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ABSTRACT

Having rejected the assumption that children meeting the criteria of "unimpaired" possess the basic perceptual skills needed to organize raw data into meaningful symbolic units, and the notion that children less adept in these skills can be categorized as "learning disabled" or "culturally disadvantaged," the Learning Research and Development Center at the University of Pittsburgh initiated a project which resulted in the Perceptual Skills Curriculum. Organized into four goals, the project determined: (1) which perceptual skills are related to reading and arithmetic at the primary level, (2) whether such skills can be trained effectively, (3) whether training can be measured in classroom behavior, and (4) ways in which the training can be implemented in the classroom. It was concluded that perceptual skills can be managed in the classroom by using an organized testing and training program which recognizes individual differences among children. (A bibliography is included.) (HS)

LEARNING RESEARCH AND DEVELOPMENT CENTER

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THE DEVELOPMENT AND VALIDATION OF AN INDIVIDUALIZED PERCEPTUAL SKILLS CURRICULUM

JEROME ROSNER

The Development and Validation of an Individualized Perceptual Skills Curriculum

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The following have worked on this Project, at one time or another, during the past three years:

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The Development and Validation
of an Individualized
Perceptual Skills Curriculum

INTRODUCTION

Developers of instructional programs must make certain assumptions about the entering abilities of the student populations for whom their programs are intended. A significant proportion of such assumptions are related to the students' basic information processing skills. For example, every first-grade instructional program for unimpaired, or so-called "normal," children--children whose chronological and mental ages approximate 6 years; whose visual and hearing acuities are within normal ranges; who can speak intelligibly and manipulate a pencil with some control--assumes that the students already know, or will readily learn, the basic visual and acoustical communication codes used in that program. Individual differences in students' cognitive abilities are anticipated; indeed, provisions may be built into the instructional program to accommodate these differences. On the other hand, individual differences in the basic processes of organizing the sensory data--the media from which meaningful visual and acoustical information is constructed--are usually of less concern. The inference is that, if the children meet the criteria of "unimpaired," they will possess these basic aptitudes.

Unfortunately, such assumptions are false. During the past decade, for example, much attention has been given to two separate groups of children who though "unimpaired," enter first grade unprepared to deal with symbols in a reliable and efficient manner; one group has been categorized as "learning disabled"; the other as "culturally disadvantaged."

Children with learning disabilities have been the concern of many investigators (see, for example, Kaluger & Kolson, 1969; Frierson &

Barbe, 1967; McCarthy & McCarthy, 1969), including a special Task Force sponsored by the National Institutes of Health (Clements, 1966; Clements, 1969; Chalfont & Scheffelin, 1969). So far, however, there is little agreement as to cause, treatment, or even an appropriate descriptive name for this group. In addition to "learning disabled," they have been called perceptually handicapped, minimally brain damaged, children with cerebral dysfunction, neurologically impaired, and dyslexic. (For an extended list, see Clements, 1966.) What agreement there is centers on the identification of certain behavioral characteristics that tend to be common to the group, including indications of perceptual dysfunction. These children usually display all of the attributes of the "unimpaired," yet they do not profit from instruction in a normal fashion.

The second group, the "culturally disadvantaged," has also been the concern of a number of scientists (see, for example, Bereiter & Engelmann, 1966; Deutsch, 1965). These children, too, often show signs of perceptual dysfunction. The symbols of the classroom tend to cause them confusion. They, also, fail to profit from academic instruction in an expected manner.

There are, of course, basic differences between the two groups: socioeconomic status, for one; and the causal factors that are usually related to their learning problem, for another. Middle-class children who show unpredicted achievement problems are labeled as learning disabled, and the speculation about cause centers around central nervous system dysfunction. On the other hand, children from families of lower socioeconomic status who perform poorly in the classroom are generally characterized as culturally disadvantaged; the inferred cause here is related primarily to experiential factors. Either group, alone, is of sufficient size to cause concern; combined, their numbers are significant indeed.

Acknowledging this situation, and being committed to a concept of "adaptive education" (Glaser, 1971), the Learning Research and Development Center at the University of Pittsburgh initiated an effort in 1969--the Perceptual Skills Curriculum Project--to study the problem. Adaptive education, in this context, indicates recognition of the educator's responsibility to teach each child, and that academic failure, if it does occur, is to be attributed to the educator--not to the child. Therefore, such categorizations as "learning disabled," "culturally disadvantaged," or what have you, are really irrelevant, since they do not provide useful information about the individual child's educational needs; indeed, they tend to be useful only in that they can serve to absolve mainstream education from the responsibility of teaching such children.

The adaptive model provides the educator with two options, both of which may be applied: (1) attempt to define the optimum instructional program for each child; (2) provide the child with the training needed to acquire those skills that are prerequisite to successful performance in a specific instructional program.

Insofar as the first alternative is concerned, Glaser (1971) correctly points out that "there are few alternative paths through elementary school." The first alternative, therefore, appears to be ruled out for that age group. Perhaps, then, yet a third option should be proposed. That is, if a child does not manifest the abilities prerequisite to achieving the academic objectives of an elementary school curriculum, he should be placed in other, non-academic programs. This approach is commonly used with the mentally retarded. Maybe such an approach is justifiable for mentally retarded children; maybe it is not. One fact is clear, however. With children of normal intelligence, such an approach is utterly inappropriate. As Resnick (1972) points out:

> ...in urbanized and industrialized societies, there is probably no more important skill in gaining control over one's own life than reading and the associated skills of literacy. If this is so, then 'respecting' an individual's freedom to not learn to read actually means condemning him to a life of bondage.

If we accept Resnick's statement--and it is very difficult to reject--we must rule out, a priori, the third alternative. The Perceptual Skills Curriculum Project directed its attention to the second option: the modification of prerequisite abilities through training.

PROJECT GOALS

The Project organized its task into four major goals:

1. Identify those perceptual skills that appear to be directly related to the basic classroom tasks of reading and arithmetic at the primary level.
2. Given identified perceptual skills that do relate directly to classroom achievement, determine whether such skills can be trained effectively.
3. Given trainable skills that are relevant to classroom achievement, determine whether the effect of that training can be measured in the classroom behaviors. In other words, can transfer be effected?
4. Given affirmative responses to all of the above, describe the training in a way that will allow it to be implemented and managed in the classroom of a public school, as a Perceptual Skills Curriculum.

During the past three years, a series of research and development studies has been conducted in an attempt to achieve these goals. Basic mechanisms have not been explored; rather, a theme of empirical validation of clinical procedures has been followed. To a large degree, the goals have been attained; it is the purpose of this paper to describe the methods employed, the information gathered, and the current status of the Project. Before doing so, however, it will be helpful to state the rationale on which this Project was based.

The rationale was originally stated in a preliminary document: a working paper description of the projected design of an individualized Perceptual Skills Curriculum (Rosner, 1969). The following statement is not identical to that original statement. Three years of research have effected certain changes in concepts. The basic premises, however, appear to have been supported and are retained.

RATIONALE

An Operational Definition of Perceptual Skills

Perceptual skills, in the context of this paper, refers to the behavioral processes of analyzing and organizing raw sensory data--the "stuff" of communication--into meaningful symbolic units. Perceptual information, then, refers to the raw sensory data; symbolic information refers to specific units of perceptual data to which society has given a construct value. To make clear the distinction between perceptual and symbolic information, look at the two "messages" shown in Figure 1.

Figure 1

Both are constructed of "stuff"--visual sensations--in the form of ink traces on paper. Hence, both contain perceptual information. Both also contain symbolic information, but our ability to gain access to that information is directly dependent upon our familiarity with the symbols and the languages to which they belong. Both are, in fact, conveying the same information; both refer to the same animal. One, of course, employs the symbols of the English language; the other uses Chinese symbols. To the viewer who is familiar with the printed English language, the word "cat" is symbolic data, constructed from perceptual information. He will perceive it either as a word or as a series of letters, dependent upon his reading skills; once he has learned to discriminate the letters, he is not likely to perceive it simply as a pattern of interrelated lines.

On the other hand, if he is not also familiar with printed Chinese language symbols, he will treat those as perceptual data; an assortment of lines that create a graphic pattern. His unit of analysis will be the line rather than the symbol. The reader of English, when asked to copy the word "cat," will do just that--copy the series of letters that comprise the word "cat." When asked to copy the Chinese written representation of the word "cat," however, he will attempt to replicate a graphic pattern--he will draw interrelated lines rather than copy a visual representation of a verbal construct.

The opposite situation will exist for the individual who is familiar with the written Chinese language but not the English. He will view the Chinese symbols for what they are--organized visual representations of spoken language. To him it is the English symbols that will be viewed as a graphic pattern--an organization of visual sensations that lack symbolic content.

A similar contrast can be made between perceptual and symbolic acoustical information. Consider the same two messages in spoken form: /cat/ and /mou/. When spoken to a user of the English language, the former is readily perceived as a meaningful single unit--a construction of sequenced phonic events that conveys meaning. In contrast, the same sounds--"cat"--spoken to a user of the Chinese language who is not also familiar with spoken English, will be processed as perceptual information--as a pattern of sounds that lacks meaning and perhaps even precise organization.

How does this pertain to children's school performance, when only one symbol system is involved? The classroom typically provides an environment where meaningful information is generated, transmitted, received, and hopefully assimilated by the students and their teacher. Figure 2 illustrates, in general, the basic behaviors assumed from "unimpaired" children who have been placed in such an environment. Information, in the form of visual and acoustical sensations, is generated and/or presented by the teacher. The child is expected to organize these into matching, meaningful constructs: visually, as pictures or alphanumeric symbols; acoustically, as phonological constructs--that is, spoken words. Simply stated, even though he may not interpret the information correctly, the child is expected to "see"--perceive--what the teacher is showing him and "hear"--perceive--what the teacher is saying to him. In addition, if he is to meet the demands of a normal classroom, he is expected to display little difficulty in learning to produce visual and acoustical symbols that match those produced by his teacher and classmates. That is, he is expected to be able to "write" that which he is shown, and "say" that which he is told. Further, he must learn to represent sounds graphically (hear and write), and to represent visual symbols acoustically (see and say). To do all this, the child must understand the construction of the visual and acoustical symbols. To understand their construction, he must be able to sort out and order the sensory elements--the "stuff"--from which they were formed. He must "perceive" first, if he is to "understand."

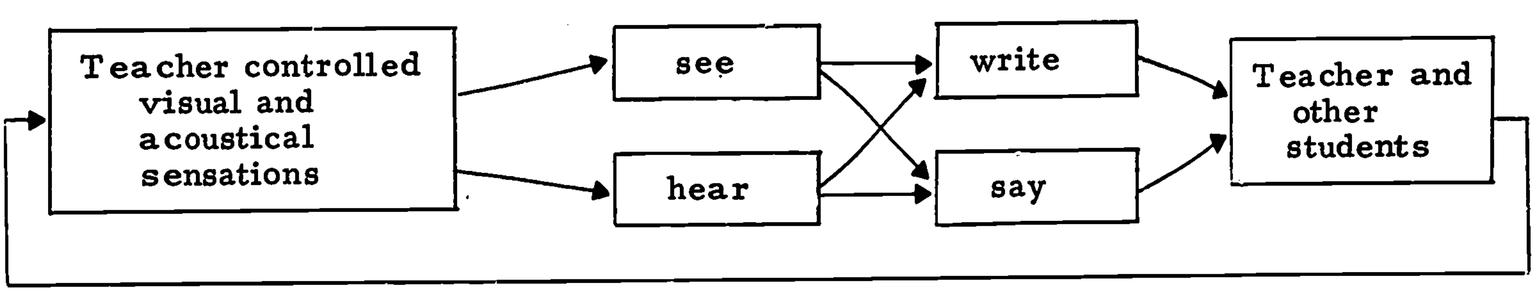


Figure 2

Not only must the student be able to perform all of these acts; he must be able to perform them easily, quickly, almost automatically. If the perceptual acts require great conscious effort, it follows that there will be less time and energy available for the interpretive aspects of the task. It is analogous to the conditions facing the student driver during his first driving lesson. He can see and hear well; his "equipment" is intact--it has been checked. He is sufficiently intelligent and adequately strong. Yet, during this first driving lesson, such an excessive amount of energy is devoted to survival--to controlling the automobile--that it is likely that his peripheral visual fields are effectively constricted; that he hears less keenly; that indeed he is operationally less "intelligent." He survives; he learns to drive. The behaviors that demanded so much conscious effort at first now become almost automatic. He can see, hear, and think more effectively while driving. He has learned to use his equipment efficiently. He has linked together a series of relatively small, segmented behaviors into larger and fewer units. He need not devote attention to a myriad of separate independent actions. He can now function on a higher level of organization.

A child entering the first grade with inefficient perceptual skills is in much the same situation as the novice driver. He is expected to receive and produce the sensory codes of the classroom reliably and efficiently. To be able to perform the behaviors reliably is not enough; unless they are also performed efficiently--almost automatically--there will be little time or energy available to sustain at and master the interpretive aspects of the task; and yet it is to these interpretive acts that his teacher will look when assessing the child's achievement. It is not enough to be able to "do it if he tries." One doesn't have limitless resources--the child cannot always "try hard." The result--probable failure, and worse yet, accusations that he was capable but just didn't try! This is particularly important in that the nature of the perceptual tasks presented to the first-grade child becomes more and more complex almost on a day-to-day basis. Hence, the child who "could do it if he tries" and did try to a sufficient degree during his first month in school, may very well find himself in an impossible situation in subsequent months, as the perceptual demands increase faster than does his ability to meet them.

For example, the child's first pre-primer and workbook pages present very simple formats; there are just a few large letters on a page. Why? Not because six-year-old children cannot see smaller print but, rather, because the publishers are acknowledging that the child is young and, hence, inexperienced in organizing complex visual presentations. Very quickly, though, the situation changes. Presentations do become more complex; letter size shrinks, and more print appears on a page. The perceptual tasks steadily become more demanding. It is assumed that the child's perceptual skills will be appropriate to this task as well as to the many other tasks that are presented daily in the classroom.

The assumption is correct for the majority of "unimpaired" children in the first grade; it is false, however, for a very significant number of their classmates (Rosner, Richman, & Scott, 1969). These are the ones who, in varying degrees, are less capable than expected in one or more of the performance skills described above: that is, in receiving and/or producing visual and/or acoustical sensations in a reliable and efficient manner. They can hear, see, speak, and manipulate a pencil, but their inefficiency in analyzing and organizing the sensations of the classroom into symbolic constructs prevents them from performing accurately, at the expected rate. They learn less of that which the teacher is teaching--they are underachievers. In one socioeconomic setting, they may be known as "learning disabilities"; in another, they are "culturally disadvantaged"; in either, they may be termed "lazy."

It is reasonable to assume that perceptual skills are developed, determined by both the child's biological integrity and his post-natal experiences. How do they develop? What experiences affect them? Two general principles of development apply. One, that all acquired motor functions proceed along a continuum from global to differentiated (Espenschade & Eckert, 1967). Secondly, that over time, the child's ability to analyze and order visual and acoustical data is less dependent upon the tactile-kinesthetic supporting cues derived from these motor functions.

In regard to the first principle, consider the motor skills of the neonate. In his first months of life he cannot voluntarily move one of his legs or arms without making compensatory, reflexive movements with the other parts of the body (Gesell, 1952). By the time he enters first grade, if development has proceeded normally, he will be able to perform such discrete acts as balancing, hopping on one foot, and skipping, all of which indicate that he has reached a level on the Global → Differentiated scale where he has sorted out many of his body parts, and his motor system is capable of reorganizing them in a variety of dynamic patterns.

Similar changes can be observed in prehension and vocalization skills. The global, reflexive grasp of the neonate develops into the palmar grasp of the one-year-old. Upon entry into first grade, the child will probably have sorted out the basic components of his hands--his fingers--to the point where he now has available a splendidly designed tool for exploring and manipulating his world in a very refined manner, as well as for controlling the movements of a writing tool efficiently--with two or three fingers of one hand (Gesell et al., 1940). In comparable fashion, the infant's undifferentiated cry is replaced by the toddler's initial vocabulary of a few words which, in turn, is expanded and refined into the appropriately articulated speech patterns of the first-grader (Lenneberg, 1967).

All of these changes appear to be the outcomes of normal growth and development. The extent to which they have occurred is, in fact, part of that which is probed when one attempts to assess maturation. If a six-year-old is significantly awkward, if he grips a pencil with four or five fingers instead of two, if his speech patterns reveal traits more typical of the four-year-old, he is described as "immature"--at least in respect to these specific behaviors; behaviors that are critically related to the classroom tasks he will be expected to accomplish.

Insofar as the second developmental principle is concerned--that is, the child's relative dependency on related tactile-kinesthetic cues in analyzing visual and acoustical data, it has been noted that "Perception is influenced by motor activity from the outset, just as the latter is by the former (Piaget, 1960, p. 87)," and that conceiving of sensory processes as independent of motor processes is "fallacious." The one-year-old appears to analyze his visual world more reliably if he is able to confirm that which he sees with some physical contact (White, 1970). As the child develops, he depends less upon overt tactile-kinesthetic information to confirm visual experiences. He acquires the ability to explore and organize with his eyes; the tactile-kinesthetic involvement becomes covert--it is internalized. In a sense, his hands have "taught" his eyes; he now can function as though imaginary hands extended from his eyes. He perceives visual data as though he were overtly manipulating it. He can explore vaster expanses of space with his eyes than with his hands--and do it much more rapidly, efficiently--clearly an advantage insofar as classroom performance is concerned. In effect, sensory-MOTOR functions have become SENSORY-motor, as an outcome of normal development. There is still a motor component in the behavior; it merely is less obvious (Zinchenko, 1970).

The motor component can and will become overt if the child--or, indeed, the adult--encounters sufficient stress to necessitate analysis of the sensations at a lower level of organization. One need only watch the five-year-old learn to count objects. Initially, he learns to touch the objects with his fingers as he simultaneously states the numerals. In time, he "touches" with his eyes and commences to perceive groupings of objects--subsets within the whole. Overt hand involvement is not needed unless he is presented with an array of objects that is not ordered; where they are scattered randomly within a field. In such situations, overt hand use--self-produced cues such as pointing, and perhaps even touching--will probably be evidenced.

A similar phenomenon may be noted in the sensory-motor behaviors related to speech and audition. The vocal mechanism, as it relates to audition, is in this sense the counterpart to the hand as it relates to vision. Until the child learns to mediate sounds visually, vocalization is the only reliable method he has for exploring what he has heard. As he matures, the child depends less upon explicit vocalization for analyzing spoken sounds. He develops the ability to analyze spoken sounds covertly--as though he had stated them aloud. Hence, again we observe a shifting from sensory-MOTOR to SENSORY-motor; and again, given a series of spoken sounds that are not familiar to the listener--be he adult or child--one will note manifestation of overt or sub-vocalization as a tangible means for analyzing that which has been heard.

Developmental studies (Zinchenko, 1970) have shown that these two basic transformations: "Global ⟶ Differentiated" and "sensory-MOTOR ⟶ SENSORY-motor," occur simultaneously. Indeed, they tend to be mutually reinforcing. The acquisition of more articulate manual and vocal motor skills provides for more precise exploration of visual and acoustical sensory data which, in turn, allows for more differentiated visual and auditory analysis behaviors that depend less and less upon tangible, tactile-kinesthetic confirmation as higher levels of organization are achieved. These more elaborate receptor skills then serve to monitor the vocal and digital manipulative skills more precisely, and so on. Hand and eye, speech mechanism and ear, function as though linked in a continuous loop, each component serving to refine the process of the other through feedback. Ultimately, as proposed above, overt explorations of visual and acoustical data become redundant and inefficient. Overt behaviors then become covert; explicit tactile-kinesthetic involvement becomes implicit. Thus the child acquires the basic information processing competencies needed to analyze and synthesize visual and auditory communications--the aptitudes assumed by the instructional programs of his classroom.

Visual-Motor Skills Development

What are these skills? It is easier to describe, first, how they are tested. Many visual-motor tests are limited to discrimination responses in which the child is asked to indicate whether two graphic patterns are, or are not, identical. Since appropriate classroom performance requires the child to produce perceptual constructs as well as receive them, discrimination tasks, as customarily designed, provide insufficient information. The ability to recognize similarities and differences in visual patterns is not equivalent to knowing the construction of patterns well enough to produce them accurately. Copying tests, therefore, serve our needs better.

Gesell (1940), Starr (1961), Bender (1938), and others have shown that most children, as they mature, are able to copy more complex geometric designs. As such, designers of primary-grade instructional programs logically assume that it is feasible to employ visual stimuli of comparable complexity.

What is involved in a copying task? What does the "good" copier know that distinguishes him from the "poor" copier? For example, why does one six-year-old copy the asterisk, an item in the Rutgers Drawing Test (Starr, 1961), relatively accurately, while his classmate, also six years old, reveals gross inadequacy in the same task? Figure 3 portrays two contrasting responses.

