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# Perception and Its Implication for the “Perceptually Handicapped Child” with Emphasis on Auditory Modality

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# PERCEPTION AND ITS IMPLICATION FOR THE "PERCEPTUALLY HANDICAPPED CHILD" WITH EMPHASIS ON AUDITORY MODALITY

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# CHAPTER I

## THE PROBLEM AND DEFINITIONS OF TERMS USED

Within the last few years there has been an increase in number of programs concerned with learning disabilities. This seems to be indicative of a growing awareness that it is the responsibility of education to offer specialized help to children with learning problems. Unfortunately, however, the perceptually handicapped child is too often either left to flounder in repeated failures in the classroom or is offered a watered-down curriculum which provides little challenge for his potential abilities (78:259-266). Psychologists, educators, speech therapists, and others have been scrutinizing past research for new meanings in a constant effort to improve understanding of the problem, the learning ability of the child, instructional materials, and the methods of workers in the field (7:273-294).

### I. THE PROBLEM

#### Purpose of the Study

It was the purpose of this study to present a review of the modern literature on perception, with an emphasis on the auditory modality, in an effort to summarize what research says concerning:

1. the neurological makeup of the perceiving organism;

2. the linguistic makeup of the perceiving organism;
3. the nature of innate perceptual capacities and of acquired percepts;
4. the nature of perceptual deficits and the importance of early identification;
5. the interrelationship of feedback and perception;
6. the interrelationship of auditory discrimination to perception;
7. the dynamics of system functions as it applies to perceptual choices; and
8. the feasibility of behavior modification as a remediation technique for perception deficits.

Assumptions

It is assumed that:

1. there is order apparent in the hegemony of the central nervous system which makes it possible for the human organism at birth, or before, to begin to perceive;
2. with the orderly maturation, the variety and number of perceptions increase;
3. with multiple perceptions, meaningful relationships between them will be discovered, commensurate with the level of maturation and of learning;

4. as relationships are perceived, experience and maturation will reinforce a contingency of increasingly finer discriminations between these relationships, allowing elements to be identified as meaningful wholes, and the wholes to be conceived of as member elements;
5. as an artifact of insufficient training, necessary pre-skills may or will be missing in some children's perceptual repertoires;
6. if training has been present, but was faulty in any of the sensory or association areas, perception may be distorted or inadequate;
7. distorted perception may be a possible factor in personality maladjustment;
8. if, for any organic reason, any of the normal pathways of learning have been blocked, a spreading effect may be noted in the lack of readiness for complex perceptual tasks except as provided for by maturation alone;
9. complex variables are operating upon and within each individual which are not readily ascertainable;
10. if man is able to devise improved means of making specific diagnoses, and early remediation, he has an obligation to do so;

11. reinforcement principles applied to perceptual repertoires may effect behavior modification; and

12. since complex auditory perceptions imply a need for an ability to abstract, and since this is a function about which very little is known, there exists a need for further research concerning how the human organism perceives and acquires complex perceptual repertoires.

## II. DEFINITIONS OF TERMS USED

For the purpose of this study, the terms indicated will be defined as follows.

Perception

An impression of, or awareness of, anything.

Auditory Perception

Recognition of the many parts of what is heard in order for their significance to be appreciated.

Auditory Discrimination

Differentiation of sounds, including discernment of the phonemes of a language.

Intrapersonal Feedback

Learner's immediate or delayed reception of visual, auditory, tactile, kinesthetic, or cognitive knowledge of success or failure, as it pertains to the overt and covert, as interpreted by the individual.

Language Disability

Gap between apparent capacity for language behavior and actual level of language functioning (4:167).

## III. ORGANIZATION OF REMAINDER OF THE THESIS

Chapter II deals with a review of the literature related to perception. The study is essentially limited to literature of the last two decades. The auditory modality received special emphasis because of its early importance in the acquisition of language and speech. The applicability of behavioristic learning theory to remediation of auditory perception deficits is considered.

A summary and recommendations for further research are included in Chapter III.

# CHAPTER II

## REVIEW OF THE LITERATURE

### I. OVERVIEW OF THE NEUROLOGICAL ORGANISM

Simon postulates that with an ascending order of the phylogenetic scale an increasing ability to perceive or "see" complex relationships may be noted (81:3-8). But the early rate of acquisition of perceptual skills is inversely related, with a human infant requiring the longest period of parental dependency, according to Hedger (39:56). Simon proposes that this latent dependency is in direct proportion to the fact that as the afferent sensory system gets notably smaller in comparison with the size of the central nervous system (CNS), it takes longer for the afferent to gain needed control over the CNS (81:16-20).

This control is essential if incoming stimuli are to be recognized as important sensory cues. In addition to the cause-effect, stimulus-response, afferent-efferent relationship, Kephart relates that the central cortex, including its fissures, is in a constant state of on-going neural activity upon which outside stimuli must impinge. Afferent stimuli compete with already present neural firings (50:56-57). Denes and Pinson report a hegemony apparent in the CNS (14:101). The neurones having the greatest authority are located on the highest level. The first of these is the cerebrum which houses the various centers used in willed processes, including those of perceiving. Next is the cerebellum or great coordinator of striped muscles and compensatory movements for learned muscle activities. The medulla houses the pheumotaxic center. All fibers, ascending and descending, pass through here so a small lesion produces great damage. The basal ganglia include the thalamus with its vital reticular formation controlling arousal and sleep mechanisms. The thalamus controls emotional output. The hypothalamus is in charge of visceral organs involved in emotions via connecting fibers of the CNS and autonomic nervous system (ANS).

While the CNS is vital for man to build a civilization, it is the ANS which keeps the offspring alive until the CNS can be trained to "take over" except for bodily emergencies. In these instances the ANS regains bodily control on a temporary basis. The ANS, as discussed by West, is comprised of two chains of ganglion, the sympathetic which excites the thoracic centers and the parasympathetic which tends to inhibit in control of unstriated muscles of the heart walls, abdomen, and cranium (98:23-42).

