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ABSTRACT

An experimental test of visual closure based on an information-theory concept of perception was devised to test the ability to discriminate visual stimuli with reduced cues. The test is to be administered in a timed individual situation in which the subject is presented with sets of incomplete drawings of simple objects that he is required to name rapidly and accurately. Interpretations of scores will reveal three categories of visual closure disability: limited closure, delayed closure, and premature closure. Results of the administration of this test to 200 children between ages 7 and 11 are reported. For younger children, the reliability of scores was too low, and for older children and adults the test did not discriminate well. Correlates between seven different perceptual tests ranged from low to very high. Ten children in each of the three visual closure disability categories were rated on behavior patterns, and the correlations were found to be particularly high for the limited closure group. Correlations between stereopsis and recovery of fusion and visual closure efficiency were also reported. References are included. (CM)

VISUAL CLOSURE

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INFORMATION THEORY AND PERCEPTION

Perception is the active process of locating and extracting information from the environment, evaluating and processing this information, organizing and integrating this information, and finally utilizing the information.

Perceiving and acting are intimately related. Perceiving provides the individual with directives for action, with the framework within which action takes place, and with the means for registering the consequences of action. It involves a feed back procedure in which the consequences of behavior are themselves perceived and continuously serve to modify the perceptual process.

Perceiving is an active process, actively carried out by the perceivor. The total functioning individual perceives withall his diverse psychological and physiological processes. Ittleson (1) says "perceiving is not only an inseparable part of all working activity, but even more important, perceiving never occurs independently of some other activity."

There are striking parallels between communication in cybernetic devices and perceptual processes in the human organism and information theory provides a useful model for the analysis of perception. It illustrates a way in which the perceptual information-processing system might be conceived to cope with the mass of information available in the environment by handling data in terms of fewer rather than more articulated constituents. To reduce the information content of a set of stimuli is to introduce redundancy within the set, which in turn forms a pattern within an otherwise disparate set of data. This creation of patterns, or

templates is analogous to the way in which we create forms by sketching in a few significant lines and curves. We can draw a tree, for example and eliminate the large number of curved lines and angles of the branches, roots and leaves but retain enough information to identify the object as a tree. The method by which the perceptual systems form patterns may be conceived of as a matter of cutting out unnecessary information and reaching the point when the stimuli of a given configuration is treated as a unified symbol (Gestalt) without reference to any of the many elements which under other conditions might be discriminated within it.

Perceptual learning is the process of learning to detect invariants or constancies in the environment under changing stimulations. It is acquired in a programmatic, bit-by-bit manner. At first, nervous excitation is random but after repeated stimulation of the perceptual system neurons they become organized in functional units or cells which can keep an input active after stimulation has ceased. With further stimulation, these units increase in stability, combine with other cells into more elaborate sequences and evolve into complex higher order organization. Consolidation and condensation of stable units develope the ability to perceive schematically using only critical features so that excess information is not processed and the entire perceptual process becomes highly efficient and automatic.

It is evident that the behavior which can be observed when subjects are asked to identify, reorganize or otherwise respond to visual stimuli which have reduced invariants or cues, or have been deprived in some way should be valuable in establishing the integrity or the visual information processing system. The visual closure test was developed within this theoretical framework.

VISUAL CLOSURE

Visual closure is the ability to unify an apparently disparate visual perceptual field into a single percept. Closure is usually considered as one of the primitive organizing tendencies in perception.

Rankin (2) writes "According to Gestalt theory, psychological organization always tends to move toward a state of Pragnanz (i.e., a good Gestalt). Closure (the tendency to fill in gaps in an incomplete structure) is a special case of the Law of Pragnanz. Attneave (3) maintains that the "good Gestalt" is a figure with a high degree of internal redundancy (i.e., a low degree of information) and that the Gestalt laws of organization (which include the law of closure) all refer to conditions which reduce uncertainty. He maintains that the human brain cannot utilize all the information provided by patterns of stimuli which are not highly redundant. Therefore, an important function of perception is to encode incoming information in a form more economical than that in which it impinges on the receptor organs. By closing gaps in a structure, we overlook irregularities (i.e., reduce uncertainty) and organize the remaining portions of an incomplete figure in a more economical form than that which impinges on the receptors. Information is greater

at gaps in a structure, and perception functions to decrease this uncertainty by filling in the gaps, thereby forming a more stable (i.e., redundant) figure."