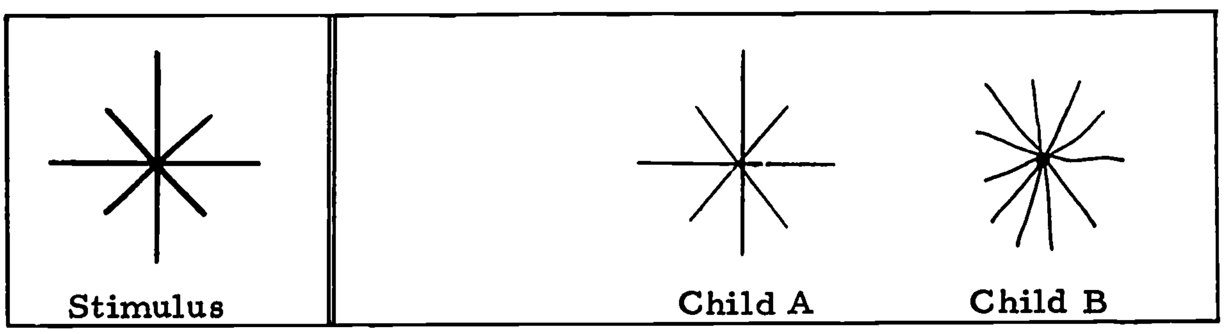


Figure 3

Does child A literally see more clearly than child B--is that the cause of B's inadequate response? That is not very likely. The relationship between visual acuity and copying skills is quite low (Rosner et al., 1969). What else then? Distorted vision?--does child B literally see the stimulus to be the way he has drawn it? Again, one cannot find support for such a notion in the currently available data. Poor drawing skills?--does child B draw what he does because he cannot control the pencil? This is indeed quite possible. Motor skills, however, can be tested with simpler forms and, in most instances, do not appear to be the cause of poor copying skills.

Why, then? The reasonable proposition is that child A perceives the stimulus to be constructed of a finite number of elements (lines) that interrelate in a specific way. Child B, on the other hand, perceives the stimulus to be constructed of a non-specific number of elements (lines) that interrelate in an imprecise manner. Child B views the asterisk much like an adult views a tree in full leaf, or any other complex visual construction. Given the task of "copying" a tree in full leaf, the adult will sketch, or represent, the trunk, branches, and leaves; under normal circumstances he cannot possible replicate the details--there simply are too many and their interrelationships are too intricate.

Child B's response indicates a representation rather than a replication. As he acquires the capacity to "see" a finite number of lines and understand their interrelationships, he will more closely approximate a replication of the stimulus design. Such a capacity seems to d pend upon certain basic skills. To "see" a finite number of lines implies a prior ability to sort out the elements--the salient attributes--of the design, either by discriminating them individually or by recognizing sub-assemblies of elements within the total pattern. At whatever level, the "sorting out" process can be enhanced by overt tactile-kinesthetic involvement (e.g., by tracing over the lines), and by verbal mediation (e.g., by counting the lines, by identifying them according to their spatial orientations, or by naming sub-assemblies--such as the + that is embedded in the asterisk--that have been recognized within the total configuration).

To order those elements requires an additional skill--the child must be able to view the lines as though they were plotted on a map of spatial coordinates. For example, consider the effect of presenting the same task--copying the asterisk--with one exception: the addition of two spatial coordinates--one vertical, one horizontal--superimposed on the stimulus, and a matching set of coordinates on the response space. (See Figure 4.)

Is it likely that the spatial interrelationships will be represented more accurately? Undoubtedly, given that the individual elements of the design had been recognized.

Let's go one step further. Again the asterisk is presented for copying, but this time it is superimposed by three vertical and three

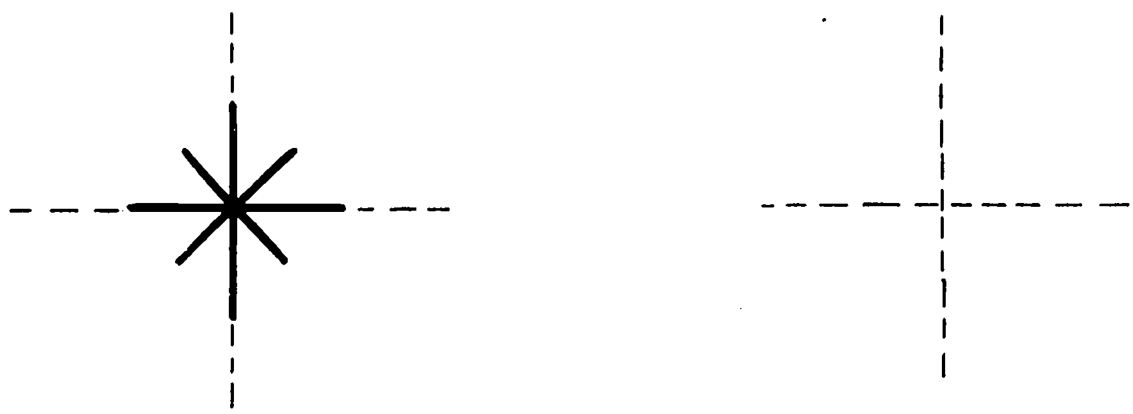


Figure 4

horizontal coordinates; matching coordinates are provided in the response space. (See Figure 5.)

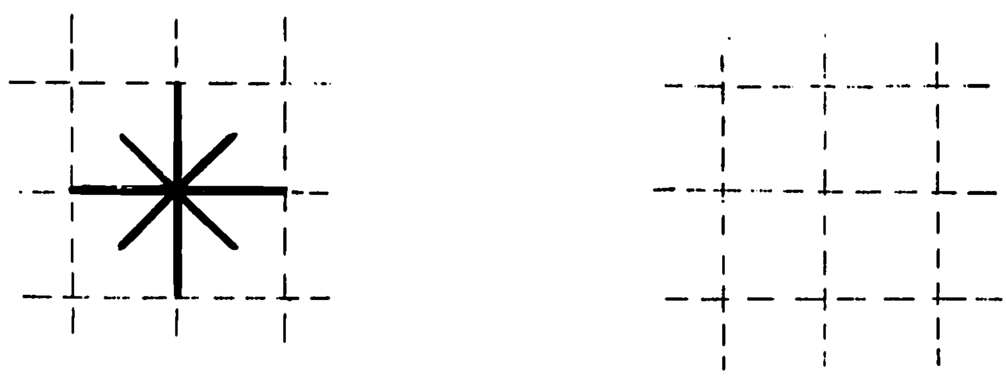


Figure 5

Does the task of replication become less difficult? Certainly--much additional organizational support has been provided.

Yet one more step. Again the asterisk--this time it is superimposed by five vertical and five horizontal coordinates, with matching coordinates provided in the response space. (See Figure 6.)

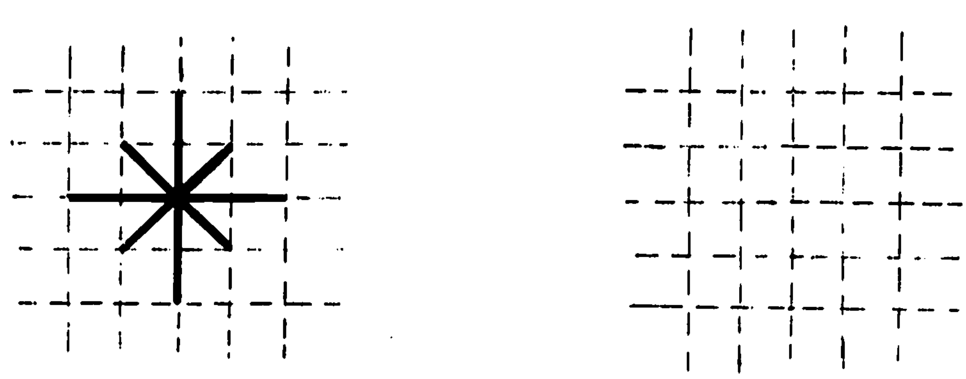


Figure 6

In this last format, the spatial interrelationships are fully displayed. All cues are overt--nothing need be inferred.

Now, look at the original asterisk and describe it verbally. You will use such spatial terms as "middle," "above," "half-way," "to the right," and so forth; terms that have no pertinence unless the space to which they relate has been defined by an implicit spatial coordinate map. It is reasonable, therefore, to assume that the copier who represents spatial interrelationships accurately, without additional organizational cues, is inferring such a map, using whatever other salient cues are available--such as the topological cues provided by the edges of the paper, and so forth.

In brief review, then, it has been proposed that growth and development normally provides the child with the capacity to analyze and reproduce increasingly complex visual constructs, wherein the unit of analysis --the salient attributes of the construct--also becomes increasingly complex and the organizers increasingly effective. Thus, there is less dependency on overt tactile-kinesthetic involvement with the visual data as well as less dependency on overt organizational cues within the stimulus field itself. To test a child's visual-motor skills means scaling his performance along three dimensions: If his sensory-motor skills are appropriately differentiated for his age, and if he displays no more need for overt tactile-kinesthetic cues and overt spatial cues than do his age peers, he will be judged as having demonstrated "normal" visual-motor skills. If his performance is less than satisfactory, the problem becomes one of determining where he was lacking--along which dimension(s) and to what degree.

<u>Auditory-Motor Skills Development</u>

Again, it is easier first to describe how auditory-motor skills are tested. Consider what is asked by most currently popular auditory perception tests. These, almost invariably, are discrimination tests that either ask for "same-different" responses to pairs of words, or ask the child to choose, from an array of three or four words, the two words that begin or end with the same consonant sound. None of these ask the testee to produce an acoustical construct; thus, none of these satisfy our criteria. Slingerland (1962) comes closer to our needs in the Echolalia subtest of her Test for Specific Language Disabilities. In this subtest, the child is asked to repeat certain words--words that are more likely to reveal auditory reception or production sequencing confusions; for example, such words as: hospital (e.g., hopsital), spaghetti (e.g., pizghetti), animal (e.g., aminal), and philosophy (e.g., phisolody). Unfortunately, the Echolalia subtest does not seem to discriminate well among primary-grade children unless their problem is severe. In addition, the subtest contains a distinct bias in favor of the child whose background has exposed him to the test item words.

There will be extensive discussion regarding a more useful instrument later in this paper. In the meantime, what does inadequate performance on an auditory perceptual task indicate? Poor hearing acuity?--only rarely. Does the child literally not hear the discrete differences between two very similar words?--such a statement would be very difficult to support with available clinical audiological data. What, then? Recall the illustration offered in the discussion of visual-motor skills. An inadequate visual perceiver was described as one who did not recognize that a visual construction was made up of a finite number of elements that interrelated in a specific manner. The description also fits the inadequate auditory perceiver. To illustrate the situation, state aloud: "Please sit down." Although speakers' styles vary, it is probable that the words were generated as "pleasesitdown"--a continuous stream of sounds. Spoken phrases, though composed of separate words, are rarely uttered in a way that acknowledges their separateness. They usually are blended together into a series of connected sounds. The responsibility for analyzing and organizing that stream of sounds into a series of words almost invariably falls to the listener. If that task cannot be perceived appropriately, the listener may be in much the same position as the individual who hears, for the first time, the once popular song: "mareseatoatsanddoeseatoatsandlittlelambseativy." As a stream of unorganized, meaningless sounds, recalling them is exceedingly difficult, if in fact even possible. If they cannot be recalled, then surely they cannot be organized according to semantic attributes; hence, meaningful information cannot be readily extracted from the sensations.

Most first-grade teachers have observed this phenomenon. Many a child has entered the first-grade classroom, having learned the "Alphabet Song," perceiving "lmnop" as a single letter. The anecdotes about similar confusions with some of the phrases of the Lord's Prayer, the Pledge of Allegiance, and other verbal presentations that were learned by rote, are ubiquitous. In most instances, the situation is benign; the result of a simple confusion that will not have a detrimental effect on learning. In some situations, however, the problem may be critical, and difficult to deal with because of the way in which acoustical information is typically presented, in contrast to visual.

Visual representations of speech, such as this printed sentence, follow certain rules. Individual manuscript letters are separated by small spaces; larger spaces separate the words. Capital letters begin sentences; periods end sentences. A second line of print parallels the first line; the third follows the pattern, and so on. Order is maintained; organization is provided. The visual sensations are treated in an organized way that enhances the viewer's chances for extracting information from the symbols. The burden for organizing a visual presentation does not rest solely on the perceiver; the presenter always shares in the task.

The rules are less precise and rigid in presenting acoustical messages. Certainly, the sounds must follow in some specific sequence, but they need not be organized to the same level as visual material. Much more variance is tolerated. Reflect upon the variety of speaking styles and speech patterns to which a child may be exposed in a school building!

It seems reasonable to suggest that the assumptions made regarding visual perception are applicable to auditory processing as well. To satisfy the auditory perceptual demands of a primary-grade instructional program, the child must recognize that spoken phrases consist of a finite series of phonic elements (salient attributes) that interrelate or occur in a specific way. Indeed, to master the basic decoding skills of reading, he must discriminate these phonic elements at the phoneme, rather than the word, level and be aware of the specific sequential relationships of those phonemes in a spoken word. He must not only appreciate that the word "cat" is constructed with three visual symbols, but that its acoustical construction is the product of three blended phonemes. It is true, of course, that children can and do memorize a limited number of words; sight reading vocabularies are important and within the repertory of all readers. However, no one can memorize all of the printed words of the language. At some point in the primary grades, regardless of the nature of the reading program used, sight-sound relationships must be developed at the phoneme level.

Acoustical events, such as occur in speech, do not have spatial attributes. As such, the salient cues that, in a visual presentation, facilitate the inference of a spatial map of coordinates, are not pertinent to auditory processes. Phonic events occur along the dimension of time, not space. It is only when we represent speech with visual symbols that a spatial dimension is called for--one that varies according to the conventions of the specific culture (e.g., English: left to right; Hebrew:

right to left). To provide some kind of a map for plotting phonic events, one must make available a structure that orders time. One such structure is rhythm; rhythm is organized time. Indeed, one reason why we tend to recall songs and poetry more efficiently than we do prose, even when there is no rhyming, is because of the overt cues--the orderliness--provided by the rhythm of the presentation. When there is also rhyme, the task becomes even easier; the regular pattern of salient acoustical attributes provides additional overt cues for organizing the sensations into meaningful sub-assemblies.

Thus, the rationale appears to be applicable to both visual and auditory perceptual skills development. To assess a child's auditory-motor skills means scaling his performance along three dimensions. If his ability to receive and generate articulated speech is appropriately differentiated for his age, and if he displays no more need for overt self-produced cues (in terms of vocalizing what he has heard) and for environment cues (in terms of requiring a more orderly presentation and/or visual mediation) than do his age peers, he will be judged as having demonstrated "normal" auditory-motor skills. If his performance is less than satisfactory, the problem becomes one of determining where he is lacking--along which dimension(s) and to what degree.

General-Motor Skills Development

Although this topic was treated to some degree in the first section of the rationale, additional comments should now be made. General-motor skills refer to those gross and fine motor processes that appear to have some relationship with visual and auditory perception. These include such gross motor functions as balancing, hopping, and skipping, as well as the more refined behaviors called for in eye movements, vocalizations, and digital manipulations.

As has been frequently stated in this paper, there are two primary sources of support available to the perceiver--the cues provided by the environment and those that he produces himself. These latter have been related to the tactile-kinesthetic information that is available to the visual perceiver by making physical contact with what he sees, and to the auditory perceiver by vocalizing what he hears. It is logical, then, that the more discrete these motor functions are, the more refined will be the support derived through tactile-kinesthetic exploration of the sensory data.

There is yet another viable speculation. It has been suggested that the child learns to organize two-dimensional space by inferring a set of spatial coordinates upon that space--by looking at visual patterns as though through a map of vertical and horizontal coordinates. It has been proposed that as the map becomes more differentiated--as more coordinates are added to it--more refined spatial relationships can be plotted. There appears to be some evidence that a positive relationship exists between the differentiation of body scheme, as demonstrated by such behaviors as hopping or balancing on one foot, the refinement of the map that the child infers on visual patterns, and the way in which certain performance tasks are solved (Witkin et al., 1962). The premise is that the more global the body scheme, the less differentiated the map of coordinates, and, thus, the less analytical the child's psychomotor skills.

The same proposition can also be extended to three-dimensional visual space. A strong argument can be made for the hypothesis that man organizes visual space on an inferred map of coordinates representing the three dimensions of vertical, horizontal, and relative distance from self (Gesell, Ilg, & Bullis, 1949). Spatial localizations are relatively accurately made in a lighted, well-defined space in which objects are positioned in an orderly fashion (e.g., a furnished room). They are more difficult to perform in a less well-defined space that contains few objects (e.g., an open field). They are most difficult--in fact, impossible--to perform accurately in an undefined space, containing no objects, and devoid of gravity (e. g., outer space) (Howard & Templeton, 1966). These observations can also be related to the proposed rationale. A well-defined space and the objects contained within it function as topological cues; the nodes from which the three-dimensional coordinates may be inferred. As the cues are removed, the viewer must infer those also; he must act as though they were present in the environment. Finally, when the very basic cue provided by gravity is removed, the viewer no longer has any basis from which to infer support, insofar as spatial localizations beyond arm's reach are concerned.

Is this pertinent to classroom performance? Undoubtedly! From his first day in school, the child is asked to shift his gaze between various points in the classroom space--the chalkboard, the wall, his desk, the teacher (in any number of locations), and so forth. To do this efficiently, he must direct his eyes accurately and make spatial judgments (particularly left to right directional shifts) with little, if any, overt tactile-kinesthetic involvement. The accuracy with which a child directs his visual gaze, the way in which he is able to maintain fixation upon the pertinent targets, the efficiency with which he shifts visual attention from blackboard to desk to teacher--all oculomotor behaviors--are functions of the relative organization of his visual space. If he cannot organize that space, if he views it as an undefined mass containing a disordered array of an indeterminate number of objects, he will display inefficient oculomotor skills. If, on the other hand, he has the capacity to order the visual space of the classroom, if he can plot the relative positions of the various visual targets in that room (teacher, chalkboard, desk, etc.) on an inferred, refined three-dimensional map of coordinates, he is more likely to display parsimonious oculomotor behaviors.

The implication is that the inattentive, distractible child is often reacting to the overwhelming (to him) demands arising from attempting to control oculomotor functions in a disorganized space. Admittedly, there is such a phenomenon as impaired oculomotor function that is independent of the conditions of the task. But, the child who can show adequate oculomotor behavior in one environment will predictably show it in any other that can be ordered to his level of need. (Although I will not elaborate upon it here, an operational space also contains an affective factor--and there is very good reason to suggest that a disordered "affective space" can also cause disruption of efficient processes. The child must develop the capacity to infer organization on relatively undefined psychodynamic spaces. Emotional maturity is, in effect, just that.)

An analogous relationship seems to exist between certain motor skills and auditory perception. As stated, a two- or three-dimensional map of coordinates cannot apply to the ordering of sequentially produced phonic events--events that occur over time. Temporal sequencing appears to be more closely linked to such rhythmic behaviors as skipping, rhythmic hopping (Kephart, 1960), and rhythmic tapping (Rosner et al., 1969), all of which require that the two body sides relate in synchronous fashion. Luria (1966) also suggests this relationship in his comments regarding auditory perception.

General-motor development, therefore, seems to be a pertinent factor in a discussion about perceptual skills, for at least two reasons. First, in that overt manipulation of visual constructs enhances the development of efficient visual analysis skills (Held & Hein, 1963) and that overt manipulation (vocalization) of acoustical constructs is important to the development of efficient auditory analysis skills. The refinement of these two sets of manipulative skills, therefore, contributes to the establishment of those differentiated perceptual abilities that are assumed in a first-grade classroom for the "unimpaired."

Secondly, it is suggested that the child's ability to order visual space is directly related to the level of differentiation achieved in his own concept of body scheme; and, that his ability to order acoustical events is directly related to the degree to which he has learned to interrelate his two body sides in a rhythmic, synchronous fashion. This does not imply that properly developed motor skills guarantee satisfactory auditory and visual perceptual skills; only that a relationship does exist.

If these assumptions are supported by empirical research, it will be evidence that the child's general-motor skills are important, not because they relate directly to such classroom tasks as learning to read and calculate but, rather, because they subserve critical, higher order perceptual skills that may, in turn, relate directly to classroom achievement. More than general motor differentiation is needed for adequate visual and auditory perceptual skills, however. It is one factor--but not the only one. Awkward motor skills do not necessarily predict unsatisfactory academic achievement; nor on the other hand, do highly differentiated motor skills necessarily predict capable classroom performance. The general-motor skills seem to be important, but primarily only as they offer support to the higher order perceptual skills of vision and audition.

Summary

The rationale, as stated, proposes that the ability to analyze the visual and acoustical constructs of the communication codes is critical to satisfactory classroom achievement. It further postulates that these analytical skills are closely interrelated with motor functions--particularly the fine motor skills of prehension and vocalization. The pervasive theme of this rationale has been that these analysis and organization skills interrelate and become more refined over time (Global $\longrightarrow$ Differentiated) as well as more efficient (sensory-MOTOR $\longrightarrow$ SENSORY-motor), depending less on both overt environmental and self-produced cues. Synthesis, production behaviors, has been stressed as the appropriate avenue for determining the degree to which analytical skills have been acquired; discrimination tests fall short of the mark.

Concern for parsimonious function has also been emphasized. Analysis skills are essential--but not exclusively. Analysis skills enable the child to disassemble a visual or acoustical construct--to sort out the coding elements and order them. Efficient classroom function, however, requires that analysis not continue to operate on this basic coding unit level; that as the child becomes familiar with the salient attributes of the classroom symbolic constructs, he will start to organize information at a higher level. That is, alphabet letters will not be analyzed down to the "straight lines and circles" level; eventually, printed words will not be analyzed down to individual letters, and so on. The basic unit of analysis will have expanded from relatively small, segmented bits to linked chains of behaviors--larger and fewer units. As such, just as with the student driver, the child will not need to devote energy to a myriad of separate actions; he will analyze constructs only to a level that is needed for efficient performance.

Goal 1 - Identify those perceptual skills that appear to be directly related to the basic classroom tasks of reading and arithmetic at the primary-grade level.

