THE PROCESS CURRICULUM

Perceptual Competence

Figure-Ground

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DEFINITION

Figure-ground perception involves the ability to differentiate certain features from a previously undifferentiated perceptual field and integrate these features into a figure or pattern that is distinctly separate from and predominant over the remaining information in the perceptual field. Those aspects of the field unassociated with the figure become the background, or simply ground.

DESCRIPTION

Theoretical Groundwork

Figure-ground discrimination has been one of the most persistent topics in the psychology of perception. The first modern attempt to systematically explain the mechanisms underlying this process was derived from the gestalt psychologists. Gestalt theory likened human perceptual and cognitive systems to an electro-magnetic field in which the structure of the central nervous system automatically imposed various modes of organization upon stimulus elements. The process of organization functioned according to a set of laws, which briefly defined are:

1. Proximity. Those elements which are closest to each other in terms of distance tend to form groups of figures.

2. Similarity. Similar elements form groups or figures.

3. Closed form. Lines enclosing a surface cause that surface to be perceived as a unit or figure.

4. Good Contour/Common Destiny. Lines which form a good contour or common destiny tend to be perceived as a unit or figure. (See figure 1)

5. Movement. Items that move simultaneously and in a similar manner form groups.

6. Pragnanz/Closure. There is a tendency to create symmetry in a figure and to close or ignore gaps in the contour. (See figure 1)

The result of sensory structuring supposedly yielded the perceptual experience of definite patterns which could not be inferred by breaking down the pattern components into discrete elements. Such a basic position is captured very well in the old gesalt maxim, "The whole is greater than the sum of the parts." This means that the appearance of a stimulus

element depends upon the whole array in which it is embedded. In the case of figure-ground perception, those stimuli which are considered as being integral to any particular configuration or organization will become figure and those stimuli not considered as integral to any such configuration become ground. The gestaltists postulated that the figure was differentiated from ground because of different chemical reactions in the cortex. A figure was believed to cause a bio-electric field dissimilar to that produced by the background and the transfer of this difference in intensity to the brain resulted in the perception of figure-ground.

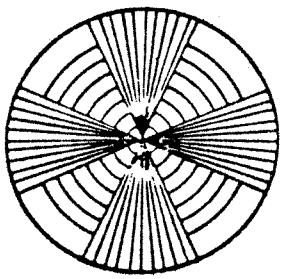

Figure 1.

Although the work of the gestalt school contributed some very fundamental insights into the role of the perceptual system as an active agent in the construction of conscious experience, it also suffers from a number of serious inadequacies. First, the principles of organization are based upon specific arrangements of sensory data in the environment. Secondly, the kinds of patterns which the principle can produce and account for are of a very limited, predetermined number and thirdly, they are innate in origin and therefore unaltered by learning (Gibson, 1969).

However, the facts are that figure-ground discrimination can be modified throguh learning and extended to an indeterminate number and variety of stimulus stituations (Gibson, 1969: Polanyi, 1959).

"Pre-perception" and "Preattentive Structuring"

There is another theoretical approach to the problems of perception gaining wider acceptance among psychologists which accomodates the gestalt insights, while at the same time transcending their limitations. This approach is descendant from American Functional Psychology, the chief exponent of which was William James. James proposed that figure-ground perception involved two processes: (1) the adjustment of the sense organs and (2) an anticipatory preparation from within the image and memory

centers concerned with the object being perceived. The latter process James refers to as the "pre-perceptual image," an integral pattern of references which is brought to bear upon the incoming sensory information. These references are of past association, including memory and emotion, and of interests, aims and aspirations. The references fuse with the incoming sensory data to produce the completed perceptual experience. As James put it, "the pre-perception is half of the perception of the looked for thing."

The past decade has brought a revival of interest in this problem and the resultant research has largely confirmed James' remarkable speculation. It has become increasingly clear that perception is primarily a process of construction and is ultimately subjective, but this does not mean that perception lacks correspondence with an outer reality, though this is possible. It rather emphasizes that the transformations and alterations which the nervous system performs upon the original physical stimulus, received by the sense organs, are profound.

In the tradition of James, Ulric Neisser (1967) has described the perceptual process as one of "analysis by synthesis." He likens this to the work of a paleantologist who reconstructs a dinosaur by carefully extracting a few fragments of bone from a mass of rubble. Neisser uses this analogy to emphasize the importance of regarding perception as an integrative, synthetic activity which involves more than just an analysis of stimulus elements. Presumably, the basic perceptual operations differentiate the elements according to patterns yielded by previous learning and are subsequently integrated into a figure. In part, the new integration is determined by existent integrations, conditioned by the unique properties of the particular array and influenced by the unrealized aims and purposes of the subject. Under such conditions the feasibility and possibility of figure-ground perception become virtually limitless.

