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A PROPOSED TAXONOMY OF THE PERCEPTUAL DOMAIN AND SOME SUGGESTED APPLICATIONS.

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THIS PROPOSAL FOR A PRELIMINARY TAXONOMY OF THE PERCEPTUAL DOMAIN, ORGANIZED ON THE PRINCIPLE OF INTEGRATION, DREW ON GUILFORD'S THEORETICAL AND FACTOR-ANALYTICAL WORK, ON WITKIN'S FIGURE-GROUND STUDIES, AND ON THE "TAXONOMY OF EDUCATIONAL OBJECTIVES" MODELS. THE TAXONOMY CATEGORIES ARE SENSATION, FIGURE PERCEPTION, SYMBOL PERCEPTION, PERCEPTION OF MEANING, AND PERCEPTIVE PERFORMANCE. POSSIBLE APPLICATIONS OF THE TAXONOMY ARE ILLUSTRATED BY THE CLASSIFICATION OF TWO DIFFERENT BEHAVIOR TYPES, EACH HAVING A CLEARLY PERCEPTUAL BASIS. A HIERARCHY OF TESTS WAS DEVISED, RANGING FROM THE SIMPLEST SENSORY TO THE MOST COMPLEX BEHAVIORAL TASK, TO MEASURE AUDITORY DIAGNOSTIC ABILITY IN STUDENTS OF AUTOMOBILE MECHANICS. SEPARATE TEST BATTERIES OF MUSICAL ABILITY, THE "SEASHORE MEASURES OF MUSICAL TALENTS" AND THE "WING STANDARDIZED TESTS OF MUSICAL INTELLIGENCE," WERE PLACED IN THE TAXONOMY CATEGORIES WITH ADDITIONAL NECESSARY TESTS SUGGESTED TO ENCOMPASS THE PERCEPTUAL DOMAIN. PERCEPTUAL ANALYSIS MAY BE USEFUL IN INDICATING THE LEVELS AT WHICH INDIVIDUAL PERCEPTUAL DIFFERENCES OCCUR. OTHER APPLICATIONS OF A TAXONOMY OF PERCEPTION ARE ALSO SUGGESTED. (WR)

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# A Proposed Taxonomy of the Perceptual Domain and Some Suggested Applications

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## Preface

During the past decade, research in perception has undergone a change in emphasis. Whereas earlier investigators had been concerned primarily with characteristics of various stimuli and with sensory neurophysiology, many present-day studies consider, in addition, individual differences among perceivers. This new approach has disclosed important relationships between perception and personality, some of which may have a genetic basis and some of which are probably learned or culturally determined.

Perhaps the most important single step in this recent direction of research interest was taken as far back as 1945 when Witkin, in an attempt to discover which cues utilized in the perception of the upright were most important under various conditions, discovered instead marked individual differences in spatial orientation. Pursuing the subject further, he concluded that although perceptions basically are anchored to external stimuli and are dependent on the sensory and neural apparatus, individuals under the same conditions of stimulation, manifest distinct perceptual styles. When subjects are presented with clear-cut situations, their differences may be only minimally expressed, but when the stimulus situation is ambiguous and contains conflicting elements, individual differences may play the most important role in determining the perceptual outcome. Witkin in his laboratory has pinpointed a phenomenon that those interested in the expression of personality have long observed in the field.

In 1959, Guilford and his group at the University of Southern California devised a three-dimensional model of "intellect" consisting of one hundred 120 twenty cells, each presumably describing a different "factor." By 1966, Guilford and Hoepfner, working on the principle that two tests showing a high intercorrelation must contain at least one factor in common, were able to set forth at least one test for almost every one of these factors. Although not all psychologists are ready to accept this factor-analytical "structure of intellect," it appears to be supported by more systematic research than competing theories.

A decade ago, Benjamin S. Bloom assembled a committee of well-known educators, later known as the Bloom Committee, who searched the literature and plumbed their thinking to identify and classify the kinds of student responses that might be considered desirable outcomes of education. They attempted to locate these behaviors on a continuum within a large matrix that eventually crystallized into three domains: cognitive, affective, and psychomotor. The greatest number of the educational objectives compiled were concerned with cognitive behavior, which varies from simple recall of learned material to synthesis and evaluation of new material. Many objectives that were considered important but difficult to formulate concerned affective behavior, which varies from simple attention to complex expressions of attitudes, interests, and values. Few educational objectives that deal with neuromuscular coordination were found in the literature, and the psychomotor domain remains to be structured. The Bloom Committee delineated behavioral hierarchies for the domains of cognition and of affect, which together form a classification of educational goals known as The Taxonomy of Educational Objectives.

The present report is concerned with an attempt to define a domain of perception and to formulate in a preliminary way its taxonomy, after the fashion of the existing taxonomies. The hierarchical categories proposed were based on the factor-analytical findings of Guilford, and consideration was given to the individual variations in perceptual style identified by Witkin. It is hoped that ideas presented will provide the groundwork for a hierarchy that will be scientifically based and yet broad enough and pragmatic enough to serve the needs of the education profession.

The author would like to thank Benjamin Rosner, William E. Coffman, and Samuel J. Messick for their invaluable assistance in carrying out this project. She is especially grateful to Charles T. Myers for his many helpful suggestions and his continuing advice and encouragement.

## Summary

The present report describes a proposal for a preliminary taxonomy of the perceptual domain organized on the principle of integration. The proposal draws on the theoretical and factor-analytical work of Guilford, on Witkin's figure-ground studies, and on the models set forth in the Taxonomy of Educational Objectives. The major categories of the taxonomy, defined and illustrated in the report by suitable tests, are as follows:

- Sensation
- Figure Perception
- Symbol Perception
- Perception of Meaning
- Perceptive Performance.