As stated in the rationale, the perceptual skills we sought to define were those that represented the child's ability to analyze visual and acoustical constructions according to specific attributes and to display these skills by productions rather than by recognition and discrimination responses. Our strategy was to: (1) identify currently available tests that probed what appeared to be critical perceptual skills; (2) administer these tests to a broad sample of preschool, kindergarten, and primary-grade children; (3) test this same population with appropriate standardized academic achievement batteries; (4) search for significant relationships between the children's performances on the various perceptual skills tests and their achievement test scores; and (5) given evidence of a significant relationship between a specific perceptual skill and one or more of the academic achievement subtest scores, analyze that perceptual skill in an attempt to discover the relevant dimensions of the behavior involved; this, in an effort to construct a test or series of tests that could probe the child's mastery of the basic underlying processes of that behavior, rather than his ability to meet the demands of a selected test item.

For example, given evidence that linked copying skills with some aspect of first-grade achievement, we then would search for a way of assessing the child's mastery of the generalizable processes required for copying designs, rather than concentrating on content--that is, on a specific geometric design or series of designs.

During the first year of the Project, the first four steps of the strategy were implemented. A number of perceptual tests were administered to approximately 300 kindergarten and first-grade pupils, at the beginning and, again, at the end of the academic year; these data were then related to the same population's scores on the Wide Range Achievement Test. The perceptual tests included two standardized visual-motor instruments: the Gesell Copy Forms (Ilg & Ames, 1964) and the Rutgers Drawing Test (Starr, 1961), and two auditory perception instruments: the Word Repetition Test (Rosner et al., 1969)--a shortened version of the Slingerland Echolalia subtest--and the Auditory Organization Test (Rosner, 1966). A number of other tests were tried and abandoned for a variety of reasons; the primary reason being those tests' inadequacies in discriminating well among children of this age, either because their criteria were too easy or too demanding.

Analysis of the data derived from this approach yielded some encouraging results. Some significant correlations were derived with indications that the auditory tests we used tended to predict reading achievement better than arithmetic achievement, and that the two standardized visual-motor tests appeared to be more closely related to arithmetic than to reading (Rosner & Cooley, 1971). Using these data, an attempt was made to determine the extent to which changes in perceptual skills affected end-of-year achievement in arithmetic and reading. Multiple correlations for the full set of predictors (i.e., beginning-of-year and end-of-year scores) were compared to multiple correlations using only the beginning-of-year scores. The differences between the multiple correlations using the first set of predictors and those using the total set of predictors reveal the amount of information, regarding achievement, in the second group of measures that was not in the initial set. The results of that analysis were consistent with the proposition that changes in perceptual skills, over the course of the school year, affect end-of-year achievement in both reading and arithmetic; that is, there is information in spring perceptual skills that is not in fall perceptual skills regarding end-of-year achievement.

Visual-Motor Skills

The next step, along with continued testing to replicate the above findings and to search for other pertinent predictors, was an attempt to discover the relevant dimensions of those perceptual skills that had been shown to meet the criteria of Goal 1. For example, it obviously was not the ability to copy the specific geometric designs of the two tests--the Gesell Copy Forms and the Rutgers Drawing Test--that was important. If Goal 2 was to be achieved--if we were to be successful in teaching the skills identified as pertinent--it was necessary to define the processes that applied to copying in general. Attending to the assumptions of the rationale, a series of studies was initiated to discover and describe a set of visual-motor tasks that would ask the following questions along a scale of increasing complexity: (1) Can the child demonstrate the ability to "see" a geometric design as a finite number of elements by reproducing those same elements? (2) Can the child demonstrate the ability to "see" the interrelationships between these elements, when they are presented on a map of coordinates? and (3) Can the child demonstrate the ability to infer a map of coordinates by reproducing a pattern, presented on a map of spatial coordinates, in a space where no map, or only a partial map, is provided?

Figure 7 illustrates the tasks that were finally designed, following a series of pilot studies: a 27-item battery, identified as the Visual Analysis Test (VAT: Rosner, 1971c). All of the first 18 items are administered in the same way. The testee is asked to "Make this side (Examiner points to response space on right side) look just like this side (Examiner points to stimulus pattern on left side). Draw the lines on this side (Examiner points) so that it looks just like this side (Examiner points)." For items 19 through 27, the Examiner adds "Some of the dots are missing on this side (Examiner points to right side). Don't draw

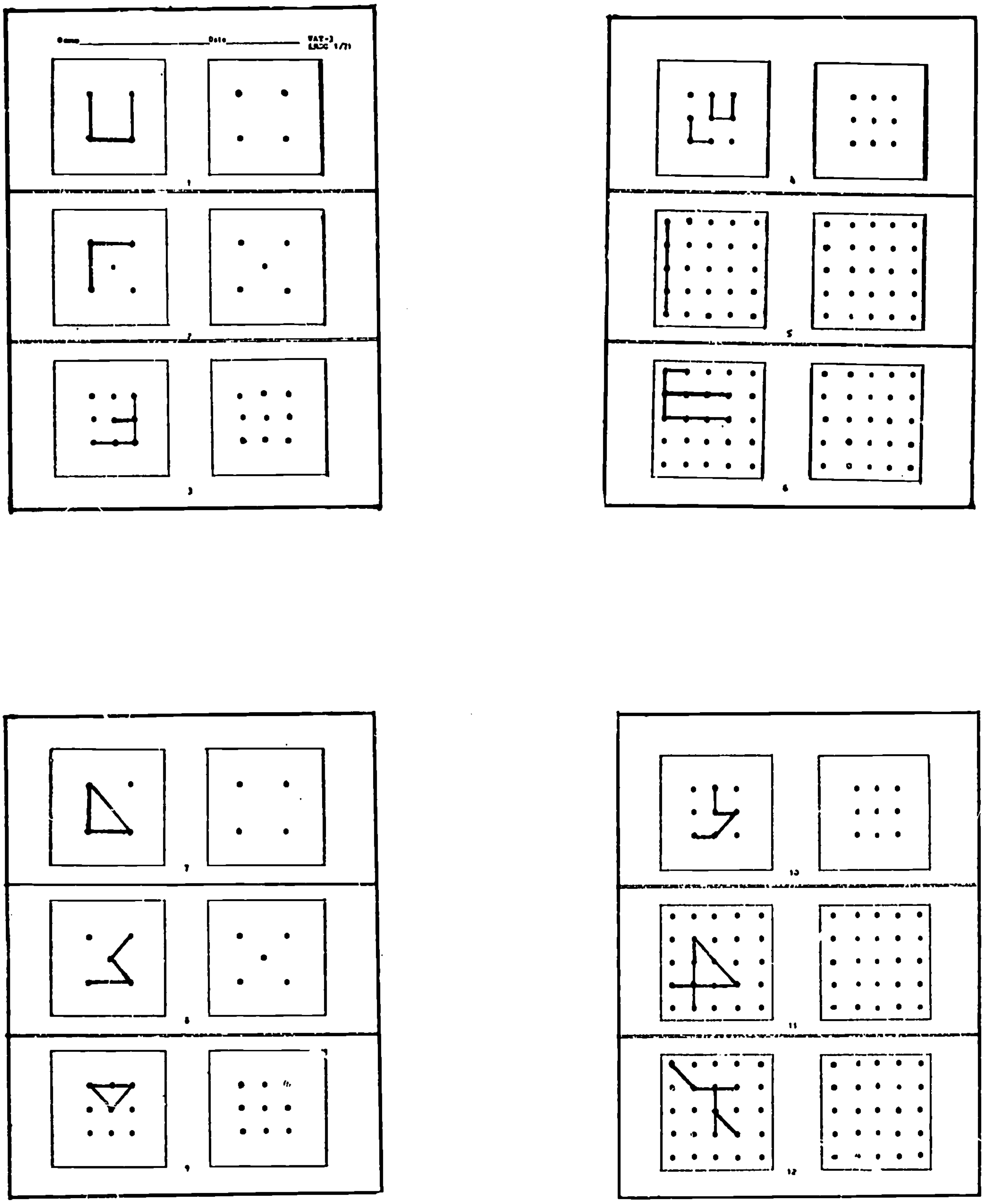
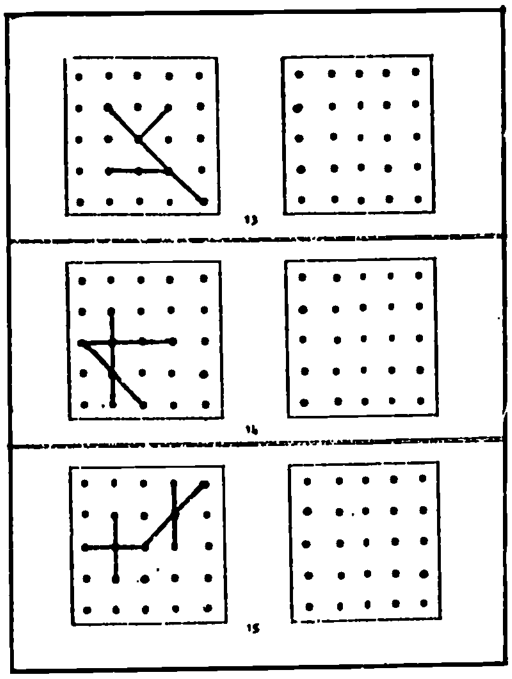
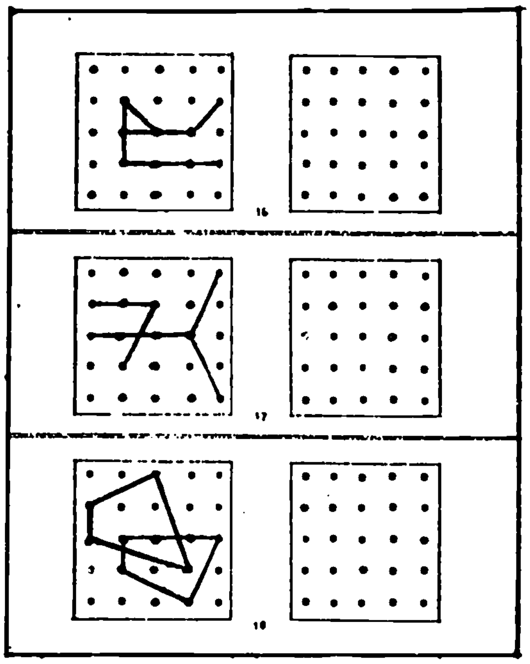


Figure 7

VAT Items (reduced to less than 1/6 actual size)





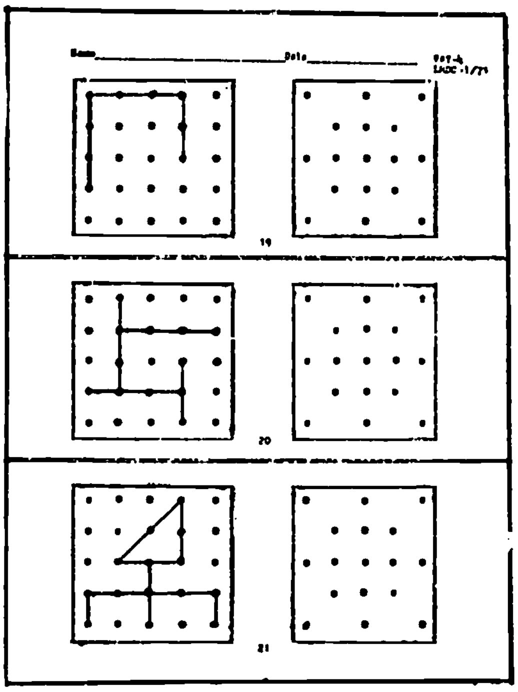


Figure 7 (continued)

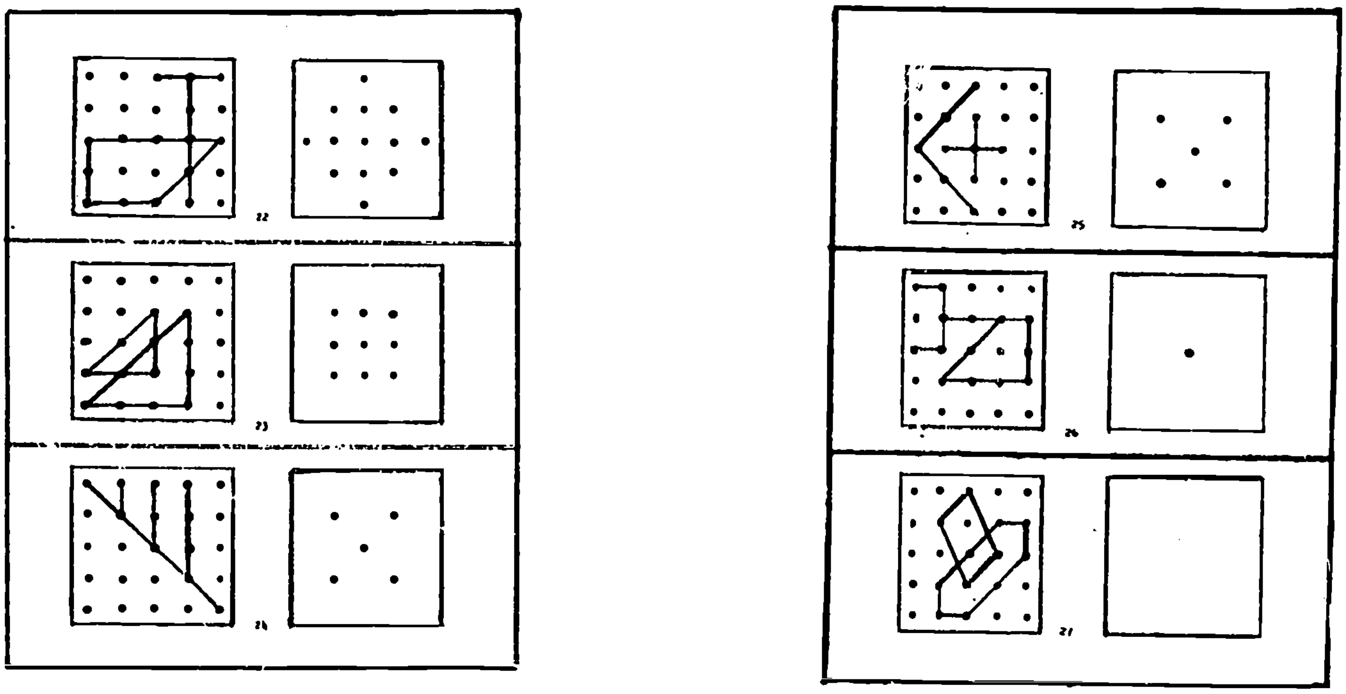


Figure 7 (continued)

the dots, just draw the lines as though the dots were there. Imagine (or pretend) that the dots are there." (For item 27, Examiner says: "All of the dots are missing... etc.")

Inspection of the test items shown in Figure 7 reveals the increasing complexity of the tasks along the three dimensions defined above: (1) the number of elements in the design; (2) the intricacies of their interrelationships and of the map on which the geometric design is shown; and (3) the number of overt spatial cues provided in the space where the response is to be drawn.

It seemed reasonable to postulate that if these were the relevant dimensions of copying skills in general, then scaling higher along these three variables should predict higher scores on a standardized copying test. Given evidence to support that hypothesis, it would then be possible, using items from the VAT, to define an organized sequence of instructional objectives for teaching the visual-motor analysis skills that underlie copying. That, of course, was the purpose of constructing the VAT. There is no need for another standardized copying test; our goal was not to produce a standardized test. Rather, we were searching for a way of describing and scaling the general processes of visual-motor development in behavioral terms.

To score the test, a transparency defining arbitrarily determined limits was prepared for each item; the transparency is superimposed over the child's response. The scorer then applies a relatively simple set of criteria to score each item on a three-point scale (0, 1, 2) that is based upon how closely the child's responses resemble the model. Possible scores range from 0 to 54. Minimum interrater reliability (Pearson Product Moment Correlation coefficients were calculated between three scorers, working independently on 100 randomly selected tests) in scoring the VAT was demonstrated to be .98; hence, the scoring procedure proved to be highly dependable.

The test was administered to 667 kindergarten, first-, and second-grade children, the total enrollment (of those grades) in three suburban Pittsburgh schools. None of these children had been tested before by this Project. Table 1 shows the means, standard deviations, medians, and ranges for each of the grade levels in each of the three schools. These data show a broad range of scores both within and across grades; they also show a direct relationship between the VAT score and chronological age, as indicated by grade level.

The next question was: do the behaviors tested by the VAT have any relationship to those sampled in a standardized copying test? To answer this, the 667 kindergarten, first-, and second-grade children referred to in Table 1 had also been tested with both the Rutgers Drawing Test[1] as well as the Visual Analysis Test, in that order. Pearson

[1] Form A of the Rutgers Drawing Test was used in the kindergarten and first grade. Form B was used in the second grade.

Table 1

VAT Mean, Median, and Range of Scores for Kindergarten, Grades 1 and 2

Grade	School	N	VAT Mean	S.D.	Median	Range
K	A	94	20.6	9.3	20	2-47
	B*	--	--	--	--	--
	C	161	16.2	8.7	16	0-42
1	A	83	33.4	7.7	34	15-48
	B	59	33.5	8.8	36	10-48
	C	73	31.0	9.9	32	7-48
2	A	74	41.2	6.1	42	24-52
	B	45	38.2	6.5	38	23-49
	C	78	34.3	8.2	35	13-49

* This school does not sponsor a kindergarten class.

Product Moment Correlations between the two test scores were .80 with the kindergarten and first-grade groups and .68 with the second-grade group; both coefficients are significant well above the .01 level of confidence. Clearly, relatively valid predictions concerning a child's performance on the Rutgers Drawing Test could be made from his responses to the VAT.

These outcomes support but do not confirm the basic objectives of Goal 1; that is, to identify perceptual skills that are directly related to primary-grade reading and arithmetic achievement. All that could be said from the study just described was that the VAT appeared to have much in common with the standardized Rutgers Drawing Test and that the former could be scored with a great deal more reliability than can most copying tests.

Yet to be answered were two critical questions: (1) Is the VAT directly related to the reading and/or arithmetic achievement of primary-grade children? and (2) If the first question is answered affirmatively, does the VAT predict achievement to at least the same degree as a well-established, standardized copying test? That is, can as much of the variance in academic achievement be accounted for by the VAT as by the Rutgers Drawing Test?

The following studies were conducted in an attempt to answer those two questions. The VAT and Rutgers Drawing Test scores of 154 first- and 153 second-graders (the total student population in those grades in two suburban Pittsburgh public schools) were related to this same population's Stanford Achievement Test scores in the subtests of Word Reading and Arithmetic Computations. Table 2 shows these correlation coefficients and the outcomes of the tests to determine the significance between these experimentally dependent correlations.

Table 2

Coefficients of Correlation between VAT, Rutgers Drawing Test, and the Word Reading and Arithmetic Subtests of Stanford Achievement Test

	Grade 1 (N = 154)			Grade 2 (N = 153)		
	Word Rdg.	Arith.	*p	Word Rdg.	Arith.	*p
VAT	.40	.55	<.025	.36	.58	<.005
Rutgers	.34	.35	NS	.40	.46	NS
*p	NS	<.0005		NS	<.025	

NS = not significant

*p = significance between experimentally dependent correlations

Notice that, while there is not much difference between the ways in which the Rutgers relates to the Word Reading and Arithmetic subtests, the VAT appears to be more closely related to the Arithmetic achievement scores than to Word Reading. For example, in grade 1, the Rutgers accounts for approximately 12 percent of the variance in both of the achievement subtests, while the VAT accounts for over 30 percent of the variance in the Arithmetic subtest scores in contrast to only 16 percent of the variance in Word Reading. There obviously is no significant difference between the two first-grade correlation coefficients that involve the Rutgers; on the other hand, the difference between the two correlation coefficients involving the VAT is different at a significance level of .025 ($t = 2.265$; $df = 151$).[2] Similar findings are shown in grade 2 also. Again, there is no significant difference between the two correlation coefficients involving the Rutgers (.40 and .46), while the difference between the two that include the VAT (.36 and .58) is different at a .005 level of significance ($t = 2.81$; $df = 150$).[3]

It is also important to note that, while both the Rutgers and the VAT appear to predict Arithmetic scores more closely than they predict Word Reading achievement scores, the VAT clearly outperforms the Rutgers. The latter, in grade 1, accounts for 12 percent of the variance in the Arithmetic achievement subtest as compared to the 30 percent accounted for by the VAT. This difference is significant at a .0005 level ($t = 3.764$; $df = 151$).[4] The same phenomenon, albeit to a lesser degree, is apparent in grade 2, where the difference between the two correlation coefficients (VAT and Rutgers), as they relate to Arithmetic, is significant at the .025 level ($t = 2.273$; $df = 150$).[5]

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[2] Word Reading • Arithmetic (grade 1) $r = .519$

[3] Word Reading • Arithmetic (grade 2) $r = .418$

[4] VAT • Rutgers (grade 1) $r = .696$

[5] VAT • Rutgers (grade 2) $r = .686$

As stated, these analyses were conducted to answer two questions concerning the VAT: namely, its capacity to predict primary-grade reading and/or arithmetic achievement and, given some positive indications regarding the test's predictive validity, its relationship to achievement as contrasted with a well-established, standardized copying test. The answer to the first question is apparent--the VAT is closely related with primary-grade arithmetic achievement, significantly moreso than with reading achievement, thus reaffirming the data reported earlier (Rosner & Cooley, 1971). More noteworthy, the VAT not only displays a close relationship to a standardized copying test; it also was shown to be a significantly better predictor of arithmetic achievement than was the Rutgers. Neither test outperformed the other in predicting reading achievement. These outcomes indicate that the VAT approximates Goal 1 objectives.