Berry and Eisenson point out the importance to speech of a third great system, concerned with muscle tonus and the smooth development and functioning of the body. This is the endocrine system, comprised of the thyroid, parathyroids, adrenals, and pituitary. The endocrine connects directly with muscles of the body through hornomes and enzymes to the blood stream (6:77-82).

A sensory fiber from the sensorium, according to Gruber, will not fire until the stimulus on its end-organ surpasses a threshold. This nerve will not, in turn, trigger the association fiber of the central cortex with which it synapses unless the original firing takes place. The association fiber must carry potential sufficient to overcome and upset the ongoing activity of that field. Each nerve either fires completely or not at all. After every detonation of a nerve fiber there is a period of inertia, called the refractory period of constant duration for each fiber. It can be seen how a neural lag could upset the delicate timing and result in perseveration or tics on the one hand, or in too rapid neural firings possibly resulting in epilepsy on the other extreme.

When the output of nerve innervation to a muscle or a nerve reaches a pre-determined level, it checks itself through feeding back a small part of the electrical output to the controlling mechanism. This feedback enables the monitoring of subsequent outputs (32:378).

The complex and highly integrated central perception mechanism of the adult owes its efficiency to the slow and clumsy learning of childhood. One currently prevailing theory held by Hanley and Thurman seems to be that all of our specializations or acts requiring fine discriminations must be introduced on top of baser, more gross movements or functions (33:6).

Within this framework, infant perceptions would be classified by Roach and Kephart as global functions (76:5). If any part of the basic structure just outlined is inadequate, the more complex perceptions to follow may also be faulty (63:297).

Piaget characterizes perception as a sub-set of sensory-motor intellect. Intellect is described as an adaptive process of assimilation resulting in adaptation necessary for accommodation to external reality. Perceptual interpretation of environment is observed as synonymous with assimilation. Interpretation includes a holistic mental structuring by the child according to the prevailing organizational system at that given instant in time. Adaptation by the perceiving organism, whether on a primary or secondary level, does not necessarily imply perceptual accuracy (22:235).

The theoretical aspects of Piaget's work on perception can be divided into two parts. The theory of perception is concerned with:

> How the perceptual apparatus functions when it fixates on stimulus elements . . . . The second part could be termed his theory about perception . . . . It is a general conception of what perception is and how it develops . . . . For Piaget, perception is a particular kind of adaptational act or process, which can only be understood in relation to the broader class of acts or processes he calls intelligence (22:225-226)

Manipulation of perceptual data forms the basis for conceptualization.

## II. OVERVIEW OF THE LINGUISTIC ORGANISM

The need for a high degree of perceptual accuracy in language acquisition is apparent. In the learning of the verbal symbols which constitute the basis for thinking and communication, Johnson argues:

> People can be made deathly sick by symbols . . . . Over- and under-verbalization and rigidity in language behavior, then, not only are indicators of maladjustments, but also foster and intensify maladjustment . . . . With a scientific attitude toward language, toward symbolisms of whatever kind, we stand to gain a fifth freedom, making other freedoms possible--we stand to gain a freedom from confusion (46:266-267).

Since children symbolize on a perceptual basis, the child with a perception deficit would seem to be at an early disadvantage. McGaugh, Weinberger, and Whalen point out that:

> . . . experiments involving the auditory system have also revealed the dependence of normal behavior upon normal feedback to the brain; for example, speech is impaired when the subject hears his own words delayed a few seconds (63:297).

Dittmann and Lewellyn (16:79-84) investigated the relationship of two types of listener response, an audible one and a visible one in an attempt to determine whether decoding takes place during the filled or empty pauses of the speaker at the beginning and ends of phonemic clauses. On an auditory basis, a telephone situation was utilized, while on the visual level, head nods, smiles, and glances were used as determinants that the listener was attending. Dittman and Lewellyn found that:

> head nods and vocalizations, along with changes in glances and brief smiles seem to have potential as markers of units in social interaction . . . (16:84).

The results of this study also indicated something else. This, and the study preceding it, point to a kind of unit information which may be of greater relevance to the encoding process in speech. This has to do with response rates to three types of terminal junctures--sustained junctures with speaker vocalization present, rising and falling junctures dealing with vocal inflections and intent, and a time lag at juncture. Of these, the sustained junctures are responded to the least, although they constituted about half of the phonemic clauses coded. Interpretation was that the listener was waiting for the speaker to go on in these instances, and that all speakers engaged in these verbal fill-ins. The perceptually handicapped child with an attending auditory deficit is at a decided disadvantage on this apparently high level of verbal-auditory social interaction.

Martin, on the subject of temporal word spacing and the perception of ordinary phonemic strings, supports the contention of other researchers in the assumption that speech normally occurs at a rate so rapid that instantaneous decisions cannot be made for each unit as to phonemic, phonetic, syntactic, structure (65:154-157). The suggestion is made that such speaking-type decisions about the early items in a sentence are probably delayed until the listener has heard enough to conceptualize a higher level auditory decision for response. This view suggests that speech items, in rapid transition, are held in mental storage until they are needed for progressive interaction. This means the child or adult with an auditory memory span deficit will not be able to perform the complex storing tasks required for adequate verbal interchange. Martin explains:

> Thus it might be expected when there is a delay between units that speech perception will suffer when the speech is heard under less than optimal conditions. The perception of speech heard through masking noise, for example, may be increasingly more difficult as the rate at which speech units are uttered depart from normal (65:81-83).

As to the influence of social pressure on perception changes, Yin and Saltzstein state:

> Social influence procedures usually involve two elements: (a) stimuli about which a subject must make some judgments, and (b) exposure of the subject to discrepant judgments made by another person or persons. If the subject's own judgments about the stimuli are changed as a result of the exposure, then social influence is said to have taken place (101:313).

Horn and Flanagan describe perceptual processing as:

> . . . including sensing, registering, assimilating, and integrating phases. Coding and memory represent an extension of the integrative phase into the responding process (43:185).