Possible applications of the taxonomy are illustrated by the classification of two different types of behavior, each having a clearly perceptual basis. The investigator first attempted to devise, in broad outline, a hierarchy of tests, ranging from the simplest sensory ability to the most complex behavioral task, that would serve as a measure of auditory diagnostic ability in students of automobile mechanics. She then examined two well-known test batteries of musical ability, the Seashore Measures of Musical Talents and the Wing Standardized Tests of Musical Intelligence, and placed the separate tests in the categories, suggesting additional tests where necessary to encompass the domain.

A perceptual analysis may be useful both to researchers and to educators in indicating the levels at which individual perceptual differences may occur. Other possible applications of a taxonomy of perception are suggested with the hope that the ideas presented here will lead eventually to a more refined delineation of this domain.

A Proposed Taxonomy of the Perceptual Domain
and Some Suggested Applications

## Introduction

The Bloom Committee has undertaken a systematic classification of educational goals that has been widely discussed. In an attempt to formulate the ways in which the educational process is expected to change students' behavior, it divided the educational sphere into two main categories, I. The Cognitive Domain and II. The Affective Domain, each of which is further structured into a logical hierarchy from a simple or concrete expression to a complex or abstract expression. Work on the cognitive domain, the easier of the two to analyze and exemplify, was completed in 1956; (Bloom et al., 1956); the hierarchy of affect followed in 1964 (Krathwohl et al., 1964). Educators have found the Taxonomy, particularly the classification of cognition, to be of great value. It is used by Educational Testing Service in the construction of Cooperative Test Division tests, by the Biological Sciences Curriculum Study in test planning, in the California school system for test development, and in certain medical examinations. In addition, it has served as a model for the construction of other classifications, for the organization of curricula, and for the evaluation of teacher performance (Kropp et al., 1966).

The authors of the Taxonomy suggested that, in addition to the domains already described, there may be a third sphere of interest in educational studies: the psychomotor domain. The importance of psychomotor performance can be seen readily, particularly in teaching simple motor skills to young children and to brain-damaged children; in the teaching of special subjects such as physical education, typing, and dancing; and in the playing of musical instruments. A classification of this important area would be welcome. The investigator suggests that still a fourth educational component, one often neglected in secondary school teaching, is the domain of perception. In view of important new research findings it seems worthwhile to consider perception as a domain separate from cognition and to attempt to formulate a structure of this domain, either to be used together with the Bloom Taxonomy, or to be included in aptitude test batteries, or to supplement performance tests in special areas such as music, art, and—perhaps most important of all—beginning reading.

A person responds to his environment as a total organism, and it is generally agreed that any attempt to divide his responses into "domains" is necessarily artificial and does violence to the unity of the respondent, just as the academic division of knowledge into courses does violence to the unity of knowledge. Elements of feeling and perceiving are surely involved in thinking. Psychologists have questioned the possibility of "imageless thought"; perhaps "perceptless concepts" cannot exist, or are comparatively rare. Perception is also intimately involved with affect. The use of the Rorschach test demonstrates an increasing emphasis on perception as a process through which personality is expressed. Plainly no one class of mental activity is entirely devoid of parts of other classes, and all three domains are related to each other and to psychomotor performance in a complex and poorly understood fashion. However, granting the arbitrary nature of any classification system, a description of domains, like a curricular outline, is justifiable on practical, heuristic, and philosphical grounds. Among the reasons that might be set forth for attempting to classify perception are the following:

1. To supplement the already existing taxonomies in the construction and comparison of curricular and testing programs.
2. To clarify the terminology of educational objectives and thereby facilitate communication; specifically, to define precisely such expressions as "having a feeling" for something, having "diagnostic ability," and being "perceptive"—terms that are widely used but only vaguely understood.
3. To emphasize the underlying perceptual basis and unity of the various divisions of knowledge.
4. To emphasize that perceptual elements are present in learning situations and are subject to analysis, organization, and control, and perhaps even to direct teaching.
5. To develop areas of awareness, such as social and esthetic sensitivities, that are significant and yet are usually dealt with only peripherally and unsystematically in the classroom.
6. To aid in the teaching and testing of creativity, insofar as these are possible.
7. To aid in the construction of tests in the special subjects of music, art, the vocations, and the professions, where some of the existing tests may be less than satisfactory.

8. To encourage research in perception by facilitating the organization of relevant literature and the design of experiments.
9. To bring together research in perception and in education with the hope of illuminating areas of mutual concern that are often ignored.
10. To assist in school programs of psychology, guidance, and placement.

## The Nature, Development, and Training of Perception

Sensory perception involves an interaction between the "real" world and an organism. Early work on perception proceeded from the view that the external stimulus determined the perception. Within the past decade, however, the idea that perception is simply a passive reaction to external events has been largely abandoned. The present trend of experimentation treats perception as an active process in which the structure and function of the sense organs and nervous system form an important link between the organism and the external world. The evolutionary process of natural selection shapes the sensory and neural apparatus to the organism's particular mode of existence.

Not all organisms respond to the same aspects of reality. Bees, for example, cannot discriminate between red and black but can see into the ultraviolet. Their compound eyes cannot distinguish between circles, squares, and triangles, but probably can resolve the rapid flutter of an insect's wing into a series of distinct pictures. A bee flying over a daisy field probably sees the flowers below as blue-green hazy spots set in a yellowish sea and overhead a deep blue-violet sky. Our eyes, on the other hand, are well suited to slow-moving, earth-bound, contemplative creatures. One essential and obvious feature of human perception is that percepts are experienced as being external to the perceiver. In one sense, the world, as we experience it, has no intrinsic meaning since it is the product rather than the cause of our perceptual processes. From an evolutionary point of view, however, our perceptual impressions, while demonstrably incomplete and occasionally subject to illusion, must have corresponded closely enough with external reality to have enabled our species to flourish. As judged with hindsight, if the real world and our perceptions of it did not correspond in large measure, we would not be here. The same reasoning, of course, applies to bees.