Working within this general framework the concept of pre-attentive structuring is particularly relevant in understanding the figure-ground process. The way in which Niesser uses this term bears close resemblance to James' notion of preperception. It describes how the basic schema, or set, segregates from the welter of stimulation, those visual or auditory units upon which more refined processes will elaborate. As it is relatively global and wholistic, preattention defines and maintains the basic frame of reference and the boundaries which articulate figure from ground. The versatilty of this process is dependent upon the quality of previous experiences in differentiating and integrating similar types of situations. For example, Neisser points out how, on request, a literate person can differentiate a single letter from another letter on a page of print. For instance, one could discern the letter "q" appearing earlier in this sentence. Having found it, he can note whether it is well-formed or how it differs from "p" or "b". Preattentive structuring keeps the "q" a separate and integral figure while this happens. This is an acquired or

learned capacity and very difficult for young children and illiterate adults.

In reaching for a broad contextual perspective for the phenomenon of figure-ground perception, it seems most useful to regard the process as a mode of perceptual attention. In particular, the preliminary phase of attention is expressed in the process of preattentive structuring, i.e., that of selecting certain elements from the welter of data and synthesizing these elements into an integral unit, which stands out from and predominates the perceptual field.

Variables affecting figure-ground discrimination and perception

Edgar Rubin (1921), one of the earliest chroniclers of the process perception, differentiated nine variables that affect figure-ground discrimination. A few of the more important factors are:

1. Shape. Figure and ground "do not have shape in the same way. In a certain sense the ground has no shape." If a ground takes on the qualities of a figure, it can be to the point of assuming a distinct shape.

2. Contour. Rubin describes contour as "the common boundary between the two fields." He goes on to say that,

> "when two fields have a common border, and one is seen as figure and the other as ground, the immediate perceptual experience is characterized by a shaping effect which emerges from the common border of the fields and which operates only on one field, or operates more strongly on one than the other."

The figure is most affected by this process but the effect of contour is exerted on the ground as well.

3. Extension. The ground-field appears to continue beneath the figure-field "in spite of knowledge" to the contrary. (see figure 2)

4. Subjective color differences between figure and ground. Color appears to be "more substantial and compact in the figure than in the ground." The color of the ground appears to be soft and fuzzy.

5. Figure dominance. Perceptual fields viewed as figure are, generally, more impressive than those viewed as ground. This results in figures being remembered better and given first mention in a description of a field. If nonsense figures are used, people often "read into" the figures particular objects or, at times, "abstract forces, tendencies,

directions and movements." This process is based on similarity of shape between the nonsense figure and the named thing, whether this similarity is the result of fantasy or of a perceived common trait.

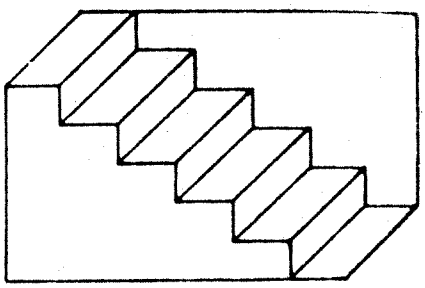

Figure 2.

6. Affect. "Feelings and past associations are strong determinants in deciding which configuration among the many possible will dominate consciousness." Solley and Murphy (1960) and Smith and Hochberg (1958) provide strong evidence to illustrate that figures associated with relatively pleasant feelings are more readily recognized than those associated with relatively unpleasant feelings.

7. The probability that a surface will be seen as figure is in part a function of the following factors:

a. "If one of (the) two homogenous, different colored fields is larger than, and encloses the other, there is a great likelihood that the smaller surrounded field will be seen as figure."

b. Conscious intent plays an important role in the selection of figure and ground. (See figure 3)

c. There is a tendency to experience cohesive, homogeneously colored, uniform fields as either entirely figure or entirely ground.

d. The sector of the system which appears "straightest" or most balanced more often is perceived as figure rather than non-straight or unbalanced sector systems. (See figure 2)

Among other variables that affect figure-ground perception are:

1. Labeling. Studies have shown that recognition of a figure is improved by the knowledge of a distinctive label for that figure (Katz, 1967)

2. Complexity. Studies by Caron and Caron (1968), Watman (1967), Willis and Dornbush (1968), and Fraisse (1967), indicate that complex figures tend to catch and focus attention more than simple figures.

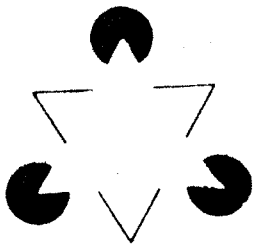

Figure 3.

