brain. These effects diminish and disappear with repeated inconsequential experience in a way which suggests a selective inhibition. With reinforcement, the response reappears. Irradiation does occur and signs of hippocampal and mesencephalic reticular formation involvement appear.

Other physiological phenomena seen associated with stimulus identification and memory function are:

Existential discrimination - The situation in which a conditioned response is established to a conditioned stimulus under contigencies such that appropriate response can be performed based simply on perception of the presence or absence of stimulation in a particular sensory modality, diminution of the electrical signs of response to that stimulus are expected.

Differential Discrimination - The situation in which a

specific attribute of a conditioning stimulus becomes the relevant discriminandum characterized on the EEG as a sharp peak expected to appear in the generalization gradient, accompanied by a marked increase in electrographic response related to the stimulus specific attribute presentation.

Repeated experience with intermittent stimuli might result in the establishment of a neural system in nonspecific structures, with the capacity of discharging in a temporal pattern reflecting the temporal pattern of the conditioned stimulus responsible for establishment of the system. Discharge of this system with that temporal pattern might serve as a representation of a past event. The interaction of such representational systems with specific sensory systems in an inhibitory fashion might account for the suppression of repeatedly experienced input during habituation, and interaction in a facilitatery fashion might account for various phenomena of assimilation of rhythms, as observed during intertrial intervals or during generalization. Congruence between the pattern of activity in this system might constitute the basis of signal identification which would seem to be a logical requirement for appropriate performance of differential responses or discrimination.

Extinction of a conditioned response is considered as a process essentially similar to that assumed to occur during differentiation, but which produces inhibition of a tendency to

perform an act in the presence of the specific stimulus. This is manifestly not the complete uncoupling of the temporary connection established to conditioning, since it is well known that an extinguished conditioned response can be readily reactivated.

Lissak et all postulated two classes of mechanisms subserving internal inhibition:

a. Differential inhibition, in which reciprocal inhibitory mechanisms of the brainstem and diencephalon prodominate. Stimulation of the brainstem reticular formation or the hypothalamus revealed that a point facilitating one of the conditioned responses always inhibited the other. Regardless of the direction of the effect, stimulation was invariably accompanied by diffuse cortical desynchronization. Slow waves were not observed during the development of behavioral differential inhibition.

b. Extinction, in which the inhibitory mechanisms are primarily of hippocampal orgin. Hippocampal stimulation inhibited both types of conditioned responses equally and independently of the stimulated point, and slow potentials appeared in the cortex like those seen during behavioral extinction. The hippocampus is proposed to have an aspecific inhibitory effect of the hypothalamus and the diffuse activating systems. Killam et al found that the hippocampal response to a conditioned stimulus progressively diminishes during the elaboration of an

avoidance conditioned response, returns while the conditioned response is being extinguished, and attribute this to the process of attaching new inhibitory significance to the conditioned stimulus.

These findings do not entirely exclude an explanation by Potzel for the "projection" of phantoms (a disturbance in perception) in certain cortical and sub-cortical lesions. He proposed that under physiological conditions cerebral centers play a "protective" role which depends on the "binding" of specific portions of central irritation.

This "protective action" of the centers gives stimuli a transverse direction and changes them into appropriate activators, that is specific impulses for perceptions and complex motor acts rather than allowing random or "centrifugal discharge" via old phylogenetic paths. It is the parietal apparatus particularly the gyrus supramarginatis which performs that transverse activity in activating the kinesthetic images of the body of the opposite side. The thalamus is the "locus" of the above-mentioned protective activity of cerebral centers. In a case of simultaneous lesions of both apparatuses there is a lack of deviation of impulses from the corresponding hemisphere, therefore, there appears a one-sided deviation of the intact hemisphere; accordingly the image of the corresponding one-half of the body is being "projected" or recognized as existing in

external space where it appears to be on an equal standing with other external objects. In this process of recognition of false projection a focus in the thalamus plays a major role by absorbing, under normal conditions, the sensory and kinesthetic stimuli and directing them to appropriate loci.

SUMMARY

This paper presents a very brief introduction to the concept of body image or self image. The semantic problem which exists concerning ambiguity of/and overlapping of meanings for the terms perceived body, postural model of the body, body image, body concept, body schema, body percept is discussed. This is followed by a section discussing the development of the ability to perceive form, integrate percepts, and the relation of sensory-motor feedback loops. An effort is made to correlate the development of these faculties with the formation of body-concept or body image. A brief introduction of the physiologic and biochemical mechanisms involved is then presented.

The purpose of the above is to lay down a background which will be useful in explaining various disorders of body image which are due to chemical, developmental, psychiatric, or anatomic (GROSS C.N.S.), pathologic mechanisms. The paper is "laced" with weighty and abstract terminology which makes comprehension difficult. This paper was written as the first part of a paper which in subsequent sections will attempt to present, in some detail, a few proposed mechanisms of pathology to account for the disorders listed above.

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