The meaning drawn from a sensory experience, then, is affected not only by the nature and context of the stimulus and the physiology of the sensory apparatus, but also by the past experience and frame of reference of the perceiver. If perception is defined as the process of organizing sensory information into patterns of experience, one may well ask how, in the case of vision, a fleeting retinal image can account for the richness of our perceptual world. It is puzzling indeed that an object is usually perceived in its true shape, size, and orientation even when its retinal projection changes. Most psychologists have assumed that at birth infants receive simple sensory information that is built upon to produce the complex perceptual field of the adult. Bower (1966), however, investigating vision in eight-week-old infants, presented evidence that they can register most of the same information that adults can register but are less well able to process it. In his experiments, infants exhibited a surprising degree of depth perception, orientation discrimination, size and shape constancy, and shape-completion ability, utilizing cues given by motion parallax and binocular parallax, but his evidence suggested that the immature perceptual system can handle simultaneously only a fraction of the information registered, and that it is the processing, which presumably takes place in the central nervous system, rather than the sensory registration that undergoes maturation. This observation, and the fact that in his experiments infants did not respond to pictorial cues led Bower to suggest that perception does not depend on static retinal images at all but rather on information contained in sequences of images, an evolutionary adaptation of obvious benefit to a mobile organism.

The observation that infants misreach in their early attempts to grasp objects has sometimes been interpreted to mean that they lack depth perception. There is now a considerable body of evidence (Gibson and Walk, 1960) to indicate that animals and humans alike are able to discriminate depth as soon as they are able to move about and before any opportunity for learning takes place. Perhaps infants misreach because they misjudge their arm-length, a parameter that changes with growth, or perhaps they cannot process visual and kinesthetic information simultaneously. The gearing of the perceptual-motor system to vision rather than to changing body structures would be a biological advantage: this interpretation would be in keeping with an evolution-oriented point of view.

To what extent individuals differ in their perceptual capacities and to what extent known differences are hereditary is the subject of much current research. Color and taste blindness and related conditions have been thoroughly studied, and impressive advances have been made in the elucidation of chromosomal and genetic abnormalities, many of which result in mental retardation. However, complete absence of a characteristic or gross abnormality does not lie within the usual range of educational problems and will not be dealt with in this article.

Evidence of stable individual differences in what might be termed perceptual style is accumulating, principally from the laboratory of Witkin and his co-workers (1962). In the well-known rod and frame experiment, the subject is seated in a dark room where all that can be seen is an illuminated rod about a yard long and an illuminated square that frames the rod. Both the rod and the frame can be rotated about a common center and both are tilted when they are first seen. The rod is then rotated until the subject is satisfied that it is vertical. Under these conditions, some subjects consistently align the rod with the pull of gravity on their bodies, whereas others align it with the frame, even when the frame is tilted as much as 45 degrees. Most subjects align the rod somewhere between these two positions so that the expression of this characteristic, rather than being dichotomous, ranges in a continuum. Those who are able to overcome the influence of a surrounding field are termed field-independent; those unable to do so, field-dependent. This characteristic is not limited to visual perception, but is associated with a broad area of cognitive and personality functioning. Field-dependent people take a long time to locate a figure hidden in a complex matrix and often have difficulty with the block design, picture completion, and object assembly parts of standard intelligence tests, but they do as well as field-independent people on other parts of the tests. In the realm of social behavior, field-independent people have a greater ability to hold themselves apart from the pressures of their social environment, sometimes even to the point of isolation.

Men appear to be more field-independent than women, although in personal or social contexts, such as the observance of nuances of facial expression, the slight sex difference may be reversed. At its extremes, this characteristic represents contrasting modes, either analytical or global, of approaching a problem, whether the problem is concrete or symbolic. Those whose mode of perception is more field-independent can adopt either an analytical or a global approach to a task, whereas those who are markedly field-dependent are less versatile and must conform passively to the influence of the context. This finding, taken with the observation that people tend to grow less field-dependent as they grow older, suggests a developmental differentiation in the ability to perceive analytically and independently of context. The developmental change is particularly marked during the 8-13-year period. People who exhibit strong field-independence at early ages, however, exhibit it more strongly as they mature so that they are outstandingly analytical at all ages. Perceptual style tends to be established early in life and to remain relatively stable. Certain precise perceptions, such as those involved in graph reading or in the interpretation of perspective drawings, may be a matter of training. Hence a teacher cannot expect to find in the classroom definite perceptual types but only a tendency toward a particular perceptual approach. Vandenberg (1962) found some evidence that the analytical versus global style of perception may have a hereditary basis.

If many genes were involved in the determination of a trait, one would expect the trait to be expressed in varying degrees that, if plotted, would be distributed along a normal, bell-shaped curve. It is often assumed that behavioral and perceptual traits, like IQ, would display this mode of distribution if they were suitably measured and plotted. In a recent study, however, Stafford (1966) administered the Differential Aptitude Tests, Form A, to 111 pairs of monozygotic twins and found bimodality in the mean monozygotic standard scores for Spatial Relation, Spelling, Language, and Clerical Speed and Accuracy, suggesting the involvement of a single gene pair or at most only a few gene pairs. Bimodality has also been found in scores obtained from the Seashore Music Test, and space visualization ability also appears to have a hereditary component transmitted, in this case, by one or more sex-linked recessive genes (Stafford, 1959; Stafford, 1961). On the other hand, some experiments have shown the effects of training on spatial ability, that is, the ability to perceive and reproduce shapes with their dimensions and relations in due proportion. Worsencroft (1955) showed that college students specializing in certain technical areas such as engineering gained more in their spatial retest scores over an academic year than did students in other curricula. And Blade and Watson (1955) found that a spatial test given at the end of the freshman year of engineering study is more valid for predicting future academic performance than a similar test given before the students have had any engineering training.