3. Experience or habit. The ability to create a specific, known figure by the association of certain contours and a portion of a similar contour, will bring to mind the habituated figure as demonstrated by James (1950, Chapter XX), and Goldstein and Mackenberg (1966).

4. Contrast. Lit and Vicars (1967) have demonstrated that luminance (dark-light) contrast has a strong positive correlation with the ability to distinguish figure from ground. Gottschaldt (1926) has shown that unless a figure possesses integrity or unity and cohesion, it may be lost in a larger figure (see figure 4) because its contours no longer contrast with

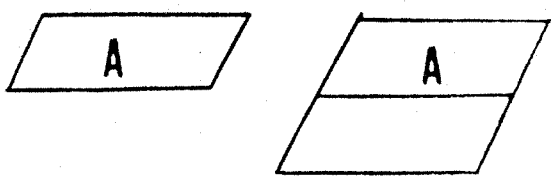

Figure 4.

the ground. Katz (Gibson, 1969, pp. 322-24) in a series of experiments demonstrated that from an age of five days onward, children prefer

patterned to plain objects. Patterning is, of course, a form of internal contrast within a figure.

5. Time. The duration of exposure to a perceptual field will have a definite effect on the ability to differentiate figure from ground. From Kahneman's work (1965), it would appear that there is a minimum amount of time needed for differentiation and that there is a saturation point beyond which no further differentiation occurs. One five-year study with 6 - 11 year olds conducted by Fraisse (1967), indicates perceptual closure takes 500 milliseconds while recognition time only takes a few milliseconds. Other variables affecting time in this study were complexity, stimulus uncertainty, preparation of the perceiver and the number of available responses.

Further factors are now being uncovered by the work of Julesz with random-dot stereograms and their application to the problem of figure-ground perception. In his book (1971) he examines the effect of stereopsis in the perception of figures on seemingly flat, computor-generated diagrams and concludes that figure-ground perception is a non-intellectual, cognitive process. The implications of his work for education have yet to be extracted from the theory he presents. Tentatively, one might speculate that the development and refinement of the cognitive concommitants of perception should become more prominent in the curriculum.

THEORETICAL JUSTIFICATION: ANISA

Learning competence is the ability of an organism to differentiate, integrate and generalize and verify experience in either one or all of the various aspects of the environment (physical, human or self) by interaction with them (Jordan and Streets, 1972).

Relationship to Learning Competence

If figure-ground perception is to be considered as a learning process it must, in some way, accord with this paradigm and display a relevance to other learning processes.

In terms of differentiation, figure-ground perception by definition, automatically fulfills the requirements outlined above. Figure is, of necessity, a differentiated aspect of ground, and the relationship of the former to practical considerations in the classroom is great.

The ability to read, to perceive depth and to create a psychomotor/perceptual match, i.e., to coordinate hand-eye activity, as with writing, are all skills that have some basis in figure-ground perception.

Form/shape perception depends upon this process and is itself the percursor to many cognitive skills. Figure-ground configurations also affect memory, in that something which is held as figure is better remembered. We can thus conclude that figure-ground perception strengthens learning competence because it involves differentiation both in itself, and in its relationship to higher order processes and skills.

Implicit in the notion of analysis by synthesis is that figure-ground discrimination also includes an integration of lower order processes. In terms very similar to Neisser's, Kessler and Kroneberger (1967) have also noted that perceptual analysis, the ability to separate figure from ground, and perceptual synthesis, the ability to match figures, relates to analytic and synthetic cognitive abilities in a positive manner. Insofar as figure-ground also serves to integrate elements of experience into a coherent pattern which enables the organsim to make effective referance to its environment, it is an important aspect of learning competence.

Once a figure has been differentiated from a number of grounds it is more likely to be abstracted from previously unencountered contexts. For example, the human perceptual system is capable of recognizing the same speech patterns in virtually unlimited variations of the particular physical characteristics (e.g., background noise, intonation, time span, etc.). In this sense, the figure-ground process manifests extensive generalizabiltiy and satisfies the third criterion of learning competence.

The interface with language and affect greatly extends the capacity to generalize figure-ground relations. When coupled with labeling, the affective reaction to figure-ground perception takes on a vast array of psychological overtones not ordinarily associated with the operation of the proces. Finally, figure-ground perception also operates in the function of imagination, i.e., the ability of the organism to create a non-visual image in the mind when the label for that image has been used in everyday speech.