Regarding cultural influences, McCarthy discussed the linguistic advantage of girls over boys. One theory offered is that girls are encouraged to participate more fully than boys in verbal exchange because of the closer mother-daughter association. A second theory proposes that boys are reinforced more consistently for skills other than linguistics. McCarthy maintains that the existing sex difference in linguistic attainment may be related to later academic success in verbal skills (62:554).

Since cultural pressures may be operative upon linguistic development of the organism, Alexander, Stoyle, and Kirk conducted a research study

> (a) to determine if vocabulary differences exist between the sexes in children 3 to 5 years of age growing up in the deprived conditions of a large city and (b) to determine if there is a significant vocabulary change over the Head Start school year and, if a change takes place, to determine if there is a difference between the sexes in the change (1:215).

They found a significant sex factor in favor of the boys as far as vocabulary was concerned. These authors also found the difference to exist over the Head Start year, and recommended that specific early help is needed to overcome the vocabulary deficit in girls living in deprived urban conditions. This finding is unusual since boys have normally been found slower than girls in maturing, including the boy's slower vocabulary development under normal learning conditions (1:215-235).

As Van Riper has indicated, the child usually learns to talk by making two very obvious but very important discoveries: first, that each sound has distinct visual, auditory, and kinesthetic features; and second, that words are made up of a series of consecutive sounds (93:107-113).

According to Johnson, vocal phonics consists of those activities related to the analysis and synthesis of sound sequences. Regarding children in whom this ability is lacking or deficient, Johnson says:

> A child who has this difficulty cannot determine when sounds are alike or unlike and he usually has difficulty in associating the sound with the printed or written symbol representing them (48:86).

DeHirsch quotes Wepman: "Auditory discrimination continues to mature beyond the eighth year" (11:63).

## III. THE NATURE OF PERCEPTION WITH EMPHASIS ON AUDITORY PERCEPTION

In considering the nature of the function termed auditory perception, Harsh and Schrickel (36:109) say that "Perception of relationships improved gradually through continued observation of activities of other persons, with increasing comprehension of their words and appreciation of their feelings." They continue: "Too often what is referred to as perception is really a more complex process, interpretation" (36:377).

In answer to the question, "What is perception?" Ittleson and Kilpatrick agree that most prominent theories about the nature of perception have grown out of the approach that there exists in the external and internal world some general correspondence about what we see, hear, and feel. The same authors summarize that:

> These theories generally agree that even though much of the correspondence may be due to learning, at some basic level there exists an absolute correspondence between what is "out there" and what is in the "mind." But there is a great deal of disagreement concerning the level at which such innately determined correspondence occurs. At one extreme are theorists who believe that the correspondence occurs at the level of simple sensations, such as color, brightness, weight, hardness, and so on . . . . At the other extreme are Gestalt psychologists who feel that complex perceptions such as the form of an object are the result of an inherent relationship between properties of the thing perceived and the properties of the brain (44:130).

Hebb (38:79-106) postulates that perceptual learning is effected essentially in the nervous system, and that it is furthered or impeded as a function of qualitative and quantitative changes in neural apparatus. This theory is based on current discoveries in neurology concerning the structural and functional characteristics of excitatory neural tissues. The formulation proposes a gradual acquisition of perceptive skill as an artifact of an integral change in cellular structure. The growth takes place at the synapses, in the form of "cell-assemblies" or synaptic knobs resulting from reinforced sensory and motoric responses. This is the neurological counterpart of psychological experience (38:100).

Hebb assumes a facilitation of intercellular bonds which form increasing numbers of connections as new stimuli impinge upon the sense-receptor organs. Repetition causes an actual growth change if enacted often enough.

Insight into the relationships between perceptions is thought to be a direct result of association or facilitation between existing synaptic knobs. This, in turn, brings about the growth of new neural pathways in a multiplicative system which has a snowballing effect with learning bringing about additional perceptions (38:133-134).

Hebb further postulates an on-going thought or central neural activity. Alpha waves are the regular neural patternings, measurable by an E.E.G., while Beta waves, also measurable, are the irregular "thought" waves. Both may go on, as nearly as can be determined, in the presence or absence of external stimuli. Each cell body, bathed in fluids, is capable of firing itself. The "all or none" firing principle applies to individual cells as well as to chains of cells. The important point here is that impinging sensory stimulations must, in effect, compete on a selective or priority basis with both internal stimuli and on-going thought waves. In this light, individual sensitivity and a gradually accruing hierarchy of selectivity would seem to be important elements in what or how the various stimuli are perceived. Both the nature and origin of cell assemblies may enhance perceptual efficiency, and once constituted, cell assemblies become the building blocks of increasingly complex perceptual tasks, according to Hebb's theory (38:121-122).

Acquisition of new percepts may require the elimination of or minimizing of irrelevant stimuli until interstructural facilitation has developed far enough to permit easy channeling of incoming stimulation to the appropriate organizational structures. Lack of such adaptation would result in mass activation of cell bodies and so result in diffuse thinking.

The importance of early learning is stressed since at any given moment, perceptual tasks are performed within the framework of formerly established cell assemblies. Experiential exposure, within the scope of readiness, tends to reinforce and thus to insure continued perceptual growth on a cortical level (38:125).

Hebb's concepts do not seem to conflict with known neurological facts, although they do involve a large number of inferences and postulates not readily verifiable. The proposed network or synaptic knobs would seem to offer a logical explanation of the repeatedly observed phenomenon wherein surgical removal of the cortex outside the speech area in later life causes a much less profound loss of IQ than does the same surgical removal in a child of pre-language age.

Penfield and Roberts (70:4) have reported on the results of ten years of brain study. According to these researchers, no recorded perception, however slight, is ever lost once it becomes meaningful. When the listener perceives a sound, the record is laid down in a ganglionic pattern which, if not reinforced, may soon be lost to voluntary recall.

The record remains permanently, ready to be used as a flash-back for the purpose of comparison and interpretation (70:8-56).