There is a widespread assumption that perceptual abilities are largely inborn and are not subject to training past early ages. However, an increasing number of educators are beginning to test this assumption. To cite one example of recent experimentation, in 1964 a summer institute in Education Through Vision was conducted at Phillips Academy, Andover (Edmonds, 1964). Under the guidance of four art teachers, 22 secondary school teachers from various academic fields met to "repair the fracture between verbalization and vision." Engaging in painting, collage-making, and other forms of visual and tactile activity, they attempted to perceive unusual relationships of form and texture. Most of the participating teachers were enthusiastic about the experience and attempted to adopt this perceptual orientation in their classrooms. Judged on a preliminary basis after a year of study with these teachers, the ability of students to see unexpected and complex relationships and draw new meaning from them appeared to have improved.

To give an illustration of the methods employed, in one exercise, the figure-ground experiment, the teachers used black and white construction paper to create designs that allowed the eye to see alternately the black forms and the white forms as background. It was observed that inasmuch as a figure-ground construction is a balance of elements, it had some similarity to a mathematical equation, and the mathematical concept that adding a positive gives the same result as subtracting a negative was demonstrated visually. This visual metaphor can also be used to illustrate that what one does not do can be as important as what one does, in the laboratory, in civic affairs, or in personal situations. The figure-ground model may disclose a "unity in diversity," an important concept in biology, ethnology, and in many other fields; it may underline the interplay involved in an individual's achievement of harmony with his natural environment or with society; and it may sharpen perception of problems involved in the attempts of society to reconcile opposing groups to create a satisfying order. The cumulative effect of this type of training and its carry-over into other endeavors is currently under study (Trismen, 1966).

## A Suggested Preliminary Classification of the Perceptual Domain

A taxonomy is a classification or a set of classifications that is ordered on the basis of a consistent set of principles. Thus the order of the terms should correspond to the "real" order of the phenomena they represent, and the method of ordering should reveal their essential properties and significant interrelationships. In the cognitive domain of Bloom, there is some evidence, despite the difficulty of finding adequate response measures, that the more complex objectives are indeed more difficult to learn than the less complex ones (Kropp, 1966a; Kropp, 1966b), as one would expect of true taxonomy. Recently, Ayers (1967) performed a factor analytic study of 40 tenth-grade science questions classified according to the Bloom system, the results of which tentatively appear to justify its hierarchical nature. He suggested that, in order to validate the structure without question, it may be essential that all students be taught the content by programmed instruction, for unless the students' background is known, the questions cannot be precisely classified, e.g., a question that tests analytic reasoning for one student may merely test knowledge for another who approaches the question with a more sophisticated frame of reference.

At present there is no general agreement on the precise number and the nature of the separate factors presumed to comprise intelligence or aptitude. Guilford (1959) proposed a schematic representation of the "intellect," the three dimensions of which are as follows:

| Contents | Operations | Products |
|---|---|---|
| Figural | Cognition | Units |
| Symbolic | Memory | Classes |
| Semantic | Divergent Thinking | Relations |
| Behavioral | Convergent Thinking | Systems |
| | Evaluation | Transformations |
| | | Implications |

"Contents" is defined as "broad classes or types of information discriminable by the organism"; "operations" is described as "major kinds of intellectual activities or processes; things that the organism does with the raw materials of information." (It may be noted that the categories of Guilford's "operations" dimension closely resemble those of Bloom's cognitive domain.) "Products" is considered to consist of "forms that information takes in the organism's processing of it." Perhaps neither the "contents" nor the "operations" dimensions is hierarchical, but the names of the categories of the "products" dimension imply increasing complexity. When the categories of the three dimensions are arranged in a cubical fashion, the intersections generate 120 cells. Guilford claims to have developed at least one measure for almost every one of the "factors of intellect" implied by the cells.

In an attempt to formulate a classification that might serve as a point of departure for future work, the investigator borrowed the "contents" dimension of Guilford's classification scheme since it appears to depend most upon sensory perception, and modified it, taking into account the work of Witkin, to suit the measurement of student performance. A category of "sensation" was added and "semantic" was changed to "perception of meaning" to make that category more general. It was felt that the term "behavior" was unsuitable for the most complex category, since all of the categories, like those of Bloom, are measures of behavior; it was for this reason that the term "perceptive performance" was substituted.

The Guilford representation has the advantage of having incorporated the factor-analytical approach from the outset. Moreover, the categories of this classification are clearly separated and not too numerous for easy and consistent placement of test items, class projects, and curricular outlines. The proposed classification, which because of its factor-analytic underpinnings and for its consistency with the parallel work of the Bloom committee has been called a taxonomy, follows:

1. Sensation. Behavior that indicates awareness of the qualities of a stimulus or of material as perceived through the senses (hue, pitch, odor, etc.). May be further divided into various sensory modalities, visual, auditory, tactile, etc.
2. Figure Perception. Behavior that indicates awareness of entity, or what is commonly called a percept (size, form, location, position, etc.). Also awareness of the relationships of parts to each other and to the whole, and awareness of relations between the parts and the background, or between the stimulus and its context. Figure-ground perceptual organization.

3. Symbol Perception. Behavior that indicates awareness of percepts in the form of denotative signs having no significance in and of themselves, such as letters, digits, and other signs usually organized as in alphabet and number systems, the relationship among tones in a musical chord or scale, or colors in a visual spectrum, when meanings and form are not considered. The ability to name the percept or assign it to an appropriate class, to indicate similarities and differences between percepts.

4. Perception of Meaning. Behavior that indicates awareness of the significance or value of a percept or symbol. The discovery of new relationships or insight into cause and effect relations between symbols or percepts. The abilities to generalize, to understand implications, and to make decisions.