Auditory-Motor Skills

A similar approach was taken to identify those auditory perceptual skills that were pertinent to the goals of the Project; i.e., search for behaviors that were representative of auditory skills in general as well as being related to some aspect of academic achievement.

Referring once more to the Rosner and Cooley (1971) study, the auditory skills tested in that initial battery (Auditory Organization; Word Repetition) tended to show closer relationships to reading than to arithmetic. The next step here, then, was to discover and describe behaviorally the underlying processes pertinent to auditory perception so that we could design a method for testing them. Undoubtedly, it was not simply the ability to repeat the kinds of confusable words that appear in the Word Repetition Test nor the clapping patterns of the Auditory Organization Test. These obviously were two ways to sample for the presence of the skills listed in the rationale: namely, the child's ability to demonstrate that he recognizes spoken words as constructed of a series of finite phonic events that interrelate or occur in a specific sequence. They did not, however, isolate the basic processes we were seeking to define. Further efforts were required.

By our definition of perceptual skills, discrimination tests were ruled out a priori. Embedded sound tests were tried in pilot studies and rejected because of their failure to discriminate well among the age group in whom we were interested. They were too difficult. A test was needed that could ask the following questions along a scale of increasing complexity: (1) Can the child demonstrate the ability to "hear" a spoken word as a finite number of blended phonic elements? (2) Can the child demonstrate the ability to "hear" the interrelationships of those elements in some production behavior? and (3) Can the child show these two abilities using increasingly complex verbal constructs? Eventually, after examining many published instruments and after numerous trial and error attempts at developing our own, we constructed a test that appeared to ask the correct questions. The test contained 40 items of varying difficulty; it was identified as the Auditory Analysis Test (AAT: Rosner & Simon, 1971).[6] The AAT contains such items as "Say birthday. Now say it again, but don't say birth."; "Say man. Now say it again, but don't say /m/ [the "m" sound]."; "Say gate. Now say it again, but don't say /t/ [the "t" sound]." A sample of the test recording sheet is shown in Figure 8. The test is administered, as indicated above, by first asking the testee to say

6 Shortly after this study had been released, an earlier study (Bruce, 1964), concerned with remarkably similar behaviors, came to my attention. Bruce had confined his study to five- through seven-year-old children, and his items were less diverse and administered differently. He did not relate his subjects' responses to reading ability. His conclusion was that the ability to analyze word sounds is a function of maturation and that a "mental age of 7+ is indicated as the level at which the skills become available in sufficient degree to permit some success with the task (p. 158)."

Auditory Analysis Test

Name______________________________ Date______________

School____________________ Grade_____ Teacher______________

Birth Date______________

A.	cow(boy)				
B.	(tooth)brush				
1.	birth(day)		21.	(sh)rug	
2.	(car)pet		22.	g(l)ow	
3.	bel(t)		23.	cr(e)ate	
4.	(m)an		24.	(st)rain	
5.	(b)lock		25.	s(m)ell	
6.	to(ne)		26.	Es(ki)mo	
7.	(s)our		27.	de(s)k	
8.	(p)ray		28.	Ger(ma)ny	
9.	stea(k)		29.	st(r)eam	
10.	(l)end		30.	auto(mo)bile	
11.	(s)mile		31.	re(pro)duce	
12.	plea(se)		32.	s(m)ack	
13.	(g)ate		33.	phi(lo)sophy	
14.	(c)lip		34.	s(k)in	
15.	ti(me)		35.	lo(ca)tion	
16.	(sc)old		36.	cont(in)ent	
17.	(b)reak		37.	s(w)ing	
18.	ro(de)		38.	car(pen)ter	
19.	(w)ill		39.	c(l)utter	
20.	(t)rail		40.	off(er)ing	

Figure 8

Sample Test Recording Sheet

the item word; after he has repeated it, the Examiner asks him to "Say it again, but don't say ____," indicating the specific sound to be omitted; (the sound(s) to be omitted are those that are shown in parentheses on the test recording sheet). Letter names are not used; rather, only the sounds to be deleted. Items A and B are introductory words to be used to provide instruction about the test. Testing stops after four consecutive errors; each item is scored either correct or incorrect. Total possible scores, therefore, range from 0 to 40.

Inspection of the test items shown in Figure 8, in the order in which they were administered, reveals the increasing complexity of the task along the three dimensions defined above: (1) the number and size of the phonic elements (e. g., from syllables to single phonemes); (2) the relative position of the phonic element in the word (e. g., from a beginning, to a final, to a medially positioned sound); and (3) the complexity of the verbal construct in which the sound is embedded (e.g., from one syllable, to multisyllable words, to an isolated phoneme followed and/or preceded by a vowel, to part of a consonant blend). Our thinking in constructing the AAT was that if these really reflected the relevant dimensions of auditory perception skills in general, then scaling higher along the three variables should predict better performance in other tasks that required analytical listening skills. Given evidence to support that notion, it would then be possible to define an organized sequence of instructional objectives, based on the items of the AAT, for teaching auditory analysis skills. That, of course, was one of our major objectives. We did not seek to develop another standardized auditory perception test. Rather, we were looking for a way to describe and scale the underlying skills of auditory-motor development in behavioral terms.

In the initial study, 234 first- through sixth-grade children (the total population of a suburban Pittsburgh public school) were tested with the AAT. Table 3 summarizes the test scores for the six grade levels. The data indicate that the demands of the AAT are met more readily by children as they mature and progress through an academic program, although marked individual differences are also apparent within each grade level.

Table 3

Auditory Analysis Test Mean Scores by Grade

Grade	N	Mean	S.D.	Median	Range
1	53	17.6	8.4	17.6	2-35
2	41	19.9	9.3	17.6	1-36
3	37	25.1	8.5	25.5	6-37
4	29	25.7	7.9	28.7	9-35
5	35	28.1	7.6	30.8	11-38
6	39	29.9	6.9	32.3	15-38

During the month in which this testing was conducted (April, 1970), the same children were also given the Stanford Achievement Test. For purposes of validation, the AAT scores were then correlated with the Language Arts subtests of that achievement test.[7] These coefficients are shown in Table 4.

That a close relationship exists between the behaviors measured by the AAT and the Stanford Language Arts subtests is apparent. The curvilinear nature of that relationship is interesting. One can speculate that this may be a function of the achievement subtests, in that their

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7 Language Arts subtest scores were treated as a single combined score by totaling the stanines in the five subtests of Word Meaning, Paragraph Reading, Vocabulary, Spelling, and Word Study Skills.

Table 4

Mean Auditory Analysis Test Scores and Correlations with Language Arts Skills

Grade	N	Mean AAT Scores	S. D.	Correlation Coefficients AAT · LA
1	53	17.6	8.4	.53
2	41	19.9	9.3	.62
3	37	25.1	8.5	.84
4	29	25.7	7.9	.72
5	35	28.1	7.6	.75
6	39	29.9	6.9	.59

first-grade items tend to require less phonetic decoding skills than do the second-grade items which, in turn, are not as demanding as the third-grade items. The fourth-, fifth-, and sixth-grade achievement subtest items, on the other hand, appear to sample comprehension skills to a greater extent. They are not as closely related to basic decoding abilities and, hence, to the phonic analysis skills that are assessed by the AAT. Further and more detailed study is necessary, however, before this reasoning can be viewed as something more than intuition.

Replication studies have been conducted since that initial effort. The data, as yet unpublished, are consistent with our initial discoveries in showing a very strong relationship between auditory skills and reading achievement.

We then compared the relationships of the two perceptual tests, the VAT and the AAT, to arithmetic as well as to reading achievement. To do this the AAT was compared to the VAT, insofar as how both related to the Word Reading and Arithmetic subtests of the Stanford Achievement Test. The population of this study was all of the first- and second-grade children in three suburban Pittsburgh schools. These correlation coefficients, and the outcomes of the tests to determine the significance between these experimentally dependent correlations, are shown in Table 5.

Table 5

Coefficients of Correlation between the AAT, VAT, and the Word Reading and Arithmetic Subtests of the Stanford Achievement Test

	Grade 1 (N = 215)		Grade 2 (N = 219)	
	Word Reading	Arithmetic	Word Reading	Arithmetic
AAT	.53	.39	.49	.34
VAT	.39	.57	.25	.50
*p	<.025	<.005	<.005	<.01

*p = significance between experimentally dependent correlations

Here again we have evidence of the closer relationship between arithmetic and the visual-motor skills of copying, and between reading and a set of auditory-motor behaviors. Notice in grade 1, for example, that the AAT accounts for 28 percent of the variance in Word Reading, while the VAT accounts for only 15 percent of the variance in that same achievement subtest. This difference is significant at the .025 level ($t = 2.215$; $df = 212$).[8] In contrast, the AAT accounts for 15 percent of the variance in the Arithmetic subtest, while the VAT accounts for somewhat over 32 percent of the variance in that same subtest. These two differ at the .005 level of significance ($t = 2.747$; $df = 215$).[8]

These specific relationships between perceptual behaviors and the two academic domains are evident in the second-grade data as well. Once again the AAT relates more closely to the Word Reading subtest, accounting for 24 percent of the variance as compared to the 6 percent that is accounted for by the VAT. These two are significantly different at the

[8] AAT • VAT (grade 1) $r = .35$

.005 level (t = 2.924; df = 216).[9] The last comparison to be discussed is the way in which the VAT and the AAT relate to the Arithmetic subtest of this second-grade population. The difference once more is statistically significant (.01) (t = 2.371; df = 216), the VAT accounting for 25 percent of the variance in that subtest; the AAT accounting for 11 percent.

These outcomes, then, also supported our efforts toward the accomplishment of Goal 1 in that the skills tested by the AAT are not only directly concerned with auditory perception but are also specifically related to achievement in the domain of primary-grade language arts.

Summary

It should again be stressed that in no sense was the VAT nor the AAT intended to serve the functions of standardized tests that are based on representative normative data. Rather, in both cases, the tests were constructed for two other purposes. First, in the form they were designed, they could be administered and scored easily, providing relatively inexpensive access to the information which was essential to our goal--namely, the identification of perceptual behaviors that appeared to relate to academic achievement.

The second purpose, one that will be elaborated upon in the section of this paper devoted to Goal 2, was also vital to our needs. That is, if it could be demonstrated that the behaviors sampled by the AAT and VAT were worth measuring, our next quest was to determine if such perceptual skills could be trained. An examination of the VAT and AAT test items will quickly reveal that they range from those that are apparently easy, to some that are quite complex; that is, from global to differentiated. To train such skills, it would be useful to know how they scaled; which were easiest, which were most difficult, and so forth. Given that information, effective training sequences could be constructed.

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9 AAT • VAT (grade 2) r = .29

The data from the initial studies of the AAT and VAT, as discussed above, provided that kind of information. By testing a large number of different aged children, and by analyzing the item responses, we could scale the relative difficulty of each item, identify the general common traits of those that appeared to be of similar difficulty, and construct a series of training procedures in which the objectives of the training were sequenced in some valid manner. This, then, was the second purpose for constructing and using the VAT and AAT.

General-Motor Skills

To date, we have not researched sufficiently the relationship between general-motor skills and academic achievement; studies are currently underway, but little of substance can be offered at this time. Our initial observations, however, tend to indicate that a direct relationship between general-motor skills and academic achievement, independent of visual and auditory perceptual abilities, cannot be supported with any real vigor. What relationships appear to exist seem to link certain motor skills with visual and auditory perceptual skills in a hierarchical manner, in which the motor skills appear to serve as subordinate factors to the relatively higher order functions of auditory and visual analysis which, in turn, provide some of the basic information processing skills assumed by reading and arithmetic instructional programs.

Goal 1 has been attained, at least to some degree. Certainly there may be other critical perceptual skills that have not yet been identified. One area of promise, for example, appears to be in the application of time limitations on visual-motor functions. Pilot studies have been conducted, using VAT-like items that are to be completed within a fixed amount of time. The initial data are sufficiently encouraging to stimulate further investigation in this direction.

We will continue to search for pertinent skills; but, enough progress has been made toward this goal to justify the initiation of efforts towards Goal 2.

Goal 2 - Given identified perceptual skills that do relate directly to classroom achievement, determine whether such skills can be trained effectively.

The information reported in the last section appeared to justify pursuance of Goal 2, while still devoting efforts to adding to the data that are relevant to Goal 1. Highly significant relationships had been demonstrated between the copying skills sampled in the VAT and arithmetic, and between the phonic analysis skills sampled in the AAT and reading. Lesser, though still significant, relationships were demonstrated between VAT scores and reading and between AAT scores and arithmetic. The next question appeared to be: Can such perceptual skills be trained or are they solely dependent upon such factors as growth, development, and genetic pre-determination--are they or are they not modifiable?

Visual-Motor Skills

A study was conducted with a group of four-year-olds (range: 3.9 to 4.9 years; median: 4.4), testing that question. As a pretest (Time 1) the Rutgers Drawing Test, Form A (Starr, 1961) was administered to the total preschool population (N = 29) in the two classrooms of a local urban school that is participating in the Primary Education Project, an LRDC early learning program (Resnick, 1967). The Design Board Program, a sub-component of the Visual-motor portion of the Perceptual Skills Curriculum, was then presented to all of the children (N = 14) in one of the two classrooms (Class A). (The Design Board Program is intended to teach the processes involved in copying skills that were considered in constructing the VAT. It does not focus on specific designs; rather it is aimed at teaching generalizable skills. Many of its objectives resemble very closely the test items of the VAT. Some description of this program will be given in the Goal 4 section of this paper; for more details, see Rosner, 1971a.)

Training was individually administered by a Research Assistant to Class A, with sessions lasting approximately ten minutes. The children in Class B participated in their regular daily programs; they were given no special substitute treatment. Four or five children were trained each day for a period of 47 days. Their accumulated training times ranged from 5 to 16 sessions, depending upon the regularity of their attendance, with the average being 12.7 (median = 13) days. The Rutgers Drawing Test (Form A) was again administered (Time 2) to both classes (A and B) following that training period. Similar training, under the supervision of a second Research Assistant, was then introduced into the second class (Class B), following the same format of individually administered 10-minute training sessions. The accumulated training time of the children in this group varied from 7 to 17 sessions, averaging 12.5 (median = 13) days. A third Rutgers Drawing Test was administered (Time 3) following the completion of the training of Class B.

Figure 9 represents the class Rutgers Drawing Test mean scores at Times 1, 2, and 3. At Time 1, no statistical difference is shown

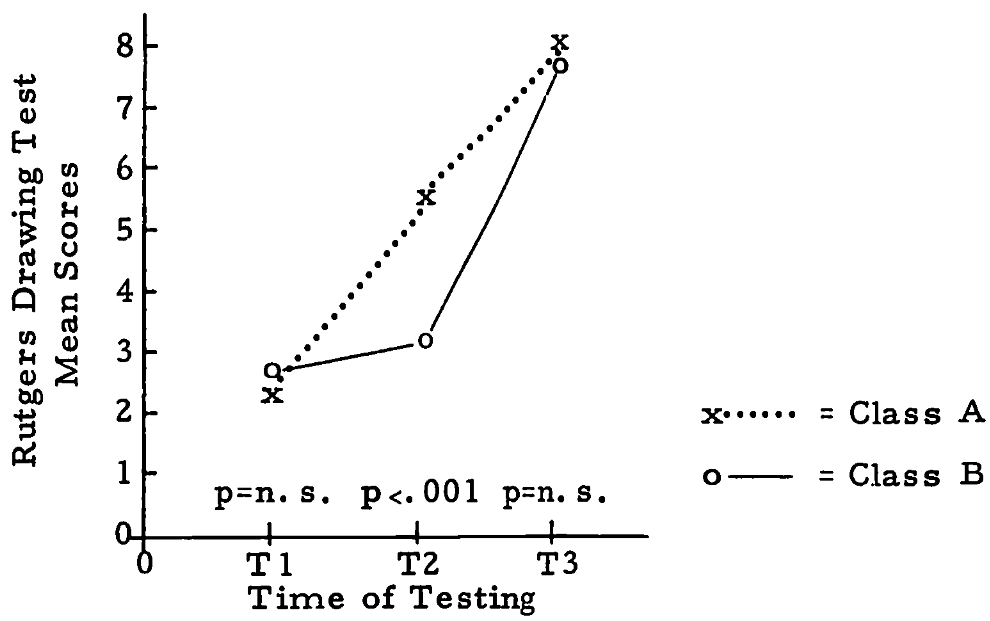

Figure 9

Rutgers Drawing Test Mean Scores for Classes A and B at Times 1, 2, and 3 between the scores of Class A and Class B. Following training, at Time 2, the scores of Class A are different from B, at a .001 level of significance, using an analysis of covariance statistic with the Time 1 Rutgers scores of the two groups serving as covariates. At Time 3, after Class B had also been trained, statistical differences between groups no longer exist. Using the normative data provided by the Rutgers Drawing Test, the Mean Equivalent Drawing Age of the two classes, at Time 1, was less than 48 months. Their Mean Equivalent Drawing Age at Time 3 was 58 months. The actual time that elapsed between Time 1 and Time 3 was 4 months.

The mean Rutgers Drawing Test scores of Classes A and B combined, at Time 3, were then compared to those of the kindergarten children in the same school. No statistical significance was shown between the Rutgers Drawing Test scores of this combined group of four-year-old nursery school children and a kindergarten group of children of similar background, enrolled in the same school, whose mean age was 10 months greater. It appears then, at least with these two groups, that the visual-motor skills of copying were amenable to training.

Another study of similar nature was initiated with two classes (C and D) of three-year-olds in the same school. Initially, no significant differences were shown between the Rutgers Drawing Test scores of the two groups. Their Rutgers Drawing Test scores were again compared after the children of Class C had received visual-motor training. This time, because of the small groups involved (C: $N = 5$; D: $N = 6$), the Mann-Whitney U test was used. Class C's copying scores, after training, were significantly higher ($p < .041$) than Class D's.

In yet another study, a multiple baseline design (Revusky, 1967) was used to explore, among other questions, the effects of visual-motor training on the copying skills of children who were not attending an LRDC developmental school.[10] Through the cooperation of the Research Department of the Pittsburgh Board of Public Education, and the Principal of one of its schools, such a kindergarten group was made available.

Among other pretests (that will be referred to in the Goal 3 section), ten children were given the Geometric Design subtest of the Performance Scale of WPPSI (Wechsler Preschool and Primary Scale of Intelligence, 1967). One child, chosen at random from the ten, was then provided with visual-motor training, using the Design Board Program. When this first child had achieved a predesignated objective in the program, he and the other nine children in the original sample were retested with the Geometric Design subtest. Following that testing, a second child was chosen at random, trained to criterion, and retested along with the remainder of the untrained group. The scheme was followed until five children were trained; average training time was 20 minutes per day for 22 days. The Revusky research design is based on the notion of treating each training segment as a sub-experiment. The test results of all the subjects, at the end of each sub-experiment, are ranked, yielding an R_n statistic. To achieve significance at the .01 level, with a population of this size, the subject who has just received the training must rank first among all of the subjects in each sub-experiment. This was the case. Each time the group was retested with the Geometric Design subtest of the WPPSI (at the end of each sub-experiment), it was the child who had just been trained who showed the greater positive change in copying skills.

The data were also analyzed a second way. By the end of the school year, as stated, five children had been trained; five had not. An analysis of covariance was conducted, using the pretest Geometric Design subtest scores as covariates. The difference between the mean

[10] The study in which this information is included was reported at the AERA Annual Meeting, New York, 1971 (Rosner, Levine, & Simon, 1971).

scores of the trained and non-trained groups was again significant at the .05 level. The study extended over a six-month period. It is noteworthy that the mean scaled score of the non-trained group of children was exactly the same at the end of that six-month period as it had been at the pretest, ($\overline{X}$ = 10.6; S.D. = 2.6) while the mean scaled score of the trained group changed from 10.8(SD = 2.4) to 13.0(SD = 1.7). (Raw scores did change; scaled scores, of course, take into consideration the chronological age of the subject as well as accuracy of his performance.)

These three studies, dealing with children of ages 3, 4, and 5, respectively, all yielded the same type of outcome. It seems evident that visual-motor skills can be trained and that the effects of such training are demonstrable in copying tasks where the test items are not at all identical to any used in the training procedures. In other words, the process of how the task is accomplished--how to copy geometric designs rather than a specific design--is being trained.

Auditory-Motor Skills

The question of Goal 2 was directed, as well, to auditory perceptual skills. That is, can a child's auditory perceptual skills be trained to a more discrete level or is improvement of these behaviors exclusively dependent upon maturation? To address this question, a study was conducted at a suburban Pittsburgh school (Rosner, 1971b). At the beginning of the academic year it was determined that only sixteen of the forty entering first-graders were non-readers. All of the others had been taught at least some beginning reading skills while still in kindergarten (see Beck & Mitroff, 1972, for a description of that beginning reading program).

The AAT was administered to the entire class (N = 40) at the beginning of their first-grade year (Time 1) and the scores of the readers

(R) and non-readers (NR) were compared. The R group's AAT scores were significantly higher ($p < .01$) than the NR's scores. The children in the NR group (N = 16) were stratified into three subgroups according to their IQ (High, Middle, Low). Each of these three groups was then randomly divided into two subgroups, resulting in two populations of relatively equal IQ and AAT scores. One of these populations (N = 8) was designated as a Control group (C); the other (N = 8), as an Experimental group (E). Half of each group was placed with one first-grade teacher, the other half with another first-grade teacher. Hence, the E group and the C group were equally distributed between two teachers--this is an attempt to control for the teacher variable. Group E was given daily 15-minute auditory analysis training sessions, outside of the classroom, by a paraprofessional. (Some description of the training will be given in the Goal 4 section of this paper. The intent of the training is to teach the same processes that were considered in constructing the AAT. It does not focus on specific sounds or sequences of sounds. Many of its objectives resemble very closely the test items of the AAT.) Group C was given no substitute treatment. Both groups were given reading instruction in their respective classrooms along with the rest of their classmates. After 37 training sessions, Group E had all achieved a predetermined level of competency. The AAT was then re-administered to all 40 first-grade children (Time 2) and the scores of the untrained readers (R), the trained E group, and the untrained C group were compared, using an analysis of covariance with the AAT pretraining scores serving as the covariates. Table 6 shows the mean AAT scores of the three groups (R, E, and C) at Times 1 and 2 as well as their mean chronological ages and IQ's.