When a sound reaches the human ear drum, it is converted from a frequency into nerve impulses to be conducted over the eighth cranial nerve to the auditory portion of the brain. This stream of nerve impulses results in a mental proposition or percept of what was heard. This perception may not agree with that of a second listener, or if human communication is involved, it may be far from identical with the verbalized intent of the speaker. Change involves not a losing of a percept, but an enlarging of it, as needs change (70:45).

There are three important sensory areas in the human cortex which receive projected streams of nerve impulses. They are as follows: from the eyes to the visual sensory areas of each occipital lobe; from the ears to the temporal lobe, bilaterally; and from the face, arms, legs, and body to the somatic sensory areas. There are also primary somatic motor areas which pass on the streams of outgoing impulses, thus producing the voluntary actions. This includes the voluntary control of the muscles of exhalation for speech and all of the speech musculatures which depend for efficiency on auditory perception (70:17).

There are many millions of nerve cells in the human brain, and each has some capacity of generating energy within itself and along its length to the synapses, where if neural discharge is high enough the adjoining nerve or ganglion cell will be fired into (70:39).

Neurologically, perception may be defined as streams of impulses determined by a gradually increasing complex of facilitations and inhibitions within the CNS. There is a sequential or temporal laying down of cortical patterns, so that electrode stimulation of the various areas will elicit responses in the same sequential or temporal arrangement in which they were recorded. It is assumed that the acquisition of auditory perception is transactional rather than additive due to a mechanism for scanning and selection of similar perceptions from past experiences. Any percept resulting from a multiple modality stimulation, i.e., visual, auditory, tactile, kinesthetic, can later be called up or aroused by any one modality, or by any familiar aspect of the former neural pattern (70:230-231).

Maximum learning is thought to take place when expectancy is confirmed and thus is reinforced. Up to a certain point, discrepancy between expectancy and perception may be exhilarating, as in novelty or surprise. But beyond this point, discrepancy may range from mildly disruptive to complete disorganization.

What is learned is in terms of what is perceived, as one can hardly be expected to remember that which is not perceived. Because of a property of expectancy called "closure" men fill in many existing gaps. For example, because of closure one may tend to see C as a circle, and to hear "thoup" as "soup" in the speech defective child's conversation. While perceptual patterns may be seen, heard, felt, or remembered by arousal of older "trace-systems," corrections are made on the basis of present threshold or level of perceptual acuity (33:56).

## IV. THE NATURE OF PERCEPTUAL DEFICITS

According to Roach and Kephart (76:1-12), perceptual learning depends upon prior motor learnings. Initial perceptual information is a burst of formless, shapeless electrical energy in the cortex without direction, spatial orientation, or figure ground relationships. Through experience with environment, perceptual data are "matched" against already existing motor data until they are perceived as synonymous.

These same authors suggest that if such matching does not take place or is restricted, the child may not achieve the coordinated perceptual-motor level essential for speech, reading, and writing. Instead, the perceptually handicapped child may exhibit constant confusion resulting from a motor world and a perceptual world from which comes opposing data.

In order of progression, with each building upon the last, the developmental sequence for perceptual fields seems to be tactile, kinesthetic, visual, and auditory. Following the perceptual-motor match is the process of perceptual projection known as directionality. This ability involves the three coordinates of Euclidian space--right-left, up-down, before-behind--with the body perceived as the center of motor patterns.

Not until the perceptual organization has been integrated is readiness for concept formation attained. Since manipulations of perceptual data form the basis of conceptualization, a faulty perceptual organization can handicap later cognitive functioning (76:9-10).

Berry and Eisenson (6:74-75) suggest that time is important in diagnosis since behavioral symptoms of a CNS disorder may partially disappear with additional maturation and emotional disturbances supplant the original cause of learning problems. Even if the ears are normal, the child may have immature auditory perception. Ewing, according to Reichstein and Rosenstein, believes that late CNS maturation is responsible for the majority of perceptual problems (75:74).

At best, diagnostic processes are tenuous. Eisenson rediagnoses 90 per cent of the aphasic children brought to the clinic with language disorders.[1] Even with neurologic examination, EEG, skull X-rays, audiometric studies, psychometric tests, medical histories, and an optimal multidisciplinary approach, the findings are often negative or

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[1]In personal communication.

inconclusive. Goldstein, Landau, and Kleffner agree that causal multiplicity creates confusion and ambivalence in differential diagnosis (29:756-767).

Mykelbust and Johnson (67:14-25) suggest that the child whose predominant disability is understanding language has sensory or receptive aphasia while the child whose main problem is difficulty in expressing language has motor or expressive aphasia. Because of the interdependence of language functions, however, the child with receptive aphasia will also exhibit a pseudo expressive aphasia as a consequence of not being able to communicate that which is not understood.

Mykelbust (68:443-450) delineates aphasia as a disorder in the use of language symbols; central deafness as a deficiency in transmitting auditory impulses from the inner ear to the auditory cortex of the brain; auditory agnosia as a generalized inability to understand verbal and nonverbal auditory symbols or sensations; and auditory imperception as a deficiency in structuring and appropriately attending to auditory stimuli. None of these relate to actual pathologies of the middle or inner ear since the hearing mechanism per se is intact.

Hardy (34:289-300, 309) associates central deafness with disturbances in the central pathways, and perceptions with lesions of the temporal lobe. Aphasia, he believes, is due to lesions in cortical areas other than the temporal.

It appears that auditory perceptual problems may be symptomatic of central nervous system deficit, late maturation, lack of experiential training, faulty learning due to inadequate model and/or emotional problems, all of which may be alleviated, resolved, or at least become less problematic if identified early enough and given proper attention.

Early identification of perceptual handicaps should be aimed at pin-pointing the deficient areas in order for remediation to be implemented. Strauss, as reported by Garrison and Force, emphasizes the need for education to focus on the following:

1. normal growth patterns of basic mental processes, i.e., perception, reasoning, language, and emotional behavior;
2. organic defects of basic mental processes;
3. disparity of growth . . . (25:356).

