# The use of behavioral parameters for a VISUAL PERCEPTUAL EVALUATION

ROCHELLE MOZLIN, O.D.


### Abstract

*The use of several behavioral parameters during a visual perceptual evaluation can provide a more comprehensive understanding of a patient's perceptual processing and its relationship to performance. The visual-motor hierarchy, simultaneous and successive processing, perceptual speed, and cognitive style are all factors which can be evaluated during the testing of all perceptual skills. Considering these concepts can help the optometrist develop a problem-oriented management plan which reflects the patient's real world problems and goals.*



### Key Words

*visual perceptual evaluation, learning disabilities, visual-motor hierarchy, reflective, impulsive, simultaneous processing, successive processing, perceptual speed*


Optometrists performing visual perceptual evaluations typically administer a battery of tests, with specific tests associated with a particular category or subdivision. For example, the Tachistoscopic Exposure Test[1] is administered to evaluate visual memory. This categorization of visual perception, as well as the tests chosen for other categories, are a reflection of the practitioner's own philosophy regarding vision and its relationship to learning. The major advantage to this approach is that it provides a framework for analysis of perceptual strengths and weaknesses.

There are, however, two major disadvantages. First, there is no standard visual perceptual evaluation. Communication between professionals, as well as the clinical training of optometric students, becomes difficult. Second, by creating subdivisions of visual perception, we are tempted to fragment the patient into specific deficit areas, and lose sight of the whole child.

The systematic observation of certain specified behaviors can minimize these disadvantages. By organized observation of these behaviors, the clinician can identify deficiencies which are causing poor performance on numerous tests that evaluate the various aspects of visual perception. The result is a more comprehensive understanding of the patient's mode of perceptual processing, which can frequently help explain success or failure of academic performance. This link is clinically important since most optometric perceptual evaluations are performed as the result of a parental or school referral of a child who is having academic difficulties.

## Definition of Learning Disabilities

Learning disabilities are defined as a heterogenous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to nervous system dysfunction.[2]

Three concepts in this definition should provide guidance to the optometrist performing a visual perceptual evaluation.

First, learning disabilities are a heterogenous group of disorders. Research into subtypes of learning disability have identified clusters of deficiencies, including visual perceptual skills. Groffman[3] reviewed seven such studies and concluded that visual perceptual deficits were present in 40% of the learning-disabled subjects. As a member of the multidisciplinary team, the optometrist's role is to diagnose and manage visual and/or visual perceptual problems which are contributing to the patient's academic difficulties. Optometrists do not treat learning disabilities. They treat the visual and visual perceptual deficits which act as "road blocks" to an effective education.

Second, learning disability is not solely a reading problem. Learning-disabled individuals most frequently have difficulty with a myriad of academic skills, including listening, speaking, reading, writing, reasoning, and mathematics. In her autobiography, Reversals, Simpson[4] described her problems:

> On bad days ... the dictionary becomes useless because I can't think of the opening letter that will help me find

the word I want ... In conversation, I say one thing when I mean to say another. ...My directional guide is so completely out-of-order that I walk blocks to the north when I want to go south. ... Numbers become scrambled so that I misdial, misaddress, and miscalculate three-quarters of the time.

Although reading difficulties are often the most obvious and the most frequent basis for referral, the optometrist should probe the patient's level of achievement on all academic skills during the case history in order to determine possible relationships with visual perceptual deficits. For example, visual spatial skills are essential to understanding mathematical concepts, especially basic operations (addition, subtraction, multiplication and division) and geometry. Writing is dependent upon visual-motor integration. Listening and speaking are analogous to speech and audition, which was one of Skeffington's four circles.[5] Language deficits may limit the patient's ability to transfer previous visual experiences to new situations. Reasoning may be viewed as the top of the pyramid.

More globally, the integration of visual input with other sources of information allows the patient to conceptualize new relationships and perform meaningful actions. Deficits in visual perceptual skills often become the "weak link," impacting all learning.