Whereas the differences in AAT scores of groups E and C were not statistically significant in the pretest (prior to training), the post-training scores of the two groups were different at a .005 level of

Table 6

Mean Age, IQ, and Measure 1 and 2 AAT Scores for Groups R, E, and C

Group		N	CA[1]	IQ[2]	AAT Time 1	AAT Time 2
R		24	73.3(3.3)	119.7(13.7)	5.63(5.2)	18.08(9.6)
NR	E	8	73.0(2.5)	105.4(8.99)	2.25(2.3)	12.00(5.3)
	C	8	71.6(1.9)	106.9(10.1)	2.13(2.5)	5.00(3.2)

[1] as of entry into Grade 1

[2] Otis-Lennon Mental Ability Test

( ) = Standard Deviation

significance ($F = 14.33$; $df = 1/13$). Group R's Time 2 scores also were compared to both groups E and C. The differences between R and E scores were no longer very marked ($p < .10$). On the other hand, the differences between R and C were now quite different ($p < .0005$), in favor of the R group. The changes shown by group R are worth commenting on. Although they were not given training specifically in auditory perception, their acquisition of skills is evident; group C, on the contrary, was not trained and made little gain. Why? A reasonable assumption is that, since group R could already read when first grade started, their continued reading instruction probably provided excellent training in auditory skills in that reading, at the primary--decoding--level, is essentially the process of learning that sounds can be mediated visually; reading is the reconstituting of those visual symbols back into speech.

The study was replicated with a different group of sixteen children about one month after the one described above had been completed. The outcomes were much the same as they were in the first study. The difference between groups, in posttraining responses to the AAT, was significant at the .005 level, based on analysis of covariance with the pretest measures of both groups being treated as covariates. Thus, both auditory analysis training studies provided strong evidence that auditory perceptual skills can be acquired through instruction.

General-Motor Skills

The question has not yet been formally put to the general-motor skills. It seems reasonable, however, to argue that there already is a great deal of information available from the fields of physical education and physical therapy to show that such gross motor behaviors as balancing on one foot, hopping, and skipping, and such refined skills as oculomotor control and finger dexterity are highly trainable. Similar evidence exists about voco-motor controls; surely the presence of speech therapists in so many elementary schools and speech clinics is justified because of the modifiability of speech articulation abilities.

Goals 1 and 2, then, appear to have been attained--at least to a sufficient degree to ask the questions posed in Goal 3.

Goal 3 - Given trainable perceptual skills that are relevant to classroom achievement, determine whether the effect of that training can be measured in classroom behaviors. In other words, can transfer be effected?

The last section offered evidence concerning the plasticity of perceptual skills--at least, those that we had identified and described in the items of the VAT and AAT. It seems apparent that these behaviors can be trained. The major question, now, is whether the effect of such training can also effect the classroom behaviors that were related to visual and auditory perceptual skills.

Visual-Motor Training

Thus far, no study has yet been conducted by this Project that attempts to assess the direct impact of visual-motor training on school achievement. Prior to the beginning of this Project, a study was conducted under the sponsorship of the Mental Health Services Division of the Pittsburgh Public Schools (Richman, Rosner, & Scott, 1969). That study followed up on an earlier one (Rosner, Richman, & Scott, 1969) in which it had been demonstrated that children in public school classes for the emotionally disturbed demonstrated a significantly higher incidence of perceptual dysfunction than did children of the same age, sex, and IQ who were attending regular classes in the same buildings. In fact, incidence of perceptual dysfunction in the classes for emotionally disturbed (70 percent) more closely approximated the incidence found in classes for the educable mentally retarded (90 percent). In contrast, the incidence among the children in regular classes was 13 percent.

The follow-up study was designed to investigate the impact of perceptual training upon the academic performance of children with perceptual dysfunction in these three types of classes: regular, emotionally disturbed, and educable mentally retarded. Another component of the study was intended to test the feasibility of using paraprofessional classroom aides to serve as the trainers.

The children ranged in age from 5 years, 10 months to 13 years, 4 months, with a ratio of three boys to each girl. IQ scores ranged from 62 to 121. Attrition reduced the original population of 175 (training N = 99; control = 76) to 143 (training N = 94; control = 49) by the end of the study. The training groups were located in five classrooms in five different school buildings. The control group classes were distributed similarly.

Two different training approaches were used: The Frostig (1964) and the Pace (1968) programs. Thirty minutes of training was provided daily by the paraprofessional aides to small groups of six or seven children for a total of 66 days. Both of these programs emphasize visual-motor training; very little effort was devoted to auditory training.

All of the children were tested with the Wide Range Achievement Test (Jastak, Bijou, & Jastak, 1965) both before and after the training period; the differences between control and trained groups were compared with analysis of covariance, using the pretest scores as the covariates.

Improvement in some aspects of academic achievement, following training, was shown in all three trained groups. In the regular classes, the only WRAT subtest score that showed significant improvement after training, in contrast to the controls, was Arithmetic ($p < .05$). Among the mentally retarded and the emotionally disturbed, significant improvement ($< .01$ to $< .05$) was shown in all three subtests (Reading, Spelling, Arithmetic) of the WRAT. This study appears to support the premise that visual-motor training (because, in fact, both training programs are almost exclusively devoted to visual-motor skills) can have impact upon academic achievement. The fact that only the Arithmetic subtest scores improved in the regular classes is yet another indication of the relatively closer relationship between visual-motor skills and arithmetic achievement as compared to reading.

This Project's only effort in this same area was part of a previously cited study in which an attempt was made to study the effects of visual-motor training on a group of psychomotor behaviors; behaviors that have been identified as having some validity in predicting school achievement, in that they are subtests of a standardized test of intelligence. I refer to the multiple baseline study mentioned in the previous section (Rosner, Levine, & Simon, 1971). Along with measuring the impact of visual-motor training on the Geometric Design subtest scores of kindergarten children, comparisons were also made in the other four subtest scores of the WPPSI performance scale. The differences between posttraining WPPSI performance scale scores of control and trained groups, using pretraining performance scale scores as covariates, were significant at the .05 level. Figure 10 illustrates the differences in pre- and posttraining scores.

Admittedly, increases in the performance scale subtest scores of a standardized IQ test are not the same, nor even the equivalent, of improvement in academic performance. It does, however, prompt speculation that whatever training effected these changes will probably have similar impact on school achievement. The hypothesis has yet to be tested to a sufficient degree. Additional studies, designed to address this question, are currently being conducted and will be reported as data are available.

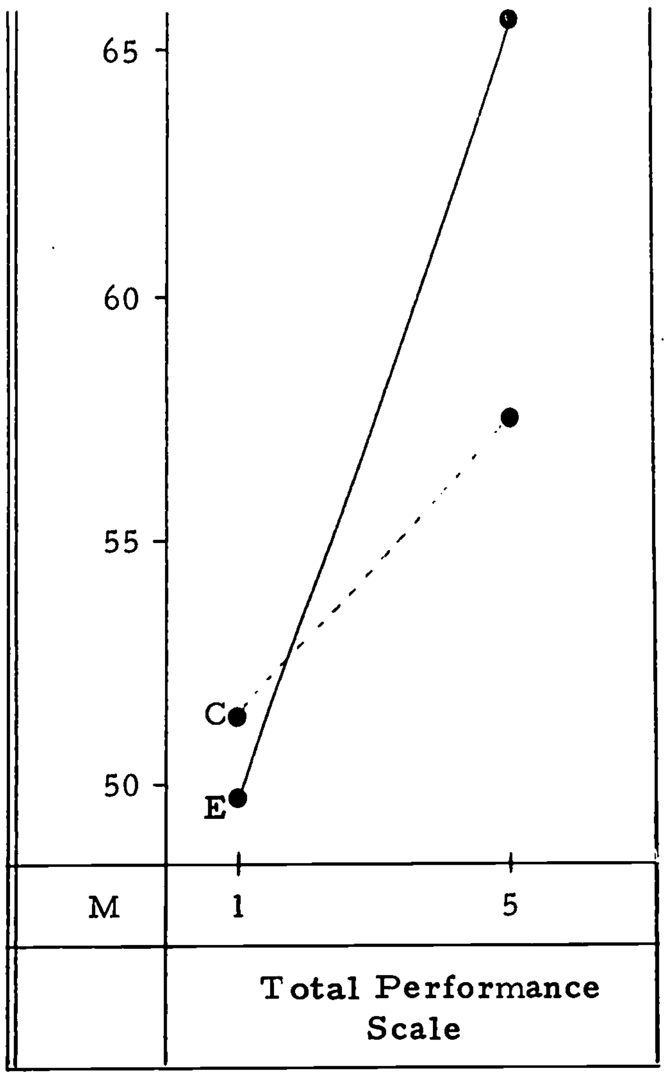

Figure 10

Mean Performance Scale Score of Experimental and Control Groups at Measures 1 and 5

Auditory-Motor Training

This problem was investigated in some of the studies cited in the previous section. Both studies that were concerned with the effects of training on auditory perceptual skills, reported in the last section, also contained a second question; that is, does auditory training have impact on the children's reading skills as well as on their listening skills? In the initial study (Rosner, 1971b), both the E group and the C group were non-readers at the beginning of the school year. Both groups received reading instruction from their classroom teachers. Since both groups were distributed equally between two classrooms, half of E and half of C were taught by one teacher; the other four children in E and the four in C were taught by another teacher.

Following the training of group E, both groups were given a reading test in which single words were presented in isolation. Comprehension was not tested; the child was asked only to "read this word." Two types of words were used: Unit words--that is, words taken from the children's instructional materials, and Transfer words--words that had not been taught in the reading program, but were constructed of familiar phonemes. Table 7 shows the mean scores of this reading test and the statistical comparisons. The differences between E and C are very evident. Note, for example, that the trained group read 88 percent of the Unit words correctly while the non-trained group did no better than 58 percent accuracy. The contrast between the two groups' scores in reading Transfer words is even more marked; here the E group was correct with 82 percent of the words while the C group managed only 48 percent accuracy.

The effect of auditory analysis training on beginning reading skills was measured also in the replication study that was mentioned in the previous section. Again, 16 children, randomly divided into two groups--one trained; one control--were distributed between two teachers. Again, both groups were given reading instruction by their teachers. (This study was initiated in November. As such, the children did have some reading vocabularies.) Outcomes of that replication study were very similar to the initial study just reported. Only the treatment of the data differed in one respect. Whereas, in the initial study, there was no pretest of

Table 7

Mean Reading Test Scores for Groups E and C

	Total Words	Group E Mean	Group C Mean	Sig. of Mean Differences	
				t	p
Unit Words	35	31.0(2.3)	20.6(7.7)	3.66	<.005
Transfer Words	25	20.5(2.6)	12.0(4.8)	4.37	<.0005

( ) = Standard Deviation

reading because all of the children were non-readers, the students in the replication study did have some reading ability in advance of the experiment. Hence, both pre- and post-reading tests were given. Posttest reading scores of the two groups were compared, using analysis of covariance computations with the pretest reading scores of both groups serving as covariates. Again, the control and experimental groups differed in their reading of unit words at the .005 level and transfer words at the .0005 level; in both instances, the differences were, as predicted, in favor of the trained group.

The above data indicate that some approximation at fulfilling Goal 3 has also been achieved. The section that follows will describe the classroom testing and training model that was finally developed as a result of these outcomes.

Goal 4 - Given affirmative responses to all of the above, describe the training in a way that will allow it to be implemented and managed in the classroom of a public school as a Perceptual Skills Curriculum.

The Curriculum, as originally conceived, was constituted of four components: Visual-motor, Auditory-motor, General-motor, and Integrative (Rosner, 1969). It has been reorganized; although it still contains four components, they are not the same four. The Integrative component no longer exists; its objectives have been incorporated into the Visual-motor and the Auditory-motor components. The fourth component, now known as Letters & Numerals, is concerned with precisely that: teaching the child to recognize, name, and produce the alphanumeric symbols common to the classroom. The other three components retain their original identities, although their content and structure have been reshaped as a result of field testing.

The curriculum reflects the structure proposed for the Primary Education Project (Resnick, 1967). Once the terminal objectives--behaviors representative of the skills generally assumed of second-grade students--had been determined for each of the four curriculum areas, a task analysis was conducted to determine the subordinate skills of these objectives. That is, once an ultimate skill had been described, the analysis sought to determine objectives that should be mastered prior to attempting to teach the top level behavior. Indeed, the primary purpose of our studies involving the VAT and the AAT was to establish a valid hierarchy of objectives in the two domains. In this fashion, a sequence of objectives is developed that, at least in theory, should serve as a map that describes the changes in behavior that occur as one acquires higher order skills.

A criterion-referenced test (Glaser & Nitko, 1971) was then constructed for each objective in the structure. The test is intended to determine only whether the child can or cannot demonstrate the behavior representative of that objective. It is not norm-referenced in any sense; in no way is it intended for comparing a child's performance skills to those of a normative population. Its only function is to enable the tester to confirm the presence or absence of a skill. The criterion-referenced test, as used here, is extremely valuable *if* the objectives are sequenced correctly. If they are, the testing allows the teacher to determine how far along the structure the child has progressed (how much he already knows), what yet remains to be learned, and, especially important, what skill is to be learned next. If the objectives are not sequenced in a valid hierarchy--if they are not scaled accurately--the testing model is, at best, useless.

Finally, having determined the child's position within a sequence of objectives that leads to a behavior that has been shown to be directly related to academic achievement, the teacher's task becomes one of teaching the child to perform the next behavior of that sequence.

The organization of the four components of the Perceptual Skills Curriculum reflects these concepts in that (1) each component is made up of behavioral objectives arranged in a structure of Levels, and Units within levels, that has been determined by on-going research; (2) each objective can be tested by an unambiguous criterion-referenced test; hence the child's competencies within the structure can be determined both as to Level and Unit; and (3) teaching activities have been designed and keyed according to Level and Unit; thus the teacher has available a variety of ways to teach the child the next higher order behavior within the structure. In this fashion, the teacher can ascertain each child's perceptual skills in all four component areas, and assign instructional activities to each of her pupils; activities that are designed to assist the pupils specifically in mastering the next objective in their personal domain of skills. Each child is assessed individually; each child receives an assignment based upon his own needs.

The Visual-motor Component

The objectives and structure of the Visual-motor component are consistent with the principles stated in the rationale. They reflect a set of hypotheses which propose a strategy for testing a child's visual-motor skills, as well as teaching him to analyze visual patterns and demonstrate those capacities by reproductions--performances more demanding than discrimination tasks. The structure of this component is shown in Figure 11; Table 8 lists the objectives of that structure.

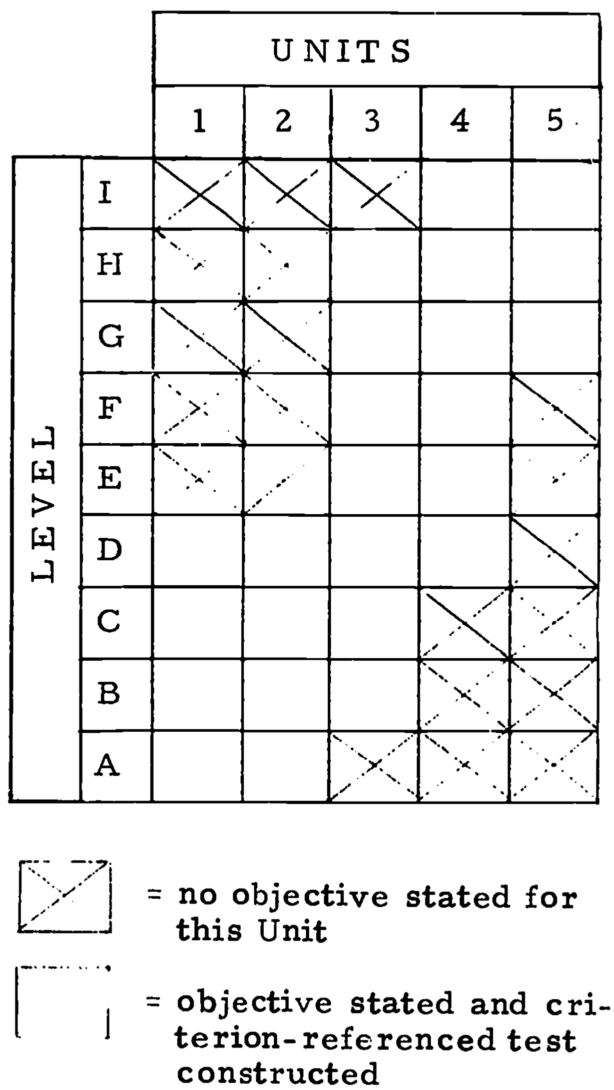

Figure 11

Structure of Visual-motor Component

Table 8

Objectives of Visual-motor Component

Level A

Unit 1: Given a group of one-inch cubes arranged in a single row, superimpose matching cubes.

Unit 2: Given a group of one-inch cubes arranged in a single row, construct a replication alongside model.

Level B

Unit 1: Given a group of one-inch cubes arranged into an interlocking row and column, superimpose matching cubes.

Unit 2: Given a group of one-inch cubes arranged into an interlocking row and column, construct a replication alongside model.

Unit 3: Given a drawing of a group of one-inch cubes arranged into interlocking rows and columns, construct a matching arrangement alongside drawing.

Level C

Unit 1: Given a Design Board F[11] on which two rubber bands (one horizontal, one vertical) have been stretched, superimpose two additional rubber bands.

Unit 2: Given a Design Board F on which three rubber bands (two horizontal, one vertical) have been stretched, replicate pattern on second Design Board F. Lower (red) and left edges (blue) of both Design Boards to be color coded.

Unit 3: Given a drawing of a Design Board F on which two rubber bands (one horizontal, one vertical) are represented, construct the pattern on a Design Board F. Lower (red) and left edges (blue) of Design Board and test pattern to be color coded.

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[11] For illustrations of the various Design Board peg arrangements, see Figure 12, which appears at the end of this list of objectives.

Table 8 (continued)

Level D

Unit 1: Given a drawing of a Design Board F on which two rubber bands (one vertical, one horizontal) are represented, trace accurately over the two lines.

Unit 2: Given a Design Board F on which two rubber bands (one vertical, one horizontal) have been stretched, replicate pattern on second Design Board F.

Unit 3: Given a drawing of a Design Board F on which two rubber bands (one horizontal, one vertical) are represented, construct the pattern on a Design Board F.

Unit 4: Given a drawing of a Design Board F on which three rubber bands (one horizontal, two vertical) are represented, copy (draw) the pattern on a second printed representation of the Design Board F.

Level E

Unit 3: Given a drawing of Design Board I on which three rubber bands (one vertical, one horizontal, one diagonal) are represented, construct the pattern on a Design Board I.

Unit 4: Given a drawing of Design Board I on which three rubber bands (one horizontal, one vertical, one diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board I.

Level F

Unit 3: Given a drawing of Design Board P on which three rubber bands (one vertical, two diagonal) are represented, construct the pattern on a Design Board P.

Unit 4: Given a drawing of Design Board P on which three rubber bands (one horizontal, one vertical, one diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P.

Table 8 (continued)

Level G

Unit 3: Given a drawing of Design Board P on which five rubber bands (vertical, horizontal, diagonal) are represented, construct the pattern on a Design Board P.

Unit 4: Given a drawing of Design Board P on which five rubber bands (horizontal, vertical, diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P.

Unit 5: Given a drawing of Design Board P on which four rubber bands (vertical, horizontal, diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P from which 8 dots have been faded (PF8).

Level H

Unit 3: Given a drawing of Design Board P on which eight rubber bands (vertical, horizontal, diagonal) are represented, construct the pattern on a Design Board P.

Unit 4: Given a drawing of Design Board P on which eight rubber bands (horizontal, vertical, diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P.

Unit 5: Given a drawing of Design Board P on which seven rubber bands (vertical, horizontal, diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P from which 16 dots have been faded (PF16).

Level I

Unit 4: Given a drawing of Design Board P on which ten rubber bands (horizontal, vertical, diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P.

Unit 5: Given a drawing of Design Board P on which ten rubber bands (vertical, horizontal, diagonal) are represented, copy (draw) the pattern on a second printed representation of Design Board P from which all dots have been faded (PF25).