Some of the more commonly used perceptual abilities diagnostic tests are the _Illinois Test of Psycholinguistic Abilities_, the _Purdue Perceptual Motor Survey_, the _Frostig Developmental Test of Visual Perception_, the _Draw A Man Test_, and the _Bender-Gestalt_.

Various methods of perceptual remediation are offered, especially in the area of deficient visual perception. One of these is the _Frostig Program for the Development of Visual Perception_.

A program for the auditory receptive channel, somewhat paralleling the Frostig for visual, has been developed by Lowell and Stoner. According to Bateman, this program for the development of auditory skills focuses attention on vocal response characteristics. Available through the John Tracy Clinic, the title is Play It By Ear (4:173).

Montessori developed perceptual training materials, including materials for auditory perception. These materials were based on the philosophy that a child needs many increasingly finer discriminative successes at manipulation with equipment which offers a built-in control of error for immediate feedback purposes. The child is encouraged in critical thinking, freedom of choice, independent work, and self-management. There are perceptual judgments which the Montessori child learns to make with ease in size, shape, texture, movement, and sound. Each of the senses receives separate and varied emphasis (78:458).

Kolstoe (53:151) recognizes the apparent continued success of the Montessori auto-education method, but feels it fails to account fully for internal differences. Kolstoe feels the extreme degree of emphasis on environmental stimulation means the mentally handicapped, the normal, and the genius must all be thought of in terms of quantity and intensity of the stimuli in a total way.

Much recent emphasis has been given to the individual's ability, or lack of ability to filter out irrelevant stimuli, as in selective listening. In considering this question, Broadbent (8:7-107) theorizes that if the individual is unable to selectively sort out the irrelevant impinging perceptual stimuli, and "select" those for attention over-responsiveness or hyperactivity results. This implies an indiscriminant response to all incoming and on-going stimuli. The effect may be a general over-loading of the receptor system.

According to Broadbent, interference of "noise" may also overload the system. This may be actual noise from the environment, of some intense or diverse nature, or it may be in the form of a malfunction of one or more parts in the reviewing system of the organism (8:106).

In his review of the literature to 1958 on perception and selective listening, Broadbent concludes that the topic of auditory perception is being recognized as more closely related to the rest of behavior than it formerly was. The proposals are :

1. that some central rather than sensory factors are involved when two messages are presented to the ear simultaneously.
2. that the rate at which information arrives is an important variable in selectivity.
3. that when information must be discarded, it is not discarded at random (i.e., the listener would elect to attend incoming information from those considered as authorities, or friends (8:34-35).

Broadbent maintains that when no material is to be discarded, there is little advantage to using two or more sensory channels for the perceptual process. However, once a limit is reached, one task will fail while the other is adequately performed even though the CNS can be trained to "see" one thing while it "hears" another, or to listen to two unlike sounds simultaneously (8:34).

Another aspect of perception is spatial and temporal arrangement of stimuli (33:32). For example, speech is a case of stimuli being dealt with in sequence, insofar as self-hearing and listener hearing are concerned. This ability to hear in sequence requires a "filter system." The filter system may be conceived of as a part of the feedback system, which, if inadequately developed, will result in distorted perceptual control. Sequencing is the ordering of events in time. The basis of temporal judgments arise through motor-temporal synchrony which must then be projected onto outside events just as the motor spatial system must be projected onto the perception of outside objects. With these assumptions in mind, as outlined by Kephart (49:201-206), it is easier to understand that as auditory perception develops, rhythm is acquired, providing the necessary temporal scale. This serves as a basis for rhythmical perception of and later transmission of speech and other environmental sounds. A deficiency in this area can create problems of speech, reading, communication, and even engender insufficient self-expression in such areas as encoding and interpretation. Aphasia is one of the communication disorders which may cause "noise" in the system.

Reichstein and Rosenstein list McGinnis, Kleffner, and Goldstein's definition of aphasia, which in itself indicates the multiplicity involved in diagnosis:

> Aphasia . . . may be regarded as an inability to express and/or to understand language symbols, and it is the result of some defect in the central nervous system rather than the result of a defect in the peripheral speech mechanism, ear, or auditory nerve, defect in general intelligence or severe emotional disturbance (75:239).

Mykelbust relates that aphasia is usually present at the time of birth; however, it need not always be congenital as it may be acquired by way of later accident or injury to cortical tissues (68:444).

## V. THE INTERRELATIONSHIP OF FEEDBACK AND PERCEPTION

One way of increasing the accuracy of perceptions is through the adequate use of feedback. On this subject, Robinson has stated:

> At any given moment we are getting back information about what we just did. And this information may, if we are "aware of our awareness," cause us to modify our behavior or to terminate it as the situation demands. This implies a need for a high degree of sensitivity to both self and others as well as to surroundings, if one is to function efficiently. Dependent upon the smooth functioning of several relatively self-regulating systems or fields on an intra-personal and inter-personal basis, or on compensatory functioning in the case of inadequacies, we get along.[2]

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[2] Personal communication.

Robinson (77:32) explains that this information is being fed back to the brain by way of numerous circuits or "closed cycles" which have all components contained within the organism (visual, auditory, tactual, kinesthetic), and "open circuits" such as the eyes and ears which check the reactions of both self and others. This is servo-theory, or self-regulating theory, " . . . derived from principles utilized in the development of automatic control systems such as are found in automatic pilot devices, missiles, and computers" (77:31). It has been hypothesized that the human brain functions in accordance with similar principles for the learning and maintaining of behavior patterns. The gradual guide-check system of acquiring auditory perception would be a case in point.