Ayres (4) in a study designed to discover relationships among the different kinds of sensory perception, motor activity, Laterality and cognitive functions identified visual figure-ground discrimination, measured with a Gestalt completion test and embedded figure test, as a major independent pattern of perceptual dysfunction. She says that operationally the closure test seems to involve organizing visual stimuli into a whole, pulling them into a foreground. It was also found that this factor is linked closely with somesthetic and motor processes as well as visual functions.

A battery of perceptual-motor measures was utilized by Miller (5) in a study comparing outstanding sports performers with low skilled performers. Closure and depth perception were two major factors identified as a valid indication for distinguishing between raising levels of sports ability.

Goins (6) investigated the relation of visual perception to early reading progress and based on the evidence postulated "the good reader either develops or possesses inherently strength of closure..." She further recommended the use of tests that measure a type of strength of closure that she described as requiring the subject to hold in mind a whole, a perceptual Gestalt, while at the same time he manipulates in some way the "parts" of the whole.

VISUAL CLOSURE TEST

The visual closure test was devised as an objectively scored test of the ability to discriminate visual stimuli with reduced cues. This ability is a primary perceptual process and has been described in factor analysis studies as "strength and speed of closure." The process involves perceiving the stimulus array as a set of elements

organized into a pattern and at the same time responding quickly by visualizing the elements that complete the unfinished configuration. Until closure is accomplished the individual elements are perceived as changing into various patterns that interfere with the completion of the task. The correct structure is derived by quickly rejecting the patterns that do not integrate into a meaningful form and synthesizing the parts given into a whole.

ADMINISTRATION

The visual closure test is administered as a timed individual test. The subject is presented with incomplete drawings* of simple objects that he is to name rapidly. Ten sets of objects are used with 4 drawings of the same object in each set. The drawings are viewed in degree of completedness from a few cues to a complete drawing. Each drawing is presented for five seconds and are continued until the patient responds. Only one response is permitted for each set. The subject is told that speed of response and accuracy are equally important and a number of demonstration sets are utilized to familiarize him with the task.

SCORING**

Three scores are obtained for each subject.

1. INFORMATION DEMAND

The measurement of the amount of information a subject requires before attempting a response. It is obtained by totaling the number of drawings exposed. The scores can range from 10 to 40. This is essentially a measure of visual input.

* * * * * * * * *

* The incomplete drawings are taken from the "Visual Closure Pictures produced by Speech & Language Materials Incs., Tulsa, Oklahoma.

** The scoring system was derived from Wescotts' (17) Study of Perceptual Inference.

2. SUCCESS

The measurement of the amount of correct responses a subject achieves. It is obtained by totaling the correct responses and scores can range from 10 to 10. This is essentially a measurement of visual output.

3. EFFICIENCY

As in all input-output systems the final criteria is efficiency. This is obtained by dividing the ratio of output to input. The Success score is divided by the information demand score and multiplied by 100. Scores can range from 0 to 100.

EXAMPLES

A.	1.	Information Demand	20
	2.	Success	8
	3.	Efficiency	40
B.	1.	Information Demand	30
	2.	Success	10
	3.	Efficiency	33.3
C.	1.	Information Demand	15
	2.	Success	9
	3.	Efficiency	60

INTERPRETATION OF VISUAL CLOSURE TEST SCORES

The results should be interpreted using both the efficiency score and the pattern of responses. 80% of children from 7-11 years of age have an efficiency score of at least 40%. An efficiency level of less than 40% is considered a low closure ability. Less than 25% is a severe disability.

The pattern of deviant scores fall into three distinct groups as follows:

	INFORMATION DEMAND	SUCCESS	PATTERN
1.	High	High	Delayed Closure
2.	High	Low	Limited Closure
3.	Low	Low	Premature Closure

Subjects in the first category, Delayed Closure, require a great deal of structure. ~~and is termed delayed closure.~~ They use only information that is obvious, are slow to reach a decision and have little flexibility. They require training that requires them to reach closure quickly and require transformation of stimuli.