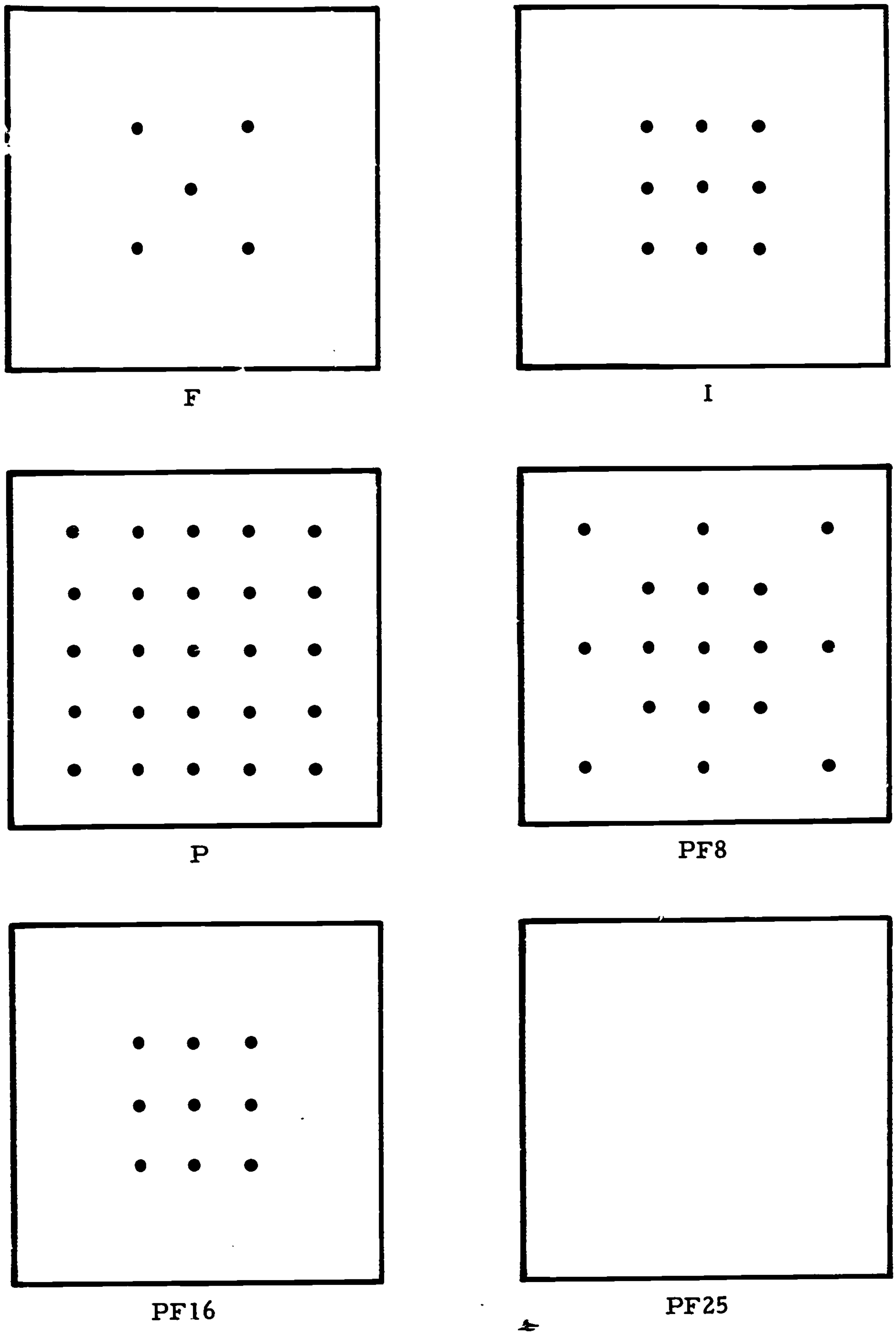


Figure 12

Design Board Arrangements

The levels of the structure are indicative of the complexity of the visual patterns with which the child must deal. The variables which affect complexity and, hence, determine the level are: (1) the number of elements contained within a pattern; (2) the nature of the spatial interrelationships of those elements; and (3) the relative position of the pattern within a defined space.

Level A objectives call for the use of simple elements (one-inch cubes) in very limited amounts (a maximum of three). Level B objectives are similar in the media employed, but their amount is increased, and the ways in which they are combined are more complex.

Level C objectives introduce a manipulative device called the Design Board--in effect, a variable peg board on which rubber bands may be positioned to form a variety of patterns. At Level C, a very simple Design Board format is used (five pegs), thus limiting the number of elements (rubber bands) that can be used as well as the complexity of their interrelationships. In addition, at this level, colored topological cues are provided to aid the child in discriminating "top" from "bottom" and left from right side.

In all subsequent levels (D through I), the Design Board is employed in some way. The formats (number of pegs) become more differentiated as do the number of elements (rubber bands) and the complexity of their interrelationships. The changes represented by Levels A through I are representative of the Global ⟶ Differentiated scaling that was discussed in the rationale. The visual stimuli presented in Level A are clearly less differentiated than those in Level B, than those in Level C, and so on. Level I presents stimuli of appreciable complexity; the most differentiated of all the levels. This ordering is based on more than speculation and logic; recall that one of the purposes of the Visual Analysis Test study (Rosner, 1971c) was specifically devoted to the task of scaling the complexity of its test items so that some validation of a hierarchical sequencing could be made. It was from these data that the ordering of the objectives was determined.

The structure of the Visual-motor component also shows units at each level. These are identified by the numerals 1 through 5. Some levels, it will be noted, contain as few as two units; others, as many as four. Each unit represents a specific type of behavior; an interaction between the trainee and the visual stimulus. The sequence of actions, as designated by the numerals 1 through 5, is projected as being representative of increasingly demanding behaviors. They are, in intent, representative of performing sensory-motor behaviors with a diminishing dependency upon <u>overt</u> tactile-kinesthetic (self-produced) support and <u>overt</u> environmental support in terms of the amount of available information--topological cues--in the stimulus field.

Unit 1 objectives, for example, call for superimposition behaviors only. In these activities, the child is asked only to superimpose--"put your block on top of my block"--elements on matching elements. He need not understand very much about spatial relationships; his major task is sorting out the elements--viewing the construction as made up of a <u>finite</u> number of elements. As such, the organization of the sensations in the stimulus field is fully and overtly available. He needs to infer nothing additional. Too, there is a great deal of overt tactile-kinesthetic support inherent in the behavior. He not only sees the individual elements in the pattern; he can also feel them, along with the matching elements that he uses to complete the superimposition task. As he superimposes, he receives more than visual confirmation of the accuracy of his performance; the tactile-kinesthetic information provided by his hands supplies tangible, matching data. All are overt supports--readily available. In one sense, then, Unit 1 kinds of behaviors could conceivably be successfully completed without visual information; the child could demonstrate mastery of the objectives while blindfolded. Thus, the support provided by the overt motor involvement and the overt organization of the sensory data is powerful indeed.

Unit 2 behaviors are a bit more demanding. Though the complexity of the stimulus (that is based on levels) may remain the same, this unit asks the child to construct a concrete model that matches another model, but not through superimposition. Rather, the child's construction is to be positioned adjacent to the model. As such, slightly less support is provided. Certainly, tactile-kinesthetic involvement is still strong; the child can feel, as well as see, both the elements of the model and of his own construction. He is not, however, provided with quite as much support in the organization of the sensory field. When he superimposed the elements, the topological map of sensory field was fully available. As long as he positioned one element at a time, there was no need for him to even be aware of a map in any abstract sense. With construction alongside a model, rather than on, it is necessary for him to infer some organization onto the space where his construction will be placed. Topological cues in the model--that is, the way in which the elements interrelate--such as above, below, alongside, and so on--must be noted and applied, if his construction is to be an accurate reproduction. Thus, although there is still a great deal of support provided to the visual processes of the child in Unit 2 tasks, it is somewhat less than in Unit 1. It is, however, still reasonable to speculate that most Unit 2 tasks could be successfully completed by a blindfolded child. Sophisticated visual analysis skills are not crucial to the activity, although they will, of course, facilitate the behavior.

Unit 3 behaviors insist upon visual function. The tasks all require the construction of a concrete model that accurately represents a drawn plan of that model. Is the behavior more complex? Obviously.

The child no longer is provided the tactile-kinesthetic support in analyzing the stimulus. A drawing of a block construction, or a Design Board pattern, does not provide him with the information needed to distinguish the elements of the construction, or their interrelationships, through touch. Unless the stimulus patterns have been embossed--or in some other way contain tactile cues--the fingers get no distinguishing information from any aspects of the drawing. It all feels the same--undifferentiated. Only the eyes can appreciate the discrete information presented; the motor involvement is vicarious--covert. The visual topological cues--such as those offered in a rubber band pattern drawn on a printed Design Board matrix--must be applied to the actual Design Board on which he will place his construction. The map of the Design Board must be interpreted visually as the exact equivalent of the drawn map. It is the only way in which the child will place the rubber bands--construct the pattern--accurately. Thus, in Unit 3 tasks, we note a fading of tactile-kinesthetic cues. In addition, there is a gradual withdrawal of the sensory field organizational supports; the drawn patterns are not the exact size of the Design Board. Since they are not the same size, the support provided by the equivalent map is more abstract, and therefore representative of less support.

Unit 4 objectives incorporate a different behavior. The child is no longer asked to construct a concrete model from a drawn plan. He must now copy a plan by drawing, rather than by manipulating concrete materials. (Note the similarity of this to the first eighteen items of the VAT.) As such, we again observe a continued fading of supporting features. Granted, the topological map on which he draws his copy matches exactly the map on which the stimulus pattern is plotted. But, he is no longer supplied the overt tactile-kinesthetic support available when constructing with concrete materials. The field upon which he draws is undifferentiated insofar as tactile cues are concerned; only the eyes can use the information in that field and monitor an appropriate response. Hence, the child is now placed in a situation where visual analysis and control of motor function is absolutely necessary for satisfactory performance. True, he can still explore the space and patterns with his fingers--but, in order to provide useful information, the fingers must be visually directed. Without visual direction, the manual explorations are worthless insofar as meaningful information processing is concerned. In operational terms, then, the child is provided with less overt self-produced supportive cues. He must infer them--act as though they were available.

Unit 5 tasks duplicate the behaviors requested in Unit 4 with one major difference; that is, a gradual elimination of the overt visual support that is provided in the response space. The child is still shown patterns that have been plotted on a printed 5 x 5 Design Board matrix--a format that facilitates visual analysis of all the pertinent spatial interrelationships of the elements in the pattern. When it comes to drawing the reproduction of the pattern, however, he is given a matching space in which some--and finally, all--of the overt topological cues (the dots) have been eliminated. He must, in order to respond accurately, "imagine" that the dots are still there; he is to draw the lines as though the dots were there. (The last nine items of the VAT call for this behavior.)

What has happened, then, as we review the changes that have been introduced since Unit 1, is a gradual withdrawal of the overt tactile-kinesthetic supporting cues and the overt visual organizational supports in the response space where the child is to place his reproductions of the stimulus. In graduated steps, he is asked to perform as though the supports were present--the process has shifted from one that provides explicit cues to one that insists on covert processes.

Through testing, the teacher is to determine the location of the child in the structure of this component of the Perceptual Skills Curriculum.

Initially, a determination of level of competency is achieved by administering the terminal criterion-referenced test of each level. The procedure that has been followed to date, and appears to serve effectively, is to commence at the terminal objective of Level F; that is, Unit 4. If the child meets the criteria of that test, the teacher administers the test for the terminal objective of Level G (Unit 5) and so on, until unsatisfactory performance is noted. For example, if the child passes the Level F, Unit 4 test, and fails the Level G, Unit 5 test, he is placed somewhere in Level G. This merely means that he knows all that is represented by the objectives of Level F and below and, in contrast, that he has yet to learn those skills represented by the objectives above that position in the structure. Consider another example. The child fails Level F, Unit 4, fails Level E, Unit 4, and passes Level D, Unit 4. He is placed at Level E.

Once level placement has been determined, a unit placement is conducted by testing backward through the level. If, for example, the child is placed at Level H, it means that he passed Level G, Unit 5, but failed Level H, Unit 5. The tester then administers the Level H, Unit 4 test, and so forth, until the child's degree of competency within the level has been established.

Once level and unit placements have been accomplished, the teacher assigns activities that are designed to teach the child to pass the next test within the Visual-motor structure. If he is placed in Level F, Unit 3, the teacher assigns activities that are similar, although not identical, to the criterion-referenced test of that unit and level. The activities will range from those that are much easier than the terminal objective to those that extend somewhat beyond the complexity of the objective. The hypothesis, of course, is that he will acquire mastery of the objective by participating in activities that approximate the objective in very small increments. In practice, this does, in fact, appear to be the case.

In addition to activities that use the materials identical to the curriculum test (e.g., Design Boards, drawn patterns, etc.), other lessons have been prepared that use a variety of manipulatives such as one-inch cubes, parquetry blocks, peg boards, paste sticks, and so forth. In all cases, regardless of the materials used, the same types of behaviors are called for in Units 1, 2, and 3. That is, the child superimposes (Unit 1); constructs concrete models from concrete models (Unit 2); constructs concrete models from drawn plans (Unit 3). The criteria of curriculum tests designate specific media for the various objectives; the lessons used to foster mastery of the objectives are determined by the teacher. The <u>way</u> the child learns the behavior is not important--that he does learn the behavior, on the other hand, is indeed critical.

Once the terminal objective of Level I has been mastered, the child is considered to be adequately competent in visual-motor function. He stops testing and training in the Visual-motor component. To date, no time constraints have been placed upon the tests; it is sufficient if it can be performed regardless of time. Recently, pilot studies that include a time constraint have been initiated. The data indicate certain important differences; they will be reported in the near future.

A question critical to Goal 4 is "does the curriculum work in the classroom? Do the children show changes in visual-motor skills that can be attributed to the curriculum?" The kindergarten and first-grade data from one of our developmental schools, and the preschool (four-year-old) data from another school, where the curriculum has been used appropriately and exclusively by regular school personnel, indicate an affirmative response.

Table 9 shows, for all three groups, the median beginning-of-year placement, the median position in the Visual-motor strucuture four months later (in mid-January), and the median number of objectives mastered

Table 9

Median Position in Visual-motor Structure in September, 1971 and January, 1972, and Median Number of Objectives Mastered in That Four-Month Period

(Possible Range = A-1 to I-5; Total Number of Objectives in Structure = 24)

		September Position in Structure		January Position in Structure		September-January Number of Objectives Mastered	
Grade	N	Median	Range	Median	Range	Median	Range
Preschool	31	B-2	B-1 to F-3	F-3	B-1 to G-3	9	0-13
K	57	C-2	B-1 to F-4	G-3	D-1 to I-4	10	0-18
1	33	F-4	B-2 to I-5	I-4	F-3 to I-6*	7	0-10

* I-6 = mastered all curriculum objectives

during those four months. The progress of the children, in all three groups, is obvious. (The relatively fewer objectives mastered between September and January, by grade-one children as contrasted to kindergarten and preschool, is probably due to the increasing difficulty of the objectives; it may, however, also be a function of time in that the first grade devotes approximately 30 percent less time per school week to perceptual skills than do the younger groups.) It should also be pointed out that this first grade had participated in an earlier version of the Perceptual Skills Curriculum during their kindergarten year. Although the earlier version of the curriculum was less effective than the current one, the entering level of this first grade's visual-motor abilities is distinctly higher than what is usual for first-grade children who have not participated at all in such a program.

Figure 13 shows these same distributions as relative cumulative frequency ogives. Two distributions (September, 1971 and January, 1972) are graphed for each class. As expected, a noticeable difference existed

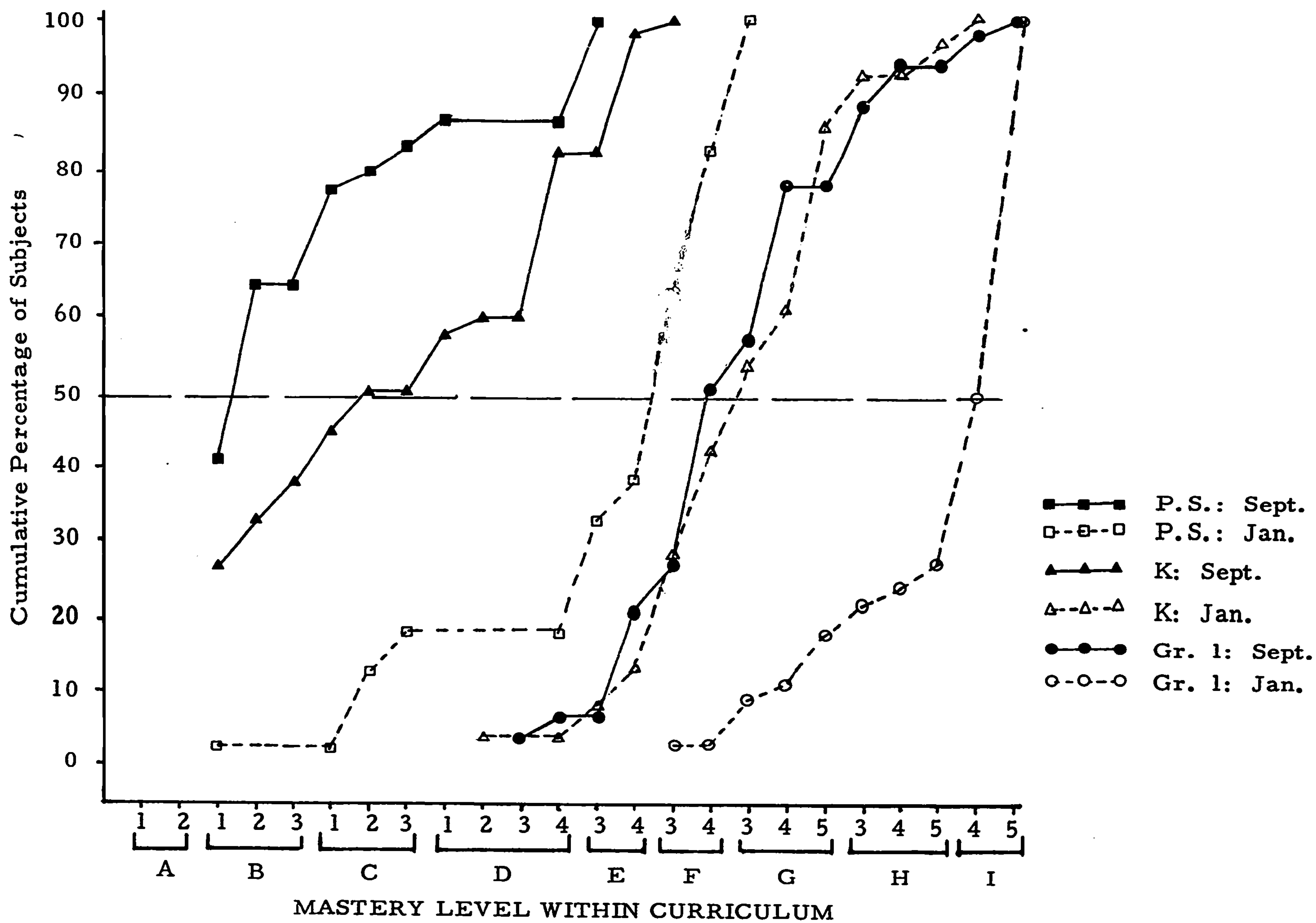


Figure 13

Relative Distribution of Objectives Mastered in the Visual-motor Component as Measured in September and January of the Same School Year between the three groups (preschool, K, and grade 1) at the beginning of the school year. It is interesting to note that, by January, 1972, the preschool group was operating in the curriculum structure far ahead of where the kindergarten group had been in September, 1971. In other words, by midway during their preschool year, these four-year-olds were well past the competency level displayed by five-year-old children when they were entering kindergarten. Hence, it can be speculated that when this preschool group starts kindergarten, their visual-motor skills, as determined by the curriculum objectives, should be far superior to the skills shown by this year's kindergarten group.

A similar contrast between the kindergarten and first-grade groups is also shown in that the January, 1972 distribution of the kindergarten children virtually duplicates the September, 1971 distribution of the first grade. Given continued progress by the kindergarten group, it is highly probable that, by September, 1972, (when they enter first grade) their skills will be far superior to those shown by this year's first-grade class. Admittedly, these are speculative projections, but they do provide strong positive indications.

A review of the objectives of this component will help to clarify why visual-motor skills are important aptitudes to academic achievement, and to arithmetic in particular. As the child masters the objectives described above, he acquires the skills that are used in sorting and ordering visual data and in understanding spatial relationships. He learns, in a way similar to the novice statistician, to "prepare the data" for further use.