Third, the disorders are intrinsic to the individual. The primary cause is not external factors such as socioeconomic factors or limited educational opportunities, although these factors may be concurrent. Whatever the nature of the central nervous system dysfunction, the result is the clinical presentation of academic difficulties. In order to be successful, the problem-oriented optometrist must assess the relationship between this chief complaint and the results of the visual perceptual evaluation. Often judgments must be made concerning the relative significance of visual perceptual deficits versus other predisposing risk factors. For example, recurrent ear infections, severe allergies, delayed speech, and low birth weight are all associated with learning disabilities.[6] A comprehensive case history, then, becomes an essential tool, identifying all key factors, providing direction for the evaluation and ultimately guiding the diagnosis, prognosis, and management.

## Quantity vs. Quality

A standardized test utilizes specific procedures, instrumentation, and scoring in order to duplicate the testing conditions at various times and places.[7] Testing materials, instructional sets and time factors (when applicable) remain constant. A raw score is obtained which can be converted to a standard score, percentile or perceptual age. The standardized test emphasizes a quantitative measurement, allowing the optometrist to compare the performance to established norms. Scores more than 0.5 a standard deviation below the mean, which corresponds to the 31st percentile, are considered by some as representative of a problem in tests of perception.[7] All scores below this cut-off can be "flagged" as a first step in the problem-oriented evaluation. Of course, test results are not considered in isolation, but rather as one point of information in the assessment process.

Utilization of standardized tests also offers the examiner reliability. Reliability refers to repeatability and consistency over time. If the same test is used on two separate occasions or by two separate examiners, the results should be the same. The use of reliable standardized tests permits comparison of pre- and post-therapy scores. Improvements on test scores are more likely the result of enhanced perceptual skills, rather than fluctuations in the score. Thus, the use of standardized tests adds significant strength to the argument that perceptual skills can be improved.

The score obtained on a standardized test reveals the quantitative performance. However, the optometrist must be careful to not lose sight of the qualitative aspects of performance. To neglect these qualitative aspects would preclude assessment of the strategies the patient used to solve the problem. The perceptual evaluation should balance quantity and quality. Groffman[8] suggests the use of recording sheets designed for specific testing procedures with observation guidelines of specific behaviors as well as administration and scoring protocols. Whether applying a structure to clinical observation with recording sheets or utilizing a more free form approach, it is important to recognize that the use of standardized tests can be enhanced by clinical observation and appropriate questioning. Holmes[9] reminds us that the goal of the evaluation is not a diagnosis but a management/intervention plan. Once the clinician understands how the patient solves problems, he or she can re-examine the patient's problems and goals in the real world and begin to formulate treatment objectives. What follows are several behaviorally-based parameters that can be utilized to systematically investigate the more qualitative aspects of a patient's performance on perceptual tests.

## The Visual Motor Hierarchy

Birch[10] recognized the relationship between vision and learning when he wrote of the hierarchical shift:

> Reading disability may ... at least in part, be the product of the failure of the visual system's hierarchical dominance ... Failure for such dominance to occur will result in a pattern of functioning which is inappropriate for the development of reading skills.

The visual motor hierarchy is the graphical representation of the developmental process described by Birch (see Figure 1). As vision becomes dominant, the motor system becomes subservient, performing actions as directed by the visual system.

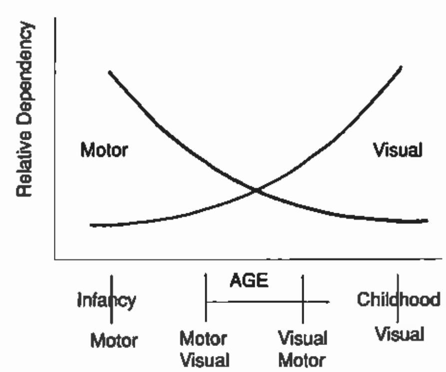


*Figure 1. Reproduced with permission from the Journal of the American Optometric Association.[11]*

Weinstein[11] described the end result of this hierarchical shift: "Vision is a light sense that generates movement patterns to bring meaning to an object of regard." Vision drives the motor system and the two are intimately connected via a feedback loop. Kephart[12] described this process as a servomechanism, where the output becomes part of a new enhanced input, creating a continuous monitoring process, until a final response is made. If the feedback is inadequate, the patient will have great difficulty equating a visual stimulus with a motor response. He or she cannot rely on vision for accurate information. Consequently, motor reinforcement or other sources of sensory input are required to validate visual impressions. During the visual perceptual evaluation, these patients perform at immature levels on the visual motor hierarchy.