Subjects in the second category, Limited Closure, have very low efficiency and are characterized by disorganization in all areas of performance. They have limited closure and require extensive training in all areas of perceptual-motor skills.

Subjects in the third category, Premature Closure, may not have a low efficiency score because of low information demand, but their problem is not utilizing available information and reaching decisions on insufficient data. They require training that inhibits closure and makes them capable of monitoring their responses.

NORMAL SCORES

The test has been administered individually to 200 children between the ages of 7-11 over a period of 2 years. The reliability of scores in younger children is not high enough as the test is presently administered and it does not appear discriminative enough with older children or adults. The distribution of scores in the normal sample does not follow a standard distribution. 82% of the subjects had a success score of at least 8 right. Less than 3% had a score of below 5. Mean success score is 8.4 and a score below 7 is considered low. A score of 9 or above is considered high.

Information demand scores fall into three categories. 65% of the scores range between 18-23. 19% are 10-18 and 16% are higher than 23.

A visual information demand score of less than 18 is considered low and a score of more than 23 is considered high.

80% of the visual efficiency scores were at least 40. A visual efficiency score below 40 is low and a score less than 25 is considered a severe disability.

While there are some indications that the younger children in the sample are not as efficient as the older children the present interpretation system appears adequate for diagnosis. No sex differences were noted.

NEUROLOGICAL IMPAIRMENT

The inability of children with neurological impairment to to accurately discriminate figure-ground perception tasks has long been recognized. It follows that the visual closure test would prove difficult for these children. A standardization on 50 children with a positive diagnosis of neurological impairment yielded the following mean scores:

Success	6.3 ~~8.3~~	
Information Demand	23	(extreme variability)
Efficiency	29	

PERCEPTUAL CORRELATES

A battery of perceptual tests was compared with the visual closure test dysfunctions. The following table summarizes the correlation. High scores indicate dysfunction in both tests.

TEST	PREMATURE	DELAYED	LIMITED
Perceptual Soeed (PMA)			
Total Score	Moderate	High	High
Percent of Error	Very High	Low	Moderate
Spatial Relations (PMA)	Moderate	Moderate	High
Visual Motor Integration (Rutgers Drawing Test)	High	Low	High
Visual Span (Detroit Test of Learning Ability)	High	Low	High
Auditory Span (ITPA)	Low	Low	Moderate
Figure-Ground Perception (So. Cal.)	Low	Moderate	High
Visual Organization (Hooper)	Moderate	High	High

BINOCULAR VISION CORRELATES

Closure has been defined as the cortical unification of an apparently disparate perceptual field. Single binocular vision is dependent upon the cortical fusion of dissimilar pattern presented to each eye. If similar perceptual processes underlie both abilities correlates should be found between optometric tests of the integrity of the binocular system and visual closure. Preliminary studies support this hypothesis. The following visual ability appears to correlate with visual closure efficiency.

Stereopsis: the perception of depth that arises from non-congruent information presented to the eyes simultaneously and depends on the detection of a difference in the phrase of patterns.

Recovery of Fusion: sufficient prism introduced binocularly will create double vision. Reduction of the prism slowly induces fusion of the two images. Low recovery of fusion appears to be associated with low closure efficiency.

BEHAVIORAL CORRELATES

Many studies have indicated personality factors correlate with closure.

The Burks Behavior Rating Scales were used to identify behavior patterns of 10 subjects from each of the three categories of visual closure dysfunction.

The following table indicates the number of children identified in each category. None of the other behavior categories were of significance.

BEHAVIORAL CATEGORY	PREMATURE CLOSURE	DELAYED CLOSURE	LIMITED CLOSURE
Poor Coordination	6	5	9
Poor Intellectually	4	3	7
Poor Acadamics	5	6	9
Poor Attention	8	2	8
Poor Impulse Control	8	1	7

SUMMARY

An experimental test of visual closure based on an information theory concept of perception has been found useful in identifying three categories of visual closure disability.