One of the men who postulates such a concept is West. Because of a background in neurology, West places much emphasis on the binary nature of the human organism, contending that it is the binary nature of the human being which invites comparison to an electronic device. Since there are only two states of living nerve fibers--(1) that of active discharge and (2) that of rest and recharge--all mental activity, assertively, can be reduced to formulas of binary numbers. The apparent polarity of the afferent-CNS-efferent system substantiates the analogy (97:80-90). In discussing the acquisition of speech, Van Riper suggests that speech depends initially upon need for gregarious human interrelations. The child who fails to relate and identify with environment will likely be inadequate in the acquisition of speech. In another sense, the child who receives feedback, by whatever means, that the many speech attempts being made are unsatisfactory or unpleasing, may either be inhibited in further attempts or may adopt various compensatory mannerisms (93:133).

Van Riper and Irwin (94:107-109) also maintain that the regulator in any automatic control system has three basic functions: (1) it scans, (2) it compares, (3) it corrects on the basis of feedback messages from the motor or its products which inform of the motor's effectiveness. This ability to monitor performance is a prerequisite to acquisition of auditory perception which implies the matching of feedback messages to predetermined or past patterns. This does not deny a concomitant development.

According to Skinner (87:7-139), the predetermined patterns are those which have been culturally arrived at via reinforcement, with the parent attempting to superimpose the prevailing verbal communication system on that of the infant. The verbal community, in this case, would be any group of any size which is relatively bounded by common language practices. Each verbal community would be comprised of many sub-groups, one of which would be the family. This group probably exerts the strongest early ties and as such would be the greatest field force in the infant's acquisition of auditory perception. Understanding precedes usage.

Van Riper and Irwin theorize further that some of these closed or open feedback circuits may not be open for some people (94: 109). The auditory circuit may be the most important one in the acquisition of language, at least in the beginning. The auditory circuit is fundamental to the auditory reception of the phoneme patterns which must be imitated later. The sounds in the environment must be perceived to be understood, and must be heard to be perceived (94: 111).

Grant Fairbanks developed a closed cycle servo-system which theoretically works on the same principle as the human speech mechanism. This servo-system may be helpful in understanding how complex perceptual skills are acquired. In the automatic comparison of the intended with the accomplished, there may be discrepancies, and ". . . the mechanism, self-triggered, directs an error signal to a mixer where input and error signals are combined and sent to the appropriate effectors" (21: 133-139).

Fairbanks assumes an input from the sensorium which is concerned with the language system. With the input signals, the comparator performs a calculation, chiefly in subtraction in a binary system, which, at any given time, yields a measure of the amount by which the control point has not yet been reached by the output. In other words, ideal output does not yet equal real input.

Fairbanks believed that in much this same way, man perceives a sound, acts upon it in speech or otherwise, receives feedback as to appropriateness of the response, and corrects for error in the next response, thus clearing up any error signal in the direction of zero. This integral relationship between systems infers a need for an undamaged feedback mechanism if new percepts are to be adequate. At this point, also, the perceptually handicapped child is at a continuing and compounding disadvantage.

Mysak (69:144-149), following Fairbanks construction of a closed cycle servo-mechanism with the ear as one input leading to a comparator which accounts for correction, prepared a model intended as an extension of the former speech machine. Mysak added what would compare in the human being with a secondary motor area, allowing for the automaticity of speech after any given pattern is learned. Mysak views the mechanism as a complete speech machine, even though the input must be fed into the machine originally by some outside source for each phase. This machine, however utilitarian in explaining procedure to us, cannot begin to equal the complexity of the human organism, for although it has a brain for scanning, storing, and comparing, it lacks the sensorium for perceiving stimuli and the periphery for gathering in stimulations without outside help.

Denes and Pinson specify learned automatisms of speech, perception, and all other behavior patterns as apparently involving the cerebrum at some time. As a perception is initiated, many association areas of the cortex may take part. Motor association areas, such as Broca's area in the left hemisphere, prompt the motor cortex to specific patterns of impulses. After being relayed back and forth to the reticular formation, command then descends along the hierarchy of control through pyramidal tracts to the lower motor neurones and to the muscles involved in executing the command. After any stimulus response, pattern becomes habituated or automatic, most of the control for this pattern is relegated to the cerebellum or the lower brain (14:93-114).

## VI. THE INTERRELATIONSHIP OF AUDITORY DISCRIMINATION AND PERCEPTION

Regarding visual and/or auditory discrimination, Watmough notes:

> Already it appears that the mechanism of vision is quite comparable to that of hearing in the way in which both of these senses discriminate, as they transmit, impulse by impulse, the stimuli that are interpreted as hearing and sight respectively. A linguist approaches these matters with hesitation. But he interprets spectrograms in a similar manner, and feels encouraged to believe that units comparable to words, and strings of such units, are credible segments of information that are being fed in succession into the network of nerves in the human organism and returned again, while we act successively and indifferently as speakers and hearers, readers and writers (99:153).

Eisenson has stated in a lecture that by the time the child is twelve years of age, the brain is already old. This implies the essential nature of early cortical training, but does not deny the innate.[3]

---

[1]Lecture at Washington Speech and Hearing Conference, Seattle, Washington, 1965.

Penfield and Roberts note that medical science is now able to make actual observations of human cortex which allow fairly accurate judgments as to just what areas of the cortex are involved when discrimination problems are due to cortical damage (70:35-36).

Some modern behavioral research and the resulting technology seem applicable to the remediation of discrimination deficits. As emphasized by Holland:

> From psychological laboratory data a number of behavioral principles have emerged with explicit relevance to modifying behavior . . . . The teaching machine movement is a current and successful example. Teaching machine programs are continually being developed with direct reference to speech pathology. Such programs show that speech clinicians can place reliance on the science of behavior as a source of tools for modifying speech and language behavior . . . .
>
> Reinforcement is perhaps the most basic, the best "known," and most superficially understood behavioral principle. By reinforcement, we mean any consequence which follows an instance of behavior--a response--and increase the likelihood that the behavior will reappear . . . (41:11-12).

In discrimination experiments, Hively (40:279-298) resolved that the experimental machine did not teach the required discriminations efficiently in one investigation; however, he also found that those who failed to learn the discrimination tasks learned something else as a result of accidental contingencies of reinforcement. Hively's experiment suggested the possible advisability of constructing an experimental machine which will present bi-modal or tri-modal sensory stimulations.