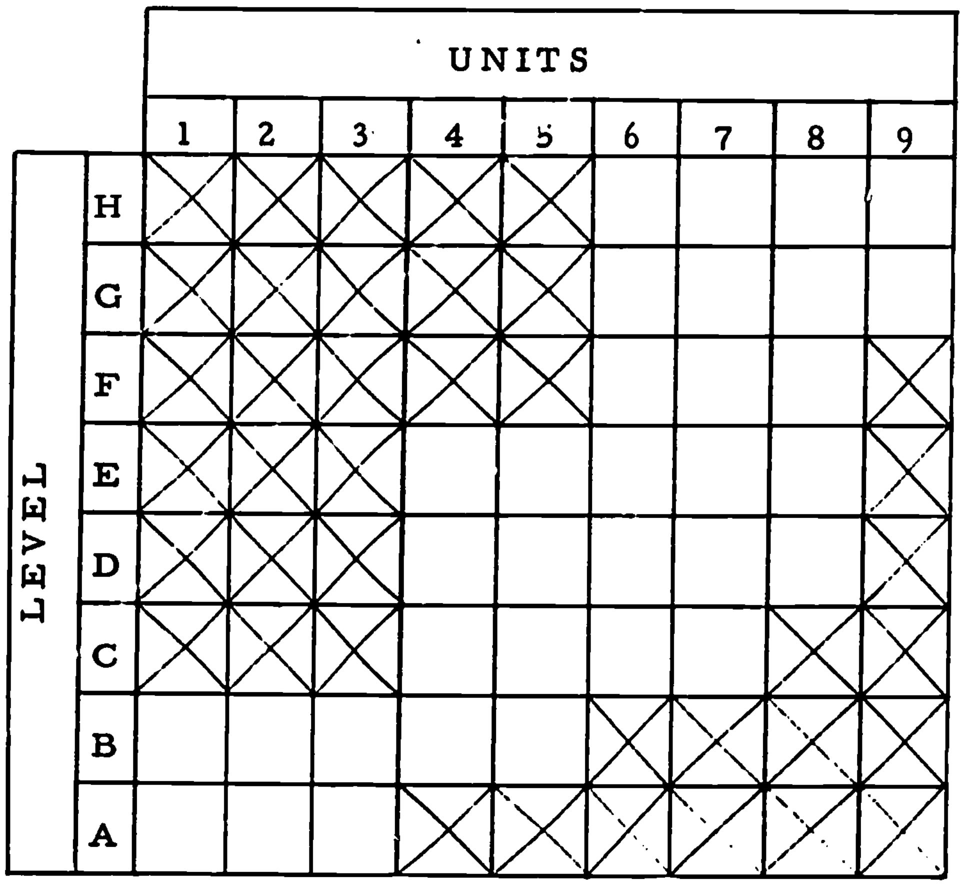
Beginning arithmetic demands similar skills. As a child learns to count objects, he overtly touches and states aloud each successive numeral. In time he learns to represent these quantities symbolically and commences to understand, spatially, the relationships between 1, 2, 3, etc. He experiences "more" and "less" tangibly (through tactile involvement) as well as visually. If he does not grasp the spatial connotations of the numeric symbols, arithmetic will be a confusing set of operations. Numerals represent quantity in some spatial dimension. Each numeral has a unit value--it is not similar to letters with their phonetic values. Each one refers to a construct; in most currently popular beginning arithmetic programs, manipulatives--literal constructs--are used in conjunction with the numerals. In time they are eliminated; the notion being that the constructs can now be produced figuratively--as though--and need no longer be literally visible. The Visual-motor curriculum shares that goal.

The Auditory-motor Component

The objectives and structure of the Auditory-motor component resemble, in design and principle, those of the Visual-motor. They, too, are consistent with the rationale. The structure of this component is shown in Figure 14; Table 10 lists the objectives of that structure.

The levels of the structure are indicative of the degree of complexity of the acoustical patterns that the child must, in some way, manipulate. The variables which determine that complexity are: (1) the number of elements (sounds) contained in the total pattern; (2) the nature of their spatial interrelationships (sequence of sounds); and (3) the complexity of the verbal construct (one or more syllables) as well as the relative position of the sound within the defined space (i.e., the relative position of a particular sound--beginning, end, medial).

Levels A and B objectives use music, clapping, and other nonverbal, acoustical stimuli. Levels C, D, and E focus on syllables, first as one syllable words (Level C); later (Levels D and E), as subcomponents of multisyllable words. Levels F, G, and H are concerned



= no objective stated for this unit

= objective stated and criterion-referenced test constructed

Figure 14

Structure of Auditory-motor Component

Table 10

Objectives of Auditory-motor Component

Level A

Unit 1: Given march tempo music, clap hands in synchrony with the music.

Unit 2: Given a series of claps, ranging from one to four, draw a horizontal dash for each clap, from left to right.

Unit 3: Given a series of claps, ranging from one to four, reproduce the clapping pattern.

Level B

Unit 1: Given music with changing tempo, clap hands in synchrony with the music, adapting to changes in tempo.

Unit 2: Given a series of long and short musical tones, ranging from one to four in total, draw an appropriate horizontal dash for each sound, from left to right.

Unit 3: Given a series of long and short claps, ranging from one to four in total, reproduce the clapping pattern.

Unit 4: Given a spoken phrase of numerals, clap hands once for each word in the phrase.

Unit 5: Given a spoken phrase of numerals, "write" the phrase, using a horizontal dash to represent each numeral (from left to right), and "read" aloud any numeral on request.

Level C

Unit 4: Given a spoken phrase of one-syllable words, clap hands once for each word in phrase.

Unit 5: Given a spoken phrase of one-syllable words, "write" the phrase, using a horizontal dash to represent each word (from left to right), and "read" aloud any word requested.

Unit 6: Given a series of spoken one-syllable words, indicate the presence or absence of a specific word in that series.

Table 10 (continued)

Level C (continued)

Unit 7: Given a series of spoken words followed by the same series from which one word has been omitted, state the omitted word.

Level D

Unit 4: Given a spoken phrase of one- and two-syllable words, say and clap hands simultaneously for each syllable in phrase.

Unit 5: Given a spoken phrase of one- and two-syllable words, "write" the phrase, using a horizontal dash (from left to right) to represent each syllable, and "read" aloud any syllable on request.

Unit 6: Given a spoken two-syllable word, indicate presence or absence of a specified syllable in that word.

Unit 7: Given a spoken two-syllable word followed by a statement of only one of the syllables, say the syllable that was omitted.

Unit 8: Given a spoken two-word series or compound two-syllable word, state single remaining word or syllable by omitting the other as designated.

Level E

Unit 4: Given a spoken phrase of one-, two-, and three-syllable words, say and clap hands simultaneously for each syllable in phrase.

Unit 5: Given a spoken one-, two-, or three-syllable word, "write" the word, using a horizontal dash (from left to right) to represent each syllable, and "read" aloud any syllable on request.

Unit 6: Given a spoken three-syllable word, indicate presence or absence of a specified syllable in that word.

Unit 7: Given a spoken three-syllable word followed by a statement of only two of the syllables, say the syllable that was omitted.

Unit 8: Given a spoken three-syllable word, restate the word omitting a designated syllable.

Table 10 (continued)

Level F

Unit 6: Given three spoken words and a specified consonant or vowel sound, indicate which word begins with that sound.

Unit 7: Given a spoken word, followed by a restatement of the word with the initial consonant sound omitted, state the omitted sound.

Unit 8: Given a spoken word, repeat the word omitting its initial consonant sound.

Level G

Unit 6: Given three spoken words and a specified consonant sound, indicate which word ends with that sound.

Unit 7: Given a spoken word, followed by a restatement of the word with its final consonant sound omitted, state the omitted sound.

Unit 8: Given a spoken word, repeat the word omitting its final consonant sound.

Unit 9: Given a spoken word, substitute one beginning or ending sound for another.

Level H

Unit 6: Given three spoken words and a specified consonant or vowel sound, identify which word contains that sound.

Unit 7: Given a spoken word, followed by a restatement of the word with one consonant sound of a two-consonant blend omitted, state the omitted sound.

Unit 8: Given a spoken word, repeat the word omitting one consonant sound of a two-consonant blend.

Unit 9: Given a spoken word, substitute any consonant or vowel sound for another.

with single phonemes, as they occur at the beginning, end, and medial positions of a word and, finally, the phoneme as part of a consonant blend. The progression of complexity in the nature of the sensations--in this instance, acoustical constructs--is consistent with the Global ⟶ Differentiated principle put forth in the rationale.

The units within the levels refer to the various behaviors--operations--that are performed with the range of stimuli defined by the levels. As was the case in the Visual-motor structure, not all units (behaviors) are called for at each level. Rather, again as was the case in the Visual-motor component, the less complex behaviors (units) tend to cluster in the lower levels--involving the simpler sensory stimuli; the more complex behaviors (higher units) cluster in the upper levels of the curriculum structure.

The sequence of behaviors, too, tends to parallel, in principle, the visual-motor sequence. That is, less overt motor involvement and less organization of the sensory data are included in the objectives of the higher units. For example, Units 1 and 2 call for non-verbal motor behaviors (e.g.: march and clap) that require only a relatively global analysis of acoustical sensations (music). Full overt contextual support is given to the sensations in that they <u>are</u> music and, as such, are inherently rhythmic. Unit 3 objectives involve a similar overt motor behavior (clapping) that is produced from memory rather than in accompaniment to music. Unit 4 asks that clapping accompany spoken sounds (syllables), rather than music. Unit 5 asks the child to represent spoken sounds (syllables) visually (with a drawn dash) and to then interpret the visual mediators that he himself has coded.

Unit 6 objectives are concerned with recognizing the presence of of sound (word, syllable, or phoneme--dependent upon level) embedded within a larger context (a phrase or word). The child is encouraged to "say it"--i.e., the sounds--as he performs these behaviors, thus providing overt motor support to the analysis function. Unit 7 behaviors are those that--using acoustical stimuli at various levels of complexity--continue to encourage "saying it." They also still provide some sensory organizational support in that they remove only one segment of sound from a larger context and ask the child to identify that smaller segment (e.g., "Say meat. Now say eat. What sound was left out that second time?").

Unit 8 behaviors are those that were described in discussing the items of the AAT. They are behaviors that require the child to analyze the phonetic construction of the word discretely enough to be able to delete a designated portion of the word and state that which remains. Unit 9, the most complex, asks the child to substitute one sound for another, at the syllable or phoneme level (e.g., "Say man. Now say it again, but say /f/ instead of /m/." Sounds not letter names are used.).

As was described in the Visual-motor section, level placement testing precedes unit placement testing. Once placement has been accomplished, the teacher will assign activities that are designed to teach the child to pass the next curriculum test--master the next objective--within the Auditory-motor structure. Most activities keyed to Levels A, B, and C are readily managed in group situations and are not at all unique activities in standard preschool classrooms inasmuch as they involve singing, marching, clapping, etc. Lessons for objectives beyond Level C require more individual attention. Training auditory skills is much more demanding on teachers than is training visual abilities. Visual tasks, by their very nature, generally yield a relatively permanent product--a design, a drawing, a construction--that can be assessed by the child and by the teacher at different times. The product can be discussed and modified, and can serve, in a very important way, to provide the method for teaching the child to assess his own performance.

The same is not true for training auditory skills. Given a task that involves "saying" something, the child requires the presence of a reliable listener to assess, reinforce, or disagree with, his own judgment. Once the sounds are produced, they are gone--unless taped. Hence, the teacher must be present, or willing to take time to listen to tapes later. And, even if the teacher is willing to do the latter, the method is not a good one. The child who performs inappropriately will be practicing his errors as he records them on tape.

Ideally, then, the child should not participate in training activities unless a reliable assessor is also present. Acknowledging this, the teacher is advised to conduct small group lessons with children who are more or less at the same position within the structure. To facilitate this, a series of stories has been written, wherein animals model the specific behaviors of the curriculum. Taped lessons have also been developed; these involve the use of "write and see" response sheets (specially prepared worksheets that turn color if the appropriate space on the sheet is moistened with a special marking pen). It is not as ideal as having a teacher listen to the child; it is, however, a serviceable adjunct to teacher-conducted lessons. There will be approximately 50 taped lessons, once developmental and try-out studies have been completed.

Once the terminal objective of Level H has been mastered, the child is considered to have achieved adequate competency in auditory-motor function. The teacher stops testing and training in the Auditory-motor component.

Again the question critical to Goal 4 is: Does the curriculum work in the classroom? Do the children show change in auditory-motor skills that can be attributed to implementation of the curriculum. Table 11 shows, for both grades, the median beginning-of-year placement, the median position within the Auditory-motor structure four months later,

Table 11

Median Position in Auditory-motor Structure in September and January, and Median Number of Objectives Mastered in That Four-Month Period

(Possible Range = A-1 to H-9; Total Number of Objectives in Structure = 33)

		September Position in Structure		January Position in Structure		September-January Number of Objectives Mastered	
Grade	N	Median	Range	Median	Range	Median	Range
K	57	D-8	A-1 to F-8	E-8	B-5 to G-8	5	0-22
1	33	E-8	D-4 to G-8	G-8	D-8 to H-10*	7	0-14

* = mastered all curriculum objectives

(in mid-January), and the median number of objectives mastered during those four months. The progress of the children in these groups is obvious.

Figure 15 shows these same distributions as relative cumulative frequency ogives. Two distributions (September, 1971 and January, 1972) are graphed for each class. As expected, a wide difference is shown between the two groups in September; indeed, the gap persists in January as well. It is noteworthy, however, that the January, 1972 distribution of the kindergarten group matches very closely the ogive representative of the first-grade class in September, 1971. If the kindergarten children continue to make progress in the curriculum, there is every reason to anticipate that their auditory perceptual skills, upon entering first grade, will be appreciably higher than those that were shown by the current first grade. Again, these projections have yet to be confirmed, but the indications are favorable.

A review of the objectives of this component will help to clarify why auditory-motor skills are important aptitudes to academic achievement, and to reading in particular. As the child masters the objectives

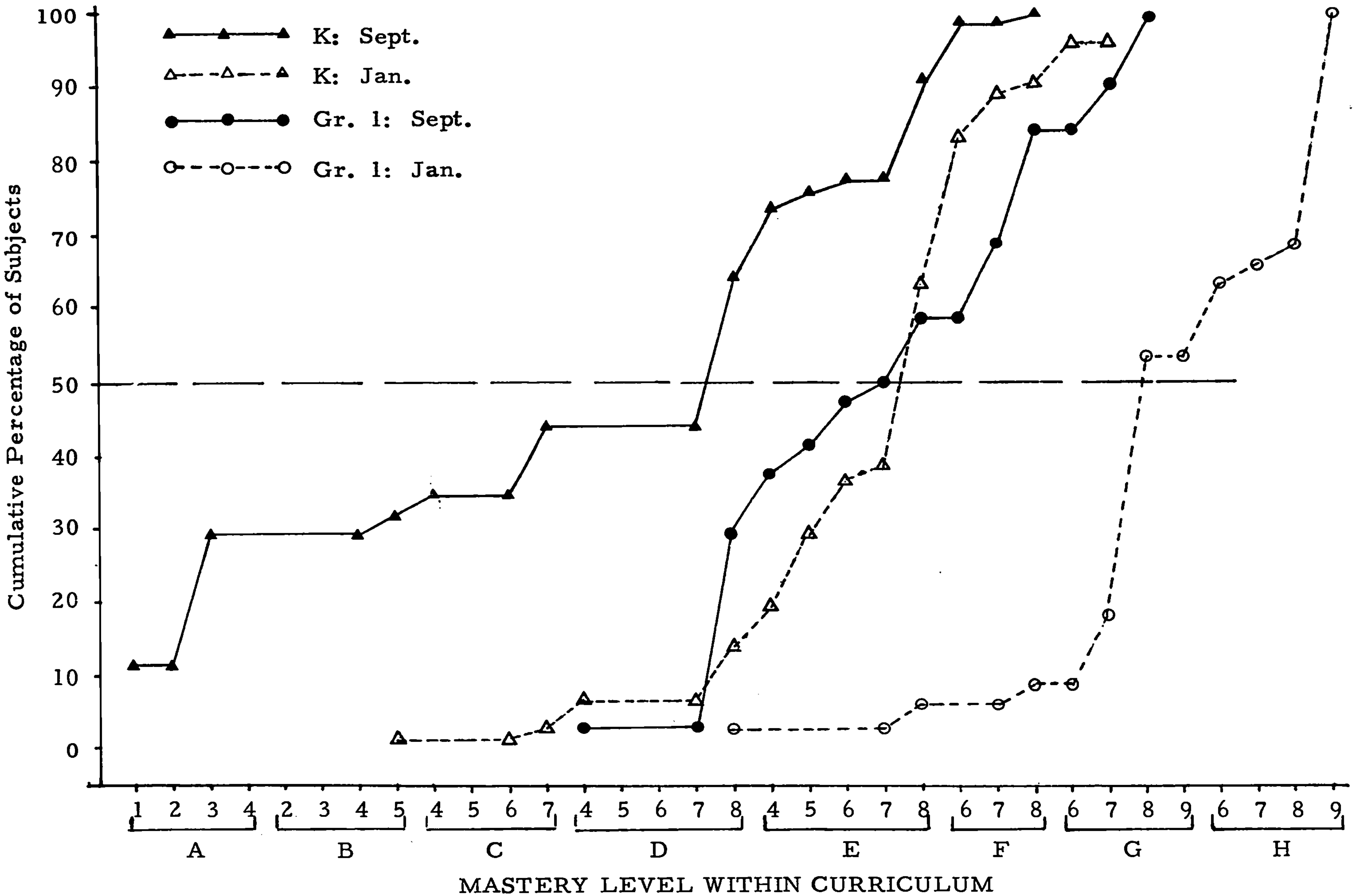


Figure 15

Relative Distribution of Objectives Mastered in the Auditory-motor Component as Measured in September and January of the Same School Year described above, he acquires the skills that are used in sorting and ordering acoustical data. Beginning reading requires the accurate production of sounds as represented by visual symbols--a task that is easier to talk about than accomplish. The visual analysis behaviors required for reading are relatively simple. The visual symbols are "real"; they can be seen, pointed to, and even felt, if proper materials are used; a printed word is nothing more than the sum of its parts--that is, the individual letters of that word. Sounds are much more abstract. Not only are they intangible--except through vocomotor exploration--they are also exceedingly short-lived.

The objectives of this component stimulate analysis of spoken words into their component parts. The Unit 5 behaviors of the auditory component will give the child access to a systematic method for mediating a temporal dimension--spoken sounds--visually, albeit to only the syllable level. As such, the child gains some insights into the phonic elements that will be represented visually in printed matter. It is reasonable to suggest that once a child has learned to represent sounds with a visual code, the task of decoding those visual symbols phonetically will be more readily understood and accomplished.

The General-motor Component

The objectives of the General-motor component of the curriculum are, again, consistent with the principles of the rationale. The purpose of this component is to identify for the teacher the gross and fine motor skills that are pertinent to visual and auditory perceptual competencies. Given identity, they can be tested and, where indicated, trained. The structure of the component is shown in Figure 16; Table 12 lists the objectives of that structure.

		UNITS							
		1	2	3	4	5	6	7	8
LEVEL	C								
	B								
	A								

☐ = objective stated and criterion-referenced test constructed

Figure 16

Structure of General-motor Component

Table 12

Objectives of General-motor Component

Level A

Unit 1: Stand with one foot crossed in front of the other for 5 seconds; then repeat with other foot forward.

Unit 2: Walk forward a distance of 10 feet with feet crossing over in front of each other.

Unit 3: Jump forward; feet together.

Unit 4: Click teeth while lips are together; move eyes freely to far left and far right.

Unit 5: Use scissors to cut paper.

Unit 6: Identify named body parts.

Unit 7: Given verbal instructions, move only one arm, then the other, while in supine position. (Angels in Snow posture)

Unit 8: Tempo set by teacher; tap right and left hands, alternately, in tempo.
Tempo set by teacher; run in place.

Level B

Unit 1: Balance on one hand and opposite knee and foot for 6 seconds; then repeat with other hand, knee and foot.

Unit 2: Hop in place on one foot, while supporting self with hands; then with other foot.

Unit 3: Broad jump - 12 inches.

Unit 4: Move tongue (inside mouth) from one cheek to the other. Move eyes laterally, looking from own right hand to own left hand.

Unit 5: Draw a single line connecting two dots that are three inches apart.

Unit 6: Name designated body parts.

Unit 7: Given verbal instructions, move one leg, then the other, while in supine position. (Angels in Snow posture)

Unit 8: Tempo set by teacher; tap each hand twice, alternating hands while maintaining rhythm and tapping pattern.

Table 12 (continued)

Level C

Unit 1:	Stand balanced on one foot for 8 seconds; then balance on the other foot.
Unit 2:	Hop forward on one foot, a distance of 8 feet; then on the other foot.
Unit 3:	Skip, maintaining synchronous pattern for at least 15 feet.
Unit 4:	Move tongue and eyes in same direction at same time, upon verbal direction.
Unit 5:	Given a string, tie a bow.
Unit 6:	Name designated body parts (touched but not seen).
Unit 7:	Given verbal instructions, move arm and leg on same side simultaneously while in a supine position; then the other arm and leg. (Angels in Snow posture) Move both hands simultaneously in the same direction to draw a horizontal line; then move both in opposite direction.
Unit 8:	Tempo set by teacher; hop twice, alternating feet while maintaining rhythm and hopping pattern.

The structure of this component differs from the two already described (V-M and A-M). The use of levels and units is repeated, but they are not as closely interdependent as was the case with the Visual and Auditory. In the General-motor component, the levels are again intended to be indicators of varying complexities of a behavior that range from global to differentiated. The units again represent a variety of different behaviors. In this sense, the structure is indeed the same. The difference lies in the fact that each unit contains an end in itself; that is, each unit is to be mastered at its highest level. In the visual and auditory components, the highest numbered unit of a level was considered to be more difficult than all of the lower numbered ones. The latter were viewed as less difficult versions of the higher units--thus, there was no need to test them, given competency in a higher unit. In the G-M structure, each unit is independent. Mastery of one, regardless of its numerical designation, is not an indication of mastery in any other unit at that level. In short, their numerical identities are not inferences of a hierarchy within the level in any way--they are merely symbols that are used to distinguish one behavior from another. To place students in a level, the teacher administers the tests of Level C. If non-mastery is shown, Level B and, if needed, Level A are then tested.

Three levels of each behavior are described as objectives; tests are provided for each objective. In placement testing, the child is tested for his ability to demonstrate mastery of the C level objective in <u>each</u> unit. The units are identified as follows:

Unit 1 - Balance-static

Unit 2 - Balance-dynamic

Unit 3 - Combination of process

Unit 4 - Fine motor-facial

Unit 5 - Fine motor-digital

Unit 6 - Body awareness

Unit 7 - Laterality

Unit 8 - Bilateral integration

Insufficient evidence has thus far been collected to validate empirically the objectives of this structure. The General-motor component is based on a conglomeration of logic, hypotheses, and perhaps even folklore. Studies will be continued to sort out what, in fact, can be supported as valid--directly related to the higher order behaviors of the classroom--and what cannot be substantiated. In the interim, it is included because it can be defended reasonably and because "it can't do any harm."