5. Perceptive Performance. Behavior that indicates sensitive and accurate observation. Diagnostic ability with respect to mechanical or electrical systems, medical problems, artistic products, etc. Insight into personal, social, and political situations in which awareness of attitudes, needs, desires, moods, intentions, perceptions, and thoughts of other people and one's self is indicated. Demonstration of a successful analytical or global approach to problem-solving in all areas of endeavor and of artistry and creativity in any medium.

Most of the auditory and visual tests proposed to illustrate the categories of this taxonomy have been devised or adapted from existing tests by Guilford and Hoepfner (1966) to measure their "structure of intellect" factors and are shown in Table I together with the "contents" and "products" class to which Guilford assigned them. Where the test name may not be familiar to the reader, a brief parenthetical description of the test is included.

Table I

Tests Chosen to Exemplify Proposed Taxonomy

| Proposed Taxonomy | Test | Guilford Categories (all "cognitive") |
|---|---|---|
| Sensation | 1. Seashore - pitch (see pgs. 16 & 17) | None - presumably Units |
| | 2. " loudness | " |
| | 3. " tone duration | " |
| | 4. " timbre | " |
| Figure Perception | 5. Block Design | None - presumably Units |
| | 6. Gestalt Completion | Figural - Units |
| | 7. Army Radio Code (Discriminate the code signals for several letters after instruction and practice) | Figural - Units |
| Symbol Perception | 8. Omelet Test (Recognize words whose letters have been scrambled) | Symbolic - Units |
| | 9. Illogical Grouping (Recognize short phrases spoken with grouping contrary to meaning of passage) | Symbolic - Units |
| | 10. Number Classification | Symbolic - Classes |
| | 11. Number Series (Find the rule for a series of numbers and indicate the next two) | Symbolic - Systems |
| | 12. Letter Series (Find the rule for a series of letters and indicate the next two) | Symbolic - Systems |
| Perception of Meaning | 13. Word Classification | Semantic - Classes |
| | 14. Verbal Analogies | Semantic - Relations |
| | 15. Word Matrix (Discover relations in rows and columns and supply the missing word) | Semantic - Relations |
| | 16. Guilford-Zimmerman General Reasoning | Semantic - Systems |
| | 17. Cartoons (Supply punch lines) | Semantic - Transformations |
| Perceptive Performance | 18. Missing Pictures (Select one of three photographed interactions that completes a given story) | Behavioral - Systems |
| | 19. Picture Exchange (Select a photograph which changes the meaning of a story by altering thoughts feelings or intentions of actions) | Behavioral - Transformations |
| | 20. Cartoon Predictions (Predict what will happen in a given social situation) | Behavioral - Implications |
| | 21. Demonstration of Diagnostic Ability | None - presumably Implications |
| | 22. Artistic Performance | " |
| | 23. Demonstration of Evaluating Ability | " |

When tabulated under the proposed categories and the Guilford "products" categories, it can be seen that the tests fall along an approximately diagonal line. Thus these two axes are connected by a group of tests.

Table II

Selected Tests Classified on Two Dimensions

| Proposed Categories | Guilford Categories | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Units | Classes | Relations | Systems | Transformations | Implications |
| Sensation | 1, 2, 3, 4 | | | | | |
| Figure Perception | 5, 6, 7 | | | | | |
| Symbol Perception | 8, 9 | 10 | | 11, 12 | | |
| Perception of Meaning | | 13 | 14, 15 | 16 | 17 | |
| Perceptive Performance | | | | 18 | 19 | 20, 21, 22, 23 |

Since the tests were chosen from the Guilford "products" dimension in which a probable hierarchy has been factor-analytically demonstrated, it is assumed that the proposed categories, which resemble the "contents" dimension, contain an implicit hierarchy. Moreover, the investigator submits that if the taxonomical nature of the Bloom cognitive domain becomes established without question, it will do so possibly because it resembles the "operations" dimension of the Guilford structure. The reasoning is that two nonhierarchical dimensions linked by a dimension that is inherently hierarchical become themselves hierarchical by implication.

## The Taxonomy Applied to Measurement in a Vocational Area

Analysis of the work of an automobile mechanic indicates that the demands of the job do not lie entirely in the cognitive domain but appear to involve special abilities such as mechanical reasoning. Tests of special abilities have recently been organized into comprehensive aptitude batteries for use in vocational guidance or personnel classification. The best known of these is probably the Differential Aptitude Battery published by Psychological Corporation. This battery consists of eight separately scored subtests that have been discussed in detail by Anastasi (1961). Such test batteries, however, rarely provide much information about aptitude for one vocation in comparison with another except for the rare person with extreme scores. Differential prediction of that sort requires more reliability and independence in the measures than is usually available. Table III lists for two groups of students the statistics for the eight scores of the DAT and their correlations with (1) ratings of proficiency as automobile mechanics by their instructors and (2) high school average grades (Bennett et al., 1959).

Table III

Correlations Between the Differential Aptitude Test and Two Different Criteria

| | Proficiency Ratings for Auto Mechanics Students (N = 84) | | | Average Course Grades for High School Boys (N = 245) | | |
|---|---|---|---|---|---|---|
| | Mean | SD | Correlation | Mean | SD | Correlation |
| Verbal Reasoning | 18 | 8 | .13 | 27 | 10 | .66 |
| Numerical Ability | 17 | 8 | .15 | 18 | 9 | .67 |
| Abstract Reasoning | 24 | 10 | .17 | 30 | 11 | .54 |
| Space Relations | 48 | 22 | -.04 | 46 | 27 | .53 |
| Mechanical Reasoning | 42 | 10 | .14 | 38 | 13 | .43 |
| Clerical Speed and Accuracy | 55 | 13 | .16 | 50 | 11 | .31 |
| Language Usage-Spelling | 31 | 24 | .15 | 48 | 25 | .50 |
| Language Usage-Sentences | 23 | 14 | .14 | 34 | 17 | .64 |

It can easily be seen that the DAT is far more effective in predicting school grades than in predicting ratings of ability as mechanics. Although these ratings may have had low reliability or low validity, these data are an indication of the difficulty of obtaining high validity coefficients for this type of criterion. In the three tests that are least academic, Space Relations, Mechanical Reasoning, and Clerical Speed and Accuracy, the auto mechanics students have higher average scores than the other group. Still there is no test in the battery in which the superior candidate for training as auto mechanic can clearly demonstrate his superiority.