1. Limited Closure
2. Delayed Closure
3. Pre-Mature Closure

The categories have proven useful in designing therapeutic regimens. Correlates with behavioral disorders, perceptual dysfunction and binocular vision disability have beenfound.

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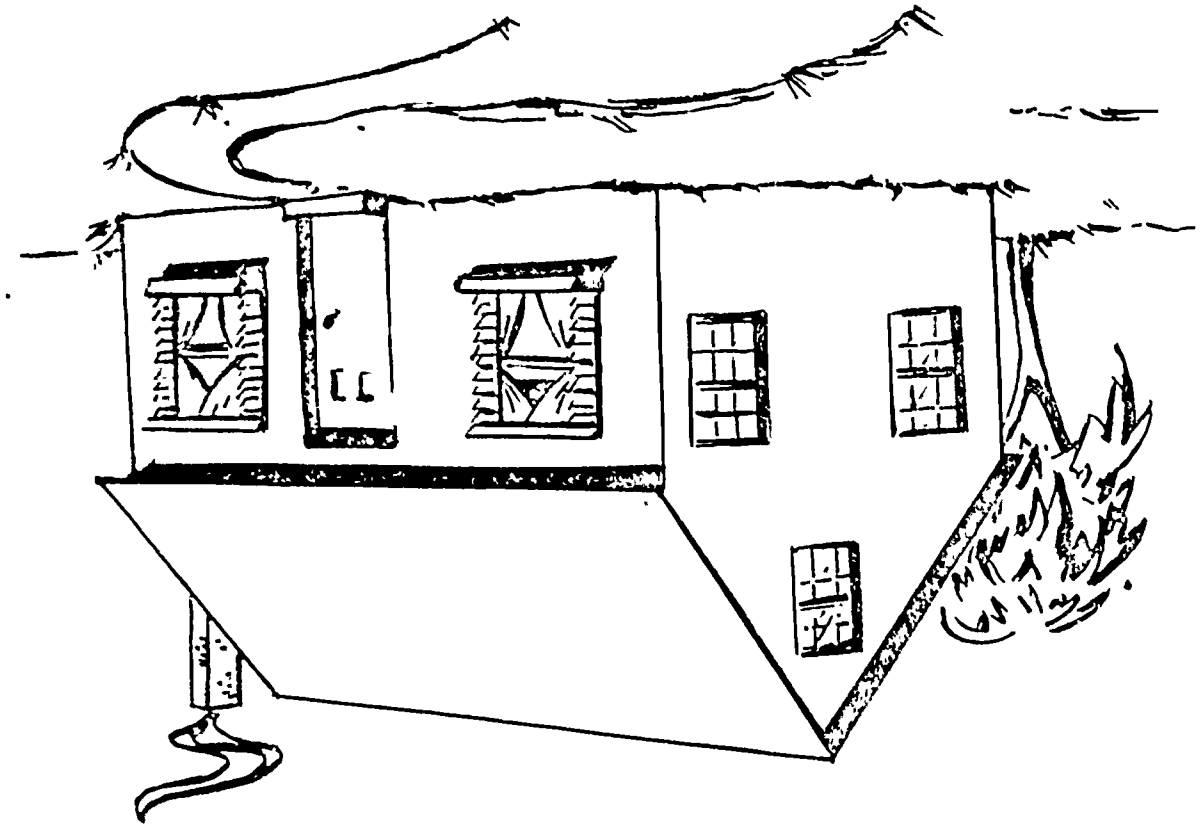
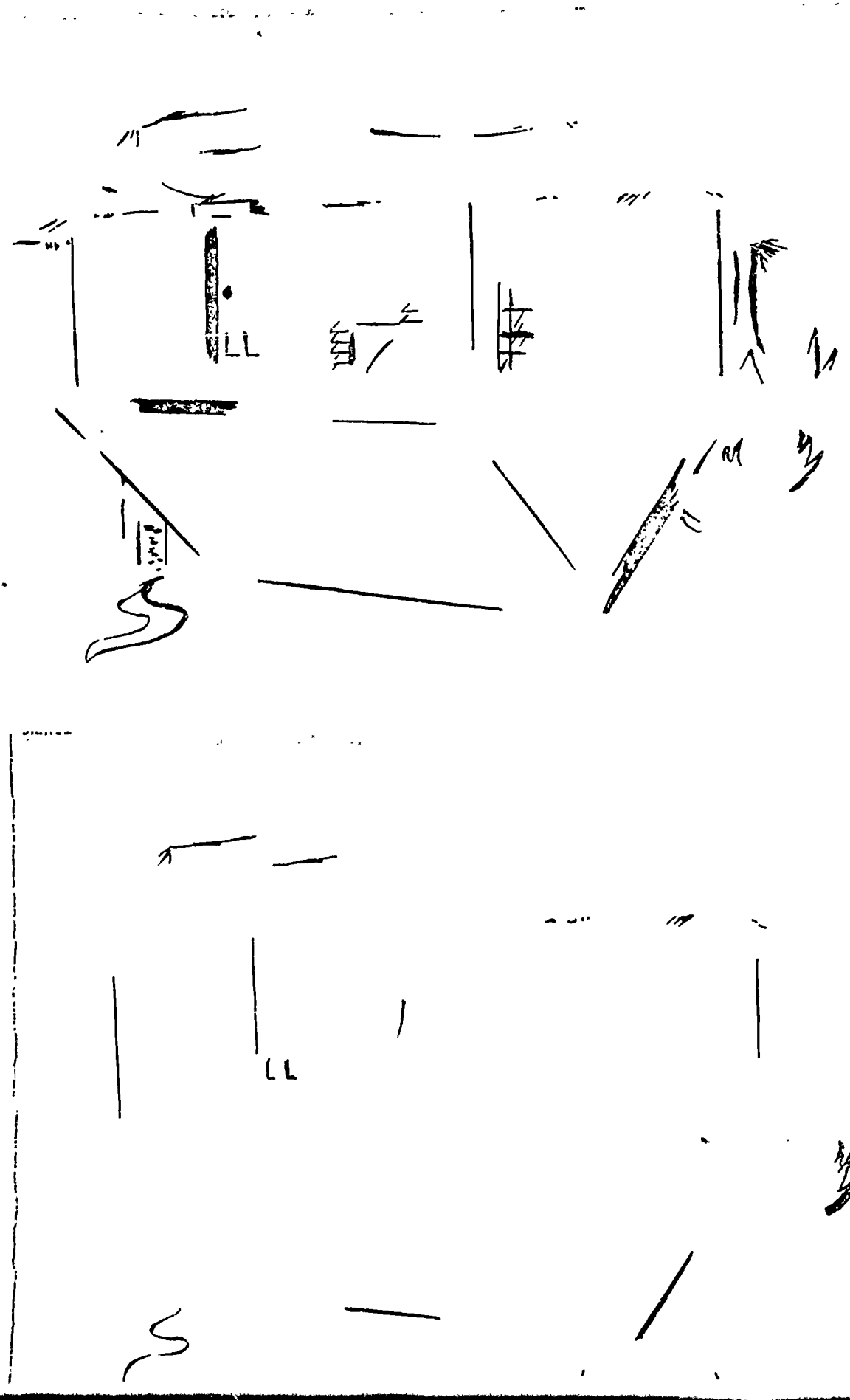
Figure 1





VISUAL CLOSURE

NAME..... DATE.....

NO.	ITEM	RESPONSE	CORRECT	INCORRECT	INFORMATION DEMAND
1	FROG				1 2 3 4
2	STAR				1 2 3 4
3.	BIRD				1 2 3 4
4.	SNOWMAN				1 2 3 4
5.	BICYCLE				1 2 3 4
6.	SPOON				1 2 3 4
7.	GRASSHOPPER				1 2 3 4
8.	SLED				1 2 3 4
9.	SLIDE				1 2 3 4
10.	STOVE				1 2 3 4
	TOTALS				

SUCCESS SCORE		HIGH	AVERAGE	LOW
INFORMATION DEMAND		HIGH	AVERAGE	LOW
EFFICIENCY		HIGH	AVERAGE	LOW

PATTERN: EFFICIENT

DELAYED

PRE-MATURE

LIMITED

FIGURE 2