The serious application of technology to the auto-instructional concept is well recognized. Still, it is obviously impossible to foresee all of the possibilities which may become technically and economically feasible during the next few decades. What does seem certain is that changes in current instructional practices, materials, and standards are inevitable, and that progress may occur in a variety of possible ways (82:295-307).

Grimes (31:221) quotes Hays as foreseeing: "that the time will soon come when linguists take the computor as much for granted as they do the typewriter and the tape recorder." Several chapters of Hays' book are concerned with computors and algorithms, storage structures, external storage, input-output systems for storing language data, acquisition storage, and the various kinds of data processing of language.

One of the valid claims of machine program writers is that teaching machine instruction not only seeks to avoid inhibition of learning which results from failure, but in addition, seeks to reinforce learning via rewarding success. A vast quantity of experimental literature, both for and against the teaching machine as a learning device, is available. Lumsdaine and Glaser have compiled a source book, with commentaries, on available research to date of printing (59:247-256). One needs to examine evidence from both research camps, as well as the findings of those in the educational field and of those who are not yet "for" or "against," to find answers to questions about the teaching machine as a possible device for lessening existing visual and auditory perception and/or discrimination problems in children.

## VII. THE DYNAMICS OF SYSTEM FUNCTIONS

Concerning the dynamics of systems functions, Harsh and Schrickel state:

> Present knowledge does not clearly specify the major psychological functions which might conceivably be related to various physiological sub-systems within the organism. Moreover, these functions and sub-systems are complexly interrelated. Thus, any readily understandable analysis of the human system must use over-simplified abstractions. One arbitrary, but possibly helpful, schema, portrayed in Figure 1, considers the individual as a data processing system in which the data bits are specific neural or biochemical events. Boxes in the left-hand column represent system functions involved, to varying degrees, in every behavior situation . . . . Boxes in the right-hand column represent some of the "built-in" or acquired programs for information processing . . . (36:20).

These same authors also explain a dynamic flux, an on-going continuum, an irreversible exchange and interaction which leads us to infer that the particular perceptual patterns of any human being, at any given time, will for him, constitute the basis for response choice based on preferential attitudes and values (36:22-23).

The state of a person's perceptual world may in a very direct way influence what control environmental forces have as the individual tends to selectively "see," "hear," and "believe" that which is consistent with the mental and physical organization at that time. There tends to be a consistency within the same individual for ways of responding. This style of response, whether based upon innate traits or acquired learning, would seem to be fundamentally related to attitudes and values. There seems to be a need for further research into this relationship as early response patterns tend to persist in style of execution. If either heredity or environmental structuring could encourage traits of flexibility and adaptation, and thus evolve habits amenable to perceptual adjustment it seems important to know how and why, according to Anastasi (3:113-125). Also, researchers may look toward the modern emphasis on interaction between fluid boundaries of self forces and other forces, at each stage in the developmental sequence of individuals as unique beings (36:24-25).

Allport takes the position that system functions warrant considerable attention, and combines available definitions of open systems under four criteria:

1. There is intake and output of both matter and energy.

2. There is achievement and maintenance of steady (homeostatic) states, so that intrusion of outer energy will not seriously disrupt internal form and order.

3. There is generally an increase of order over time, owing to an increase in complexity and differentiation of parts.

4. Finally, at least at the human level, there is more than mere intake and output of matter and energy; there is extensive transactional commerce with environment (2:43).

Allport further implies that to apply the technology of system functions to human perception, the individual must be viewed as a total complex system composed of many diverse, autonomous yet inter-dependent sub-systems (2:48-51). If the three largest physiological systems--the central, autonomic, and endocrine--are to be considered for systems analysis, they must be divided and sub-divided to the microscopic makeup of a cellular system. A break-down at any level could exert a compounding effect at other levels. Other systems involving the whole <u>physical</u> orientation of the individual in time and space, the <u>socio-cultural</u> membership and participations, as well as the <u>psychological</u> views (perception, cognition, temperament, affectivity, motivation and learning) can also be subjected to analysis (2:48). <u>Situations</u> are interpreted by Harsh and Schrickel as the occasion for system functions. This necessitates that a situation be perceived before system function becomes operative (36:24). These same authors report:

> The end products of systems functions are effects which may physical, biological, social, or psychological. These effects can operate (as determinants) within the individual or upon objects, persons or groups. Effects may merely modify a continuing situation or they may serve to terminate an episode. Internal effects probably feed back into various system functions (in a continuous feedback loop) . . . leading to modification of action (36:24). (See Figure 1.)