The various trades and technologies appear to value highly the characteristic known as "diagnostic ability" which may be defined as the ability to recognize malfunction of a part or a system by perceptible signs. This ability, rather than simple manual dexterity, is viewed by many as characterizing the most promising auto mechanics students and is often considered to be an art as well as a science. It is obvious that sensory perception as well as intellectual capability play a major role in the diagnostic process. A good diagnostician may spend as much time listening to and touching a malfunctioning engine as he spends in using his tools or his knowledge, yet sensory tests are rarely included in differential aptitude batteries.

The auditory sense, then, appears to be invaluable for the diagnostic procedures of automobile mechanics. Tests for this sense can be recorded on tape using a high fidelity binaural recording system and need not be administered by specially trained persons. The following is an analysis of the perceptual diagnostic problems of automobile mechanics following the outline of the proposed taxonomy:

1. Sensation. Tests for auditory threshold, auditory range, and pitch discrimination. Possibly some of the Seashore tests would be applicable. (see p. 17)
2. Figure Perception.
   (a) Tests for awareness of a sound against a background of engine hum. Either sound or hum, both, or neither, may be abnormal. Example: slight knock against an engine hum.
   (b) Tests for discrimination among several sounds against a background of engine hum. One or several sounds, or hum, may be abnormal. Example: an engine hums, the springs squeak, and the cylinders miss. Can the student separate (but not necessarily identify) these sounds?
3. Symbol Perception. Tests for ability to identify which part or manipulation produces which sound in both normal and abnormal situations. Example: a tappet click superimposed on a background of engine hum. Student should be able to identify improperly adjusted overhead valves.
4. Perception of Meaning. Tests for cause and effect. Example: abnormal engine hum. Student should identify as muffler trouble or rough engine with backfire due to improper valve tuning or whirring due to engine turning over but not starting.
5. Perceptive Performance. The examiner (or the stem of the question) may describe operations performed on a car and the sounds resulting from them may be played on tape. The student should be able to identify the defect or propose further tests.

Example: you turn the key, step on the starter and you hear nothing. What do you suspect? Answer: the electrical system is at fault. Then you switch on the headlights and they go on. What do you suspect? Answer: a broken wire to the starter.

The general idea is that for categories 2, 3, and 4, one could play tapes of some sounds of malfunctioning in automobiles and by the kind of question asked or the kinds of choices presented to the subject, determine the limits of his capabilities. For example, category 2 would test whether the student is able to separate all the sounds involved in one complex sound; category 3 would test whether he knows what each of the sounds represents; and category 4 would test whether he can correctly identify the cause of the aberrant sound. For the "performance" category, one would try to reconstruct the diagnostic situation under examination conditions and ask the student to propose tests to identify the defect. Auditory diagnostic tests similar to those suggested could also be of importance in machine shop work, radio and television repair, and certain medical specialties such as cardiology, and might be incorporated in some of the aptitude test batteries. Possibly a similar series of tests involving taste perception could be of value to those engaged in food and beverage tasting.

## The Taxonomy Applied to Measurement in an Artistic Area

In contrast to testing in other fields, progress toward the measurement of artistic aptitudes has been relatively slow. This is attributable, perhaps at least in part, to the difficulties involved in testing perception and, in part, to the difficulty of setting artistic standards. In art, perhaps even more than in other areas, an individual may play any of a variety of roles, each with its own set of qualifications. A musician, for example, may be composer, performer, critic, teacher, or appreciator, or he may exhibit any combination of these talents. To cover the field of artistic aptitudes would require many different types of tests. But, granting these difficulties, some kinds of tests have been and can be devised to aid in the selection and guidance of music students.

From the psychologist's point of view, although most music tests devised by musicians, cover aspects of musical ability, they rarely distinguish between aptitude and achievement, a tenuous distinction indeed in the artistic area. Moreover, procedures of administration and grading are not standardized. Musicians, on the other hand, distrust many of the psychological tests because of the unmusical and atomistic nature of the materials used, usually a series of oscillator tones of varying frequency, duration, or rhythm. They contend that this type of fine discrimination is not really called for in the performance of most musicians. They also claim that the interpretation of test results is not subject to standardization in the usual sense. A poor sense of pitch may be a handicap for a player of stringed instruments, for example, whereas a poor sense of loudness is a more serious inadequacy for a pianist. To overcome this latter objection, the results of the individual tests in many batteries are usually reported individually.

The Seashore Measures of Musical Talents, a widely used instrument, attempts to measure sensory discrimination of the most elemental musical components. This battery includes tests for discrimination of pitch, loudness, and duration of tone, judgment of rhythm and timbre, and tonal memory. Seashore himself recognized that these sensory tests do not measure musical talent as a whole, and that they constitute only one tool in its measurement. Contrasting markedly with this approach, the Wing Standardized Tests of Musical Intelligence were designed to include genuinely musical material and, at least in part, attempt to measure the esthetic elements involved in appreciation. The major abilities assessed in the Wing battery are termed chord analysis, pitch change, tonal memory, rhythmic accent, harmony, intensity, and phrasing. In both test batteries a series of items of each class of abilities is played from a phonograph record. Within each class the discrimination tasks become increasingly difficult. It is of interest that the Seashore tests, particularly the pitch discrimination test, have been widely used outside the field of music for the selection of personnel for certain military and civilian jobs. For a detailed discussion of these and other music tests see Anastasi (1961) and Wing (1954).