Training activities for these objectives also are provided for the teacher. One needs only to study the objectives to appreciate that the activities are of a sort that can be readily accepted by preschool, primary, and physical education teachers. Most activities can be implemented in a group format and need not be considered as anything but recreational activities that are not uncommon in that setting. The major obligation of the teacher, in using this component of the curriculum, is to recognize the individual differences in the general motor skills of her students and adapt training methods to the needs of those children while still including them into the group. The general rule, here, is inclusion of all--even those who are awkward--rather than exclusion of those who are less competent.

Does the curriculum work? Do the children show changes in general-motor functions, having been exposed to the appropriate training activities? Table 13 shows, for both grades, the median number of objectives mastered at the beginning-of-year placement test, and the median number of additional objectives mastered during the four months that followed placement testing. (These data are presented differently than the Visual-motor and Auditory-motor because the structure is not organized as a linear sequence. It is very possible for a child to be at one level in one unit and at a different level in any other unit. To avoid confusion, the data merely represent total number of objectives; no attempt is made, in this presentation, to isolate individual units.) The progress of the children is obvious.

Table 13

Median Total Number of General-motor Objectives Mastered at September Placement Testing and the Median Number of Additional Objectives Mastered in the Subsequent Four Months

(Total Number of Objectives in Structure = 24)

		September Placement Objectives Mastered		January Additional Objectives Mastered		Total Objectives Mastered	
Grade	N	Median	Range	Median	Range	Median	Range
K	57	9	0-9	15	3-24	6	0-15
1	33	15	9-18	24	18-24	9	6-15

Figure 17 shows these distributions as relative cumulative frequency ogives. Again, as was shown with the Visual-motor and Auditory-motor components, the children have made marked progress. Indeed, the kindergarten children, in January, 1972, are approximating the competency level that the older children showed at the beginning of their first-grade year.

The Letters & Numerals Component

The fourth component of the Perceptual Skills Curriculum is concerned with the symbols of the classroom. Its objectives were defined as they were because mastery would indicate an ability to use the symbols in the variety of ways asked for in the classroom. The structure of this component is shown in Figure 18; Table 14 lists the objectives of that structure.

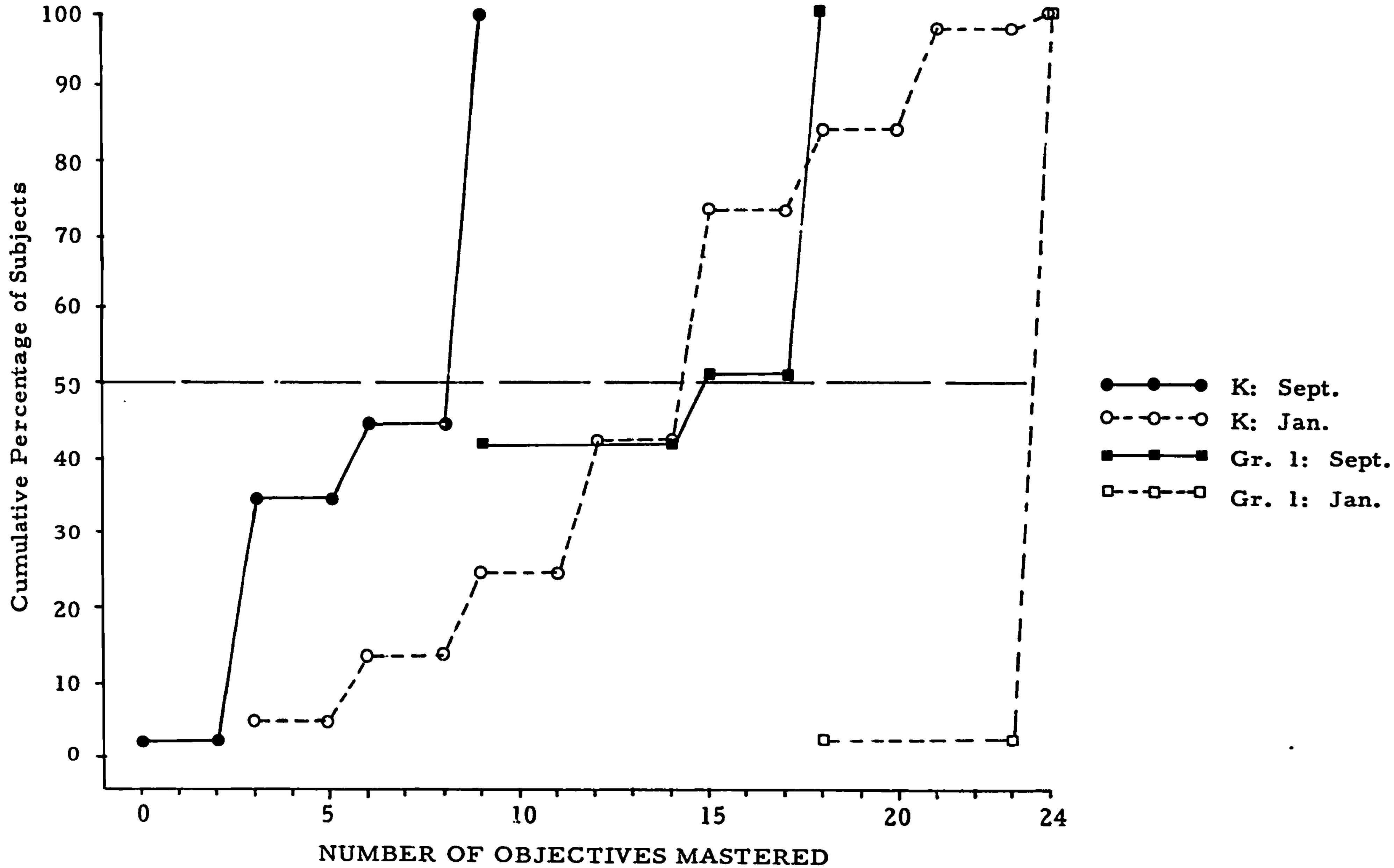


Figure 17

Relative Distribution of Objectives Mastered in the General-motor Component as Measured in September and January of the Same School Year

		UNITS												
		1	2	3	4	5	6	7	8	9	10	11	12	13
LEVEL	D													
	C													
	B													
	A													

□ = objective stated and criterion-referenced test constructed

Figure 18

Structure of Letters & Numerals Component

Table 14

Objectives of Letters & Numerals Component

Level A

Unit 1: Given the numerals 0 1 2 3 4 5 6 7 8 9; match numerals to sample.

Unit 2: Given the capital letters A C D E G; match letters to sample.

Unit 3: Given the capital letters J O Q U; match letters to sample.

Unit 4: Given the capital letters I L M T V; match letters to sample.

Unit 5: Given the capital letters W X Y Z; match letters to sample.

Unit 6: Given the capital letters B F H K; match letters to sample.

Unit 7: Given the capital letters N P R S; match letters to sample.

Unit 8: Given the lower case letters a c d e g; match letters to sample.

Unit 9: Given the lower case letters j o q u; match letters to sample.

Unit 10: Given the lower case letters i l m t v; match letters to sample.

Unit 11: Given the lower case letters w x y z; match letters to sample.

Unit 12: Given the lower case letters b f h k; match letters to sample.

Unit 13: Given the lower case letters n p r s; match letters to sample.

Level B

Unit 1: Given a printed numeral (0 1 2 3 4 5 6 7 8 9), in an array of numerals, point to specific numeral upon verbal command.

Table 14 (continued)

Level B (continued)

Unit 2:	Given a stated letter (A C D E G) point to it in an array of capital letters.
Unit 3:	Given a stated letter (J O Q U) point to it in an array of capital letters.
Unit 4:	Given a stated letter (I L M T V) point to it in an array of capital letters.
Unit 5:	Given a stated letter (W X Y Z) point to it in an array of capital letters.
Unit 6:	Given a stated letter (B F H K) point to it in an array of capital letters.
Unit 7:	Given a stated letter (N P R S) point to it in an array of capital letters.
Unit 8:	Given lower case letters (a c d e g) point to the stated letter.
Unit 9:	Given lower case letters (j o q u) point to the stated letter.
Unit 10:	Given lower case letters (i l m t v) point to the stated letter.
Unit 11:	Given lower case letters (w x y z) point to the stated letter.
Unit 12:	Given lower case letters (b f h k) point to the stated letter.
Unit 13:	Given lower case letters (n p r s) point to the stated letter.

Level C

Unit 1:	Given the printed numerals 0 1 2 3 4 5 6 7 8 9; name the numerals.
Unit 2:	Given the printed capital letters A C D E G; name letters.
Unit 3:	Given the printed capital letters J O Q U; name letters.

Table 14 (continued)

Level C (continued)

Unit 4:	Given the printed capital letters I L M T V; name letters.
Unit 5:	Given the printed capital letters W X Y Z; name letters.
Unit 6:	Given the printed capital letters B F H K; name letters.
Unit 7:	Given the printed capital letters N P R S; name letters.
Unit 8:	Given the printed lower case letters a c d e g; name letters.
Unit 9:	Given the printed lower case letters j o q u; name letters.
Unit 10:	Given the printed lower case letters i l m t v; name letters.
Unit 11:	Given the printed lower case letters w x y z; name letters.
Unit 12:	Given the printed lower case letters b f h k; name letters.
Unit 13:	Given the printed lower case letters n p r s; name letters.

Level D

Unit 1:	Print numerals from dictation.
Unit 2:	Print capital letters from dictation. A C D E G
Unit 3:	Print capital letters from dictation. J O Q U
Unit 4:	Print capital letters from dictation. I L M T V
Unit 5:	Print capital letters from dictation. W X Y Z

Table 14 (continued)

Level D (continued)

Unit 6:	Print capital letters from dictation. B F H K
Unit 7:	Print capital letters from dictation. N P R S
Unit 8:	Print lower case letters from dictation. a c d e g
Unit 9:	Print lower case letters from dictation. j o q u
Unit 10:	Print lower case letters from dictation. i l m t v
Unit 11:	Print lower case letters from dictation. w x y z
Unit 12:	Print lower case letters from dictation. b f h k
Unit 13:	Print lower case letters from dictation. n p r s

The Letters & Numerals component is also arranged according to levels and units. It, too, differs from the Visual and Auditory structures; the levels are representative of the behavior--what the child is to <u>do</u> with the symbol; the units are indicative of a specific subset of numerals, capital letters, and lower case letters. For example, Level A objectives require the child to <u>discriminate</u> the various shapes of all the symbols and to demonstrate mastery with "matching to sample" items. Level B objectives ask the child to recognize the letters and numerals by their name; to be able to <u>point</u> correctly at any symbol named by a tester, as presented in an array of other symbols. Level C objectives are concerned with the child's ability to <u>name</u> the letters and numerals, upon visual presentation. The objectives of Level D are concerned with the child's ability to <u>print</u> the letters and numerals from dictation. Thus mastery of a unit at the D level, in this structure, implies the ability to perform the behaviors of naming that specific set of letters and pointing to them from dictation--behaviors that have been designated as subordinate to the Level D objectives.

The units, within the levels, provide a systematic method for classifying the symbols. There are thirteen units in all. The first includes all of the numerals from 0 to 9; the next six units include all of the twenty-six capital letters; the last six units contain all twenty-six lower case letters. Their organization is shown in the listing of objectives shown in Table 14.

The division of letters into six units was not as arbitrary as initial inspection would suggest. It is evident that lower case letters are more susceptible to directional confusions than are capital letters. For this reason, the lower case alphabet was divided into three basic classes:

1. Those that, in all but one case, can be related to the lower case c; and, in addition, if they contain a vertical line, it

appears to the right of the rest of the letter. The letters of Units 8 and 9 belong in this group.

2. Those that, in all but three cases, can be related to the lower case r; and, in addition, if they contain a vertical line, it appears to the left of the rest of the letter. The letters of Units 12 and 13 belong in this group.
3. Those that tend to be symmetrical and, by elimination, did not meet the criteria for inclusion into the above two groups. These are the letters in Units 10 and 11.

To place students in a level, the teacher administers the tests of Level B. Given evidence of mastery here, Level D tests are used; given the opposite--indications of non-mastery at Level B--Level A tests are used. Once a level of ability has been established, the teacher sets about implementing lessons to teach the higher order objectives--to teach the child to pass the tests.

Material and lessons designed to aid the teacher in teaching the objectives are also provided, although the teacher is encouraged to use, in addition, whatever appropriate materials she has available. Over one hundred supplemental instructional tapes and worksheets have been developed along with twenty-six tapes and worksheets that can be used to test the child in the various objectives without requiring the constant presence of a tester.

Does the curriculum work? Inasmuch as teachers have successfully taught these symbols for many generations, it is no great feat we seek to accomplish here. Use of the curriculum, however, alerts the teacher to each of her student's competencies and needs; a child is less apt to be overlooked. To this extent, the curriculum is indeed useful. Table 15 shows, for both grades, the median number of objectives mastered at the beginning-of-year placement test, and the median number of additional objectives mastered during the four months that followed placement testing. (These data, too, are presented differently than the Visual-motor and Auditory-motor because the structure is not organized as a linear sequence. It is probable that a child will be on one level in some units and on a different level in other units. To avoid confusion, the data merely represent total number of objectives; no attempt is made, in this presentation, to isolate individual units.) Again, the children's progress is obvious.

Table 15

Median Total Number of Letters & Numerals Objectives Mastered at September Placement Testing and the Median Number of Additional Objectives Mastered in the Subsequent Four Months

(Total Number of Objectives in Structure = 52)

		September Placement Objectives Mastered		January Additional Objectives Mastered		Total Objectives Mastered	
Grade	N	Median	Range	Median	Range	Median	Range
K	57	2	0-19	13	0-50	16	0-37
1	33	44	4-52	52	30-52	18	0-34

The cumulative frequency ogives graphed from these data are shown in Figure 19. It is evident here that, although the kindergarten group has made progress, from September to January, it is still far below the level of competency shown by the first grade in September. This is a markedly different picture from that observed in the other three curricular components, where the kindergarten children, in January, were approximating, or surpassing, the first-grade children's September performance.

The difference, in this component, is probably a function of the amount of time devoted to teaching the Letters & Numerals objectives.

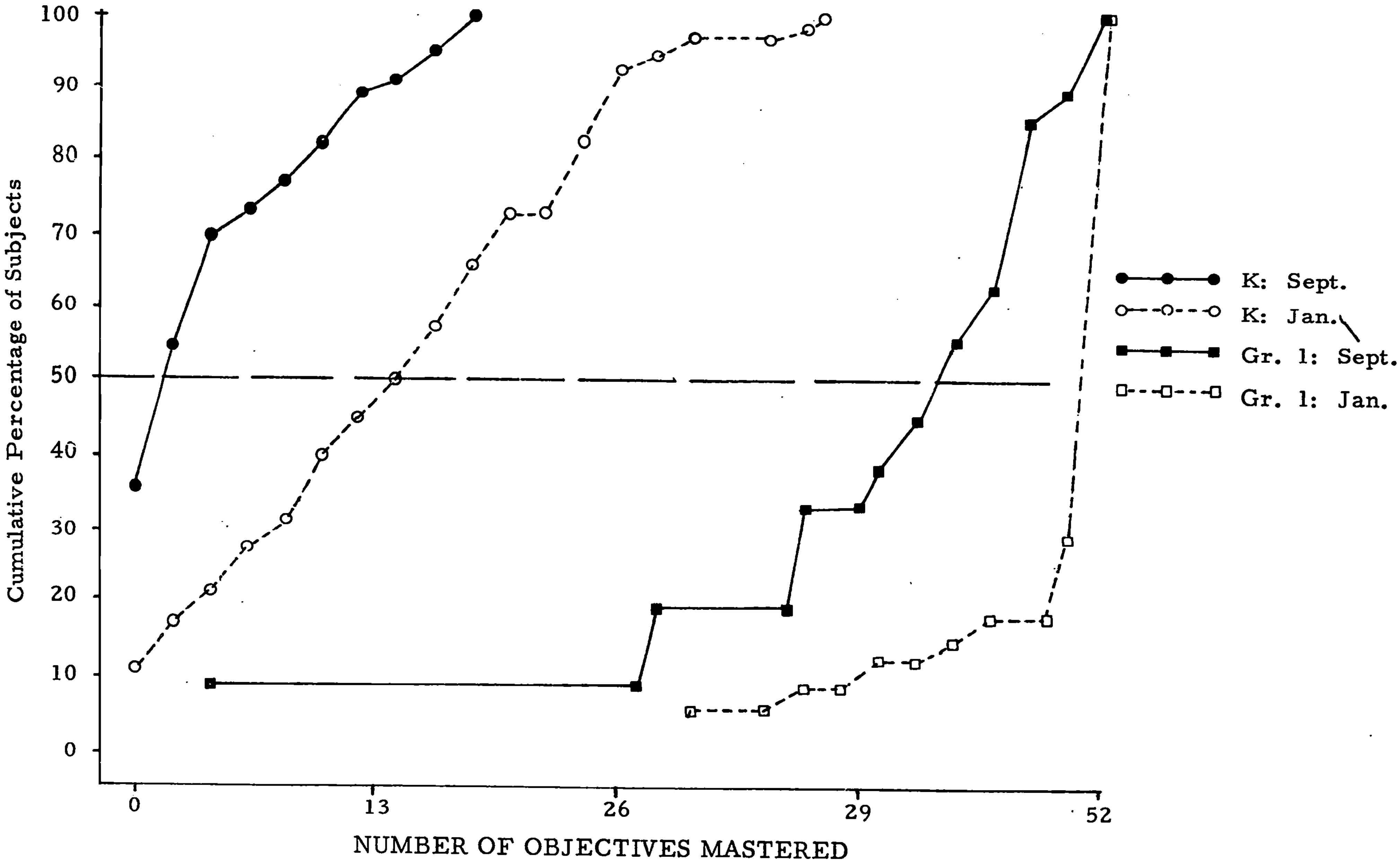


Figure 19

Relative Distribution of Objectives Mastered in the Letters & Numerals Component as Measured in September and January of the Same School Year

It is conceivable, however, that the curriculum activities do not teach the objectives as well as they should. End-of-year kindergarten data will provide more data and enable us to make a valid judgment.

SUMMARY AND CONCLUSIONS

The four goals that we set have, to at least some degree, been attained. Certain behavioral processes, that we called "perceptual skills," have been identified as directly related to primary-grade achievement. They have been described behaviorally, and it has been demonstrated that they can be taught to young children. Further it has been shown that when children are taught these basic information processing skills, transfer effects--in classroom behaviors--are evidenced. Finally, it has been shown that the teaching of perceptual skills can be managed in the classroom by using an organized testing and training program that recognizes individual differences among children.

Four behavioral structures have been described--components of the Perceptual Skills Curriculum. Our evidence indicates that mastery of the terminal objectives of these structures, by six- and seven-year-old children, predicts their competency in the basic information processing skills that are presumed by the usual instructional programs of the first and second grades.

Competent visual-motor skills will indicate an ability to analyze and organize visual data according to spatial attributes--to extract specific patterns of visual information from larger and more complex patterns. Evidence has been provided that relates this set of skills more closely to the tasks of beginning arithmetic than to reading.

Competent auditory-motor skills will indicate an ability to analyze and organize acoustical data--to extract specific patterns of auditory information from greater and more complex patterns. Evidence has been offered that relates this set of skills more closely to the task of beginning reading than to arithmetic.

The direct value of competent general-motor skills is still debatable. Clearly, they are useful. Facility in manipulating a pencil, and in controlling the speech production mechanism and the extraocular system, can hardly be considered as undesirable. Awkwardness is rarely a positive feature; social acceptance in a classroom often centers on such a factor. Thus, although there is still insufficient data that relates general motor skills with academic achievement, the component is concerned with desirable behaviors.

The fourth component--Letters & Numerals--is more concerned with content than process. As such, it is not really devoted to perceptual skills. The component is included, primarily, because it represents a very necessary set of primary-grade behaviors and, also, because the behaviors are such that they require the child to organize and relate visual and acoustical information simultaneously. Visual-motor skills center on one's ability to bring order to three-dimensional space. Auditory skills, on the other hand, are related to the dimension of time. Printing letters in an ordered manner--as, for example, in spelling--requires both types of organizational skills. Directionality, such as from left to right, insists upon visual-motor directives. Sequencing letters so that they map accurately on the sounds requires auditory perceptual competencies. Hence, learning to name and print the letters of the alphabet, and learning to arrange them in a left to right sequence, are representative of basic integrative functions that are critical to satisfactory school performance. The child is learning to mediate visually the dimension of time (hear and print) and, in reverse, to mediate acoustically the dimensions of visual space (see and say). Thus, when he has acquired competency in these behaviors, his chances of meeting the demands of the primary academic programs should be enhanced.

Are there other critical variables--perceptual skills--that relate, in a different way, to classroom achievement? Probably. Those already identified and described in this paper do not seem to be sufficiently extensive nor adequately complex to account for as much of the variance in classroom achievement as we would like. In retrospect they may even seem trifling, compared to the time and effort devoted to the task by the staff of this Project and the many other LRDC Research Associates who have contributed valuable guidance. Thus far, however, no other important variables have been defined. Perhaps, as Simon (1969) states:

> A man, viewed as a behaving system, is quite simple. The apparent complexity of his behavior over time is largely a reflection of the complexity of the environment in which he finds himself (p. 25).

Is it possible that the child's analysis and synthesis skills, initially challenged by relatively uncomplicated visual and acoustical perceptual constructs, become no more elaborate but, instead, become only more efficient--that they apply the same behavioral processes to larger and more abstract units of analysis? The question cannot now be answered; the prospect is an interesting one.

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