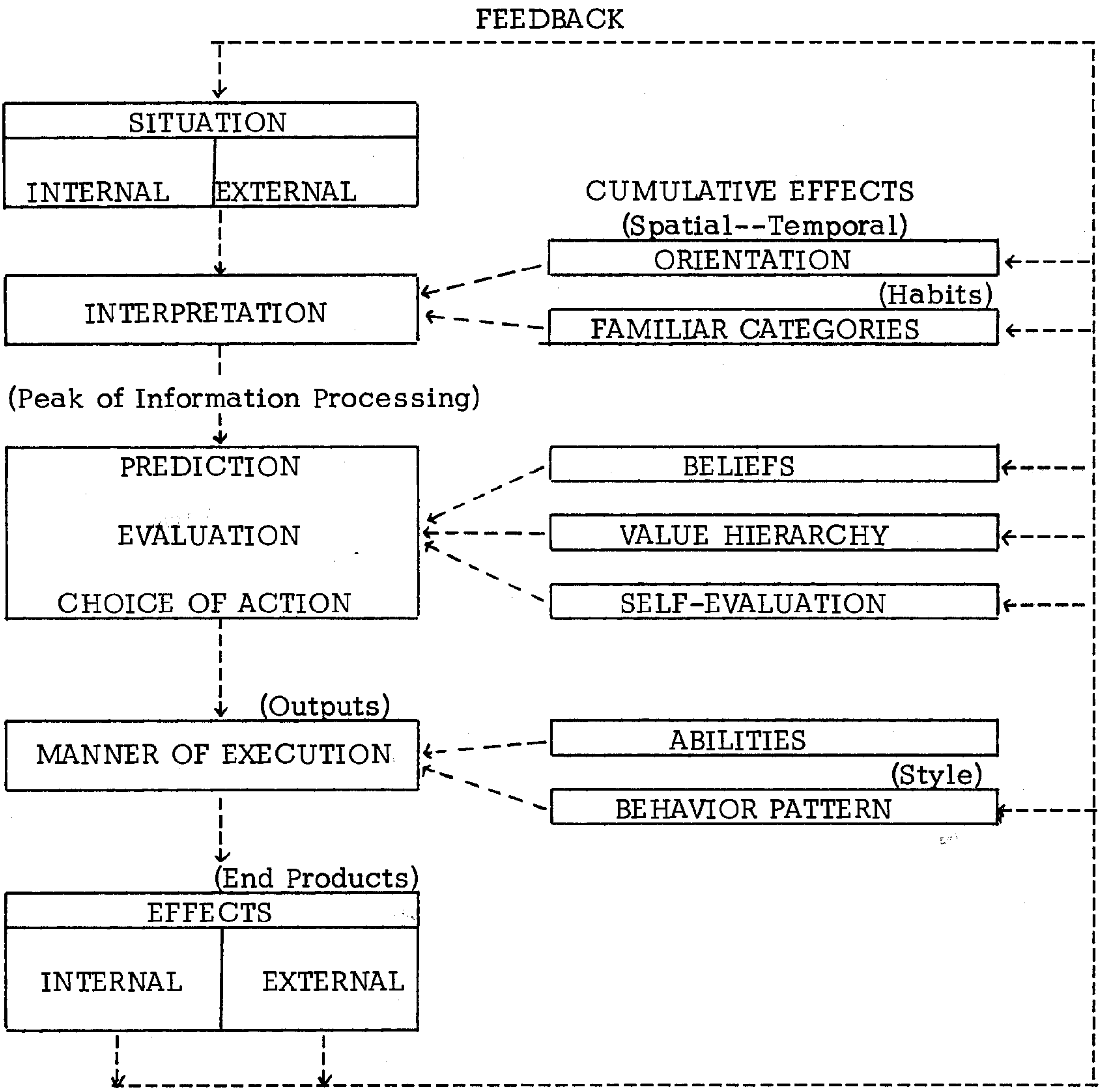


FIGURE 1

SYSTEM FUNCTION SCHEMA FOR AN INDIVIDUAL

A communication gap, or specifically, an auditory perception deficit, could occur within the scope of any of the four determinants of the system functions, physiological, physical, socio-cultural, or psychological. The multiplicity of errors effected by a single breakdown at any level becomes evident when subjected to system analysis. When any sub-system is deviant or altered, the feedback reflects this position with a re-cycling which affects future output. Roach and Kephart cite the work of Gesell in order to substantiate the understanding that perceptual organization is probably a changing factor at each age level (76:2). Dietz feels that humans apparently tend to perceive experience in such a way as to support present integration, rejecting modifications which threaten the unitary character (15:394). Reichstein and Rosenstein suggest this may mean the child with a perceptual deficit will exhibit concomitant and compounding problems which might be largely alleviated if early differential diagnosis can pin-point the basic flaws (75:73).

# CHAPTER III

## SUMMARY AND RECOMMENDATIONS

Auditory perception appears to have received less direct attention from researchers than visual perception, particularly as it applies to the perceptually handicapped child. McCaugh, Wienberger, and Whalen agree this phenomenon may be due to a seemingly general agreement concerning the secondary role of auditory perception as compared with visual in general discrimination learning and concept formation (63:297). Or it may be due, in part, to the recent stress on perceptual motor development research, to which visual perception lends itself so readily for testing and remediation (63:297).

In the light of the early and continued importance of auditory perception to speech and language, however (47:34-35), and with the evolving realization that communication skills play a dominant part in personality formation (79:7), more research might profitably be directed to the area of auditory perception.

Because of the tendency toward both physical and mental organization, the child "perceives," "interprets," and "reacts" selectively in an adjustive manner. Without perceptual progression, whether due to maturational lag or learning deficit, maladjustment may occur.

The key for a more self-actualizing perceptual adjustment may lie in early training for flexibility and adaptability where a deficit exists, in the hope that early traits will become a basis for the autonomous heirarchy of "perceptual sets" which appear to govern choice of actions.

The approach is multifactorial, and interdisciplinary, with educators serving as progressively integrated members of the team.

McCandless and Spiker point up that the need exists for careful convergent (laboratory) and divergent (longitudinal) research concerning etiology or correlated factors, diagnostic procedures, and remedial practices in learning disabilities (61:33). It is recommended that the child who exhibits an auditory perception deficit receive more emphasis in a concentrated effort to apply the specificity of systems functions to this area of human communication disorders.

It is further recommended that behavior modification techniques be considered as an educational tool for programming remediation, regardless of etiology. These are not original recommendations. Bateman relates that as far back as 1962 Kleffner suggested:

> Those who have chosen to concern themselves with the pathology underlying language problems have rarely been able to go beyond speculation. From this group come guesses about brain damage, cortical inhibition, hemespheric dominance, cerebral plasticity, synaptic connections . . . .

> Etiologic investigations . . . have told us little more than that such problems can occur with various etiologic backgrounds or without any significant etiologic factors being apparent . . . .
>
> The behavioral approach . . . has been more fruitful in a practical sense than approaches through pathology and etiology (4:168).

Bateman suggests:

> The very fact that we cannot exchange parents or repair damaged brains has led to the present day concern of many with behavioral and symptomatic rather than pathological or etiological factors (4:168).

The history of human and technological development, each of which aids the other, would seem to suggest that current methods and developing theories for research, will necessarily be a matter of constant revision, retrial, and reimplementation.

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