The six tests of the Seashore battery, four measuring sensory discrimination and two figure perception, and the seven tests of the Wing battery fall rather easily into the proposed categories, as shown below. It may be observed that the first three Wing tests deal with ear acuity and could be classed as "figural" and the last four, which have been classified as "meaning," deal with preference or taste. Tonal memory is assessed in both the Seashore and the Wing tests, although in slightly different ways. None of the tests in either battery covers the area of symbol perception. Other tests often used by music teachers and discussed by Wing (1954) are included below under this heading. This category, then, and the category of "perceptive performance" would correspond to the type of musical performance elicited from students by musicians, thereby reconciling the musician's and the psychologist's approaches.

1. Sensation. Discrimination of pitch: judging which of two tones is higher

   Discrimination of loudness: judging which of two sounds is louder

   Discrimination of tone duration: judging which of two tones is longer

   Judgment of timbre: judging whether two tone qualities are the same or different

2. Figure Perception. Judgment of rhythm: judging whether two rhythms are the same or different

   Tonal memory: detecting which note is changed in a melodic phrase (Wing and Seashore)

   Chord analysis: detecting the number of notes in a single chord

   Pitch change: detecting the change of one note in a repeated chord (Subject indicates same or different)

3. Symbol Perception. Intervals: playing two notes separately or together and asking subject to name top note when bottom note is given or vice versa

   Cadences: playing two successive chords which produce an effect of full or partial completion and asking subject to state which gives a greater feeling of finality

   Variations: inverted and root positions of chords in both major and minor modes

   Resolution of discords: dominant 7ths, 9ths, 11ths, and 13ths with their inversions; augmented and diminished triads, etc. Subject asked to state which leaves him with the more rested feeling

   Key: melody played and subject asked to sing key note or alter the key of a few bars of a song and to locate place of key change

4. Perception of Meaning. Rhythmic accent: judging which of two performances of the same piece has the better rhythmic pattern

   Harmony: judging which of two harmonies is more appropriate for a melody

   Intensity: judging which of two playings of the same piece has the more appropriate pattern of dynamics

   Phrasing: judging which of two renditions of the same piece has the more appropriate phrasing

5. Perceptive Performance. Subject asked to perform a selection on an instrument of choice, or to compose a selection, or to listen to a selection and write a critique.

The use of tests of musical aptitude rests on the implicit assumption that this ability is largely dependent on innate factors. In connection with the earlier consideration of the relative effects of heredity and training on perception, it is of interest to note that the Seashore tests appear to be unaffected by music training. In a three-year retest of students at the Eastman School of Music, little or no change in mean scores was found; however it must be noted that this was a select group of students who were probably already superior in musical ability and experience. Other experimental studies have yielded inconsistent results (Anastasi, 1961). Wing (1954) referred to considerable evidence concerning the weakness of the Seashore tests to predict able musical performance although he reported that the results appeared to gain in validity if the total scores were used. His approach to the problem of music testing was empirical; he attempted to find those tests that proved the most efficient as judged by their agreement with the estimates of music teachers.

In his studies, Wing found little correlation between musical ability and general intelligence and postulated a specific and inheritable musical ability factor, analagous to but distinct from the general intelligence factor postulated by many psychologists. The correlation between five different intelligence tests and the Wing tests was of the order of .3, and that between the Wing tests and other academic measures was similarly low. Thus the forecasting efficiency of an IQ test for the results of the musical aptitude test was little better than chance. Wing also claimed to distinguish a "bipolar factor" dividing his tests and the persons tested into two main types—analytic and synthetic—and a third factor dividing tests and persons into those responding principally to harmony or to melody and possibly to rhythm. A developmental factor also appears to be in operation with respect to musical ability. In the Wing tests there is an increase in average total score with age, leveling off at about age 17. Ear acuity tests show steady growth with age from age 8 onward, while the appreciation tests show a negligible score up to age 11. It would be of interest to determine if performance on the Wing and Seashore tests could be improved by ear training before the age of 8.

## Conclusion

It may be noted that the proposed hierarchy not only incorporates a factor-analytic approach but also parallels the Bloom hierarchies as follows: (The juxtaposition of the terms is meant to indicate only relative order within the taxonomy and does not imply equivalence of psychological level.)

| Cognitive | Affective | Perceptual |
|---|---|---|
| 1. Knowledge | Receiving<br>Responding | Sensation |
| 2. Comprehension | Valuing | Figure Perception |
| 3. Application | Conceptualization | Symbol Perception |
| 4. Analysis<br>Synthesis | Organization | Perceptual Meaning |
| 5. Evaluation | Characterization | Perceptive Performance |

The principle of the classification of cognition is complexity; from "knowledge" to "evaluation" the intellectual operations become increasingly complex. Involvement is the principle on which the affective domain is organized. The emotional engagement increases progressively from "receiving" through "characterization." In going from the lowest to the highest level of the perceptual domain, the information registered by the sense organs is processed by an increasingly complex neural apparatus. "Sensation" involves primarily those pathways leading from the sense organs to the appropriate cortical area and those motor pathways necessary for a minimal response. "Perceptive performance," however, brings into play large areas of the sensory, association, and motor cortex and those areas of the nervous system involved in memory, judgment, and creativity. The behavioral response called for engages the total individual. It appears appropriate, therefore, to term the principle of the organization of the perceptual domain integration.

As in the case of the existing taxonomies, it is assumed that the same classification of student performance may be observed at different levels of education and in different schools, although in practice some variation in classification may be necessary to render the taxonomy applicable in all instances. It is also assumed that within the culture human perceptual ability is relatively universal in a statistical sense: similarities are greater than differences. There is, however, a geographical and cultural aspect to perception, as well as to cognition and affect, and none of the taxonomies may be applicable without modification to groups or classes differing widely from those of the culture in which they were developed.