The figure-ground perceptual process is amenable to verification in many ways. One way of ascertaining the accuracy of a figure is by tactile encounter, i.e., simply touching it. Another is by hearing the figure so that, if one hears a voice at the same time one sees a person, then these two stimuli tend to verify each other. Other means of verification would all tend to fall under one of the two previous categories since they would involve touch or hearing and for that reason need not be elaborated. The built-in ability to verify the figure-ground process means that the major requirements of the ANISA learning competence paradigm have been met.

DEVELOPMENTAL CONSIDERATIONS

An attempt to delineate the development of figure-ground perception is

open to a great deal of controversy. As seen earlier in this pager, the figure-ground process is dependent upon various sub-processes which emerge at different periods in a child's development. Since some of these sub-processes are affected by learning and experience, the specific age levels may vary. Thus, the main value of chronological charts is to provide a sense of the general sequence in which these sub-processes appear.

In determining developmental considerations, a chart is presented here which attempts to demonstrate the development of differentiated perceptual skills that comprise figure-ground perception.

Age	Behavior
40 to 60 days	Children able to see movement and notice changes in size.
30 to 180 days	Children's ability to distinguish fine lines improves (eight times). They are able to see now straight lines like this: whereas before they could only see slanted lines of this type: 
300 days	Children able to notice depth. (Walk & Gibson, 1961, Walk, 1966).
24 months	Children unable to relate objects to themselves in ordering environment. Use other objects as a guide. (Miller, 1934).
24 to 30 months	Children learn most space words. (Holmes, 1932; Ames & Learned, 1948).
18 to 66 months	Children able to perceive position of one object in relationship to another object providing their vocabulary includes the proper space word. (Leuba, 1940).
3 to 5 years	Children can be educated to perceive the difference between up-down reversals. For

example, "p", "b", or "d", "q". (Davidson, 1935; Vernon, 1957; Rudel, 1959).

3 1/2 to 7 years — Children pay more attention to the bottoms of objects than to the tops. Example:

Not notice this --------

Notice this --------

(Kerpelman & Pollock, 1964).

3 1/2 to 8 years — Children are able to see the differences between objects pointing up or down, right or left or at different angles. (Rudel & Teuber, 1963).

4 to 5 years — Children become aware of color as a difference between objects. (Rubin, 1915).

4 to 7 years — Children arrange objects by making them level and straight up and down. (Strang, 1967).

4 years — Children are able to detect objects similar to an object pointed out by the teacher. (Rudel & Teuber, 1964).

5 to 11 years — Children are able to perceive depth more clearly. (Gilinsky, 1960).

9 to 11 years — Children begin to be aware of depth as a way of ordering objects. (Lowenfield, 1957).

11 to 13 years — Children begin to gain perspective. (Lowenfeld, 1957).

13 to 17 years — Children reach perceptual maturity. (Lowenfeld, 1957).

Unfortunately, there is no direct data on the developmental stages or sequences of figure-ground perception. One reason is simply the lack of longitudinal studies concerning this process. Some of the studies indicated here and in the body of this paper recognize an age pattern for developing a perceptual skill relevant to the process, but the integrated pattern of development needs to be researched.

EDUCATIONAL OBJECTIVES

PROTOTYPICAL LEARNING EXPERIENCES

Objective: To provide an exercise in figure-ground perception by attempting to differentiate various figures from ground.

Age-level: 2 - 5 years

Material: One felt board

Several sets of felt shapes as follows:

One set of small, medium and large shapes containing four shapes: square, triangle, rectangle and circle. Each set of shapes should come in four colors as follows: one color to match the background, one color opposite to the background, one bright color and one dull color. This means the teacher will have 16 different shapes for each of the three size-ranges.

Screen

Personnel: One questioner.

One child.

Procedure: Mount several different sized, colored and shaped objects on the felt board while keeping the child from observing this procedure.

Take the child to the farthest of three predetermined distances (20, 10 and 5 feet, for example) and after showing him the felt board, ask him what he sees. This can be done in the form of a game by trying to see how many correct answers the child gets at each distance.

Bringing the child increasingly smaller distances from the felt board until all items are named. When the child

ascertains all the figures at a distance, change the objects on the felt board and let him try again.

As the figures get smaller and colors more similar to the background they should be more difficult to perceive.

Evaluation: Note the size, color and shape of the objects on the felt board and keep track of each child's ability to separate figure from ground from various distances.

Objective: To increase figure-ground perceptual ability.

Age-level: 4 - 8 years.

Material: Any picture using embedded figures as seen in a child's puzzle book under the heading of, "Hidden Objects". Another more difficult task would be using geometric shapes, sub-divided into other shapes. (see figure 5).

Personnel: One observer.

One child.

Procedure: Present the child with the task of finding as many figures as possible in the picture.

Evaluation: Note the picture given to the child and then score the number of figures recognized without assistance and with assistance.

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