It is entirely possible that a classification intended to facilitate psychological, genetic, and developmental studies may differ from a classification intended to be of assistance to educators. There is no objection, of course, to having more than one set of classifications for different purposes. The one suggested here is intended primarily to aid in seeing a possible range of educational objectives, the most usual of these being the transmission of information, appreciation, skills, and the quality of sensitive and accurate observation that may be termed "perceptiveness" which leads to insight, social awareness, and esthetic judgment.

There is a tendency on the part of educators, which is being challenged by programs such as Education Through Vision, to assume that the perceptual basis is inherently present in any given learning situation. Learning theory indicates that organized and related perceptions are better learned than those that are specific and isolated, and the taxonomy proposed here provides a basis for organization that is consistent with recent research findings and views.

The still very incomplete picture emerging from the research laboratory may be summed up as indicating that infants appear able to register, with respect to vision at least, the perceptual elements of their surroundings. As they mature they become increasingly able to process and relate the elements of sensory information adaptively so that their behavior conforms to the demands of the external world. At still later ages differences in perceptual ability and style, which may be in part hereditary, manifest themselves. To what extent these differences are trainable, teachable, or culturally determined is at present largely unknown.

The proposed scheme may possibly be useful to researchers and educators alike in pointing up the levels at which individual perceptual differences may occur. The earlier in the performance hierarchy a perceptual difference from the norm of a personal idiosyncracy occurs, the more one would expect the subsequent categories to be affected. If a prospective automobile mechanic, for example, were markedly field dependent (at the figural level) he might not be able to perform complex diagnostic analyses, and since this characteristic is probably not readily affected by training, he might be judged unsuitable for the vocation. Similarly in the case of music students, a poor ability to discriminate tone qualities (sensation), for example, would affect tonal memory (figural), interval identification (symbolic), and the judgment of harmony (meaning), and would render performance on a stringed instrument (perceptive performance) difficult. A poor musical composition by an otherwise competent student, in contrast, might be improved upon by further study. A music or art school might employ measurement of the first two categories, which appear to deal with more inherent characteristics, to select candidates able to profit from training. The last three categories, which appear to involve learning and experience to a greater degree, might be used to structure their training to lead to the desired behavioral outcome. A similar analysis could be made for the language arts, ranging from the problems involved in learning to read to those concerned with understanding and writing poetry.

Lastly, it might be mentioned that there is a characteristic of professional work that rarely appears in conventional tests: the professional person often has to find, identify, and describe his own problems, whereas the problems in most tests are listed and numbered; they are explicit, independent, and completely given. The difference between performance in these two situations may be related significantly to a person's perceptual capacities and may be assessed by tests encompassed under the "perceptive performance" category of the proposed taxonomy. It is hoped that the ideas presented will stimulate thought and experimentation that will lead eventually to a more refined delineation of the perceptual domain.

## References


Anastasi, Anne. Psychological Testing. (2nd ed.) N. Y.: Macmillan, 1961.

Ayers, J. D. private correspondence.

Bennett, G. K., Seashore, H. G., & Wesman, A. G. Manual for the Differential Aptitude Tests (3rd ed.), New York: Psychological Corporation, 1959.

Blade, Mary F., & Watson, W. S. Increase in spatial visualization test scores during engineering study. Psychol. Monogr., 1955, 69, No. 12 (Whole No. 397).

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R., Taxonomy of Educational Objectives. N. Y.: Longmans, Green and Co., 1956.

Bower, T. G. R. The visual world of infants. Sci. Amer., 1966, 215 (6), 80-92.

Edmonds, G. H. An experiment in visual training. Focus; The J. of the Mass. Council for Public Schools, Inc., Feb. 1964.

Gibson, Eleanor J., & Walk, R. D. The "Visual Cliff." Sci. Amer., 1960, 64-71.

Guilford, J. P. Three faces of intellect. Amer. Psychologist, 1959, 14, 469-479.

Guilford, J. P., & Hoepfner, R. Structure-of-intellect factors and their tests, 1966. Rep. psychol. Lab. Univer. S. Calif., No. 36, 1966.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. Taxonomy of Educational Objectives. Vol. 2. The Affective Domain. N. Y.: David McKay, 1964.

Kropp, R. P., & Stoker, H. W. The construction and validation of tests of the cognitive processes as described in the taxonomy of educational objectives. Cooperative res. Project No. 2117, 1966. (a)

Kropp, R. P., Stoker, H. W., & Bashaw, W. L. The validation of the taxonomy of educational objectives. J. exp. Educ. 1966, 34 (3), 69-76. (b)

Stafford, R. E. Evidence of an underlying genetic dichotomy for certain psychological traits. Paper read at Amer. Psychol. Ass., Cincinnati, Sept. 1959.

Stafford, R. E. Evidence for the sex-linked inheritance of spatial visualization. Paper read at East. Psychol. Ass., Philadelphia, Apr. 1961.

Stafford, R. E. Bimodal distribution of "true scores" by twins on the Differential Aptitude Tests. Percept. mot. Skills, 1966, 471.

Trismen, D. A. Planning tests to measure outcomes of the research program Education Through Vision. Princeton, N. J.: Educational Testing Service, May, 1966.

Vandenberg, S. G. The hereditary abilities study: hereditary components in a psychological test battery. Amer. J. hum. Genet., 1962, 14, 220-237.

Wing, H. D. Some applications of test results to education in music. Brit. J. educ. Psychol., 1954, 24, 161-170.

Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodenough, D. R., & Karp, S. A. Psychological Differentiation. N. Y.: John Wiley, 1962.

Worsencroft, R. R. The effect of training on the spatial visualizing ability of engineering students. J. engng. Drawing, 1955, 19, 7-12.