Some perceptual tests which explore the patient's position on the visual motor hierarchy are not standardized tests. They rely on clinical observation and qualitative judgments. However, many have observation guidelines and age expecteds. A good example is the Circus Puzzle.[13] Young children, 2-3 years old, will attempt to complete the puzzle motorically by forcing the pieces into the cutout areas of the board. Feedback is minimal, resulting in a trial and error approach. The 6-year-old is expected to make visual judgments to orient the piece properly, guide the hands and self correct.

The patient's performance relative to the visual motor hierarchy should be evaluated on more than one test or procedure. Performance is likely to vary, depending on the task demand and the patient's perceptual strengths and weaknesses. It is not uncommon to see a regression to a lower level of functioning with a test requiring a higher level of cognition. Observations made during several tests result in a range of function, rather than a discrete level.

The visual motor hierarchy offers significant insight into understanding the chief complaint of academic difficulties. If the patient must rely on the motor system to gain information from the environment, vision has not emerged as the dominant processing system. Should that patient be expected to perform in a classroom where information is presented primarily visually?

## Cognitive Style

Kagan[14] described cognitive style using the dichotomous terms "reflective" versus "impulsive." Impulsive children "select and report solution hypotheses quickly with minimal consideration for their probable accuracy. Other children of equal intelligence take more time to decide about the validity of solutions. The former have been called impulsive, the latter reflective."

The Matching Familiar Figures Test[15] is the instrument most often associated with the determination of cognitive style. Time and number of errors are both considered, defining four classifications:[16]

Fast and inaccurate (impulsive)
Fast and accurate
Slow and inaccurate
Slow and accurate (reflective)

Although created for one particular test, this classification system can be applied to other perceptual tests. Just as the patient's placement on the visual-motor hierarchy may vary with the task, cognitive style may change, depending on the problem presented. Performance on several tests during the perceptual evaluation may define a range of behaviors on a reflective- impulsive continuum. Often the correlations with academic performance are striking. For example, during the reading lesson, a child completes the vocabulary worksheet very quickly, but makes a high number of errors and blurts out incorrect responses during class participation. On the other hand, during the geography lesson, the child listens intently and works independently on his or her map (he or she may still have difficulty waiting, and still blurts out incorrect responses).

Kephart's[12] conceptualization of visual-motor integration as a closed loop system provides a framework for understanding impulsive-reflective behavior. If the feedback loop is intact, the monitoring process continues until a perceptual-motor match is made. Thus, the reflective individual inhibits a final response until more appropriate information is obtained, resulting in improved accuracy. At the other extreme, the impulsive individual's feedback loop lacks integrity. It might also be characterized as "leaky." The response latency and accuracy are both reduced because less information is being processed.

Kephart's[12] model implies that cognitive style can be modified by strengthening the feedback loop. Rouse and Scheiman[17] remind us that optometric vision therapy is an interactive process between the patient and the optometrist in which the optometrist facilitates the patient's internalization of visual processes. By emphasizing how a particular technique is accomplished and enhancing feedback to the patient, the optometrist can fortify that closed loop system. Impulsive behavior is diminished as visual processing improves.

## Simultaneous and Successive Processing

Luria[18] described three hierarchical zones of cortical function: the primary or projection areas, the secondary or association areas, and the tertiary or overlapping zones. These zones are governed by the "law of diminishing specificity." The lowest zones are modality specific (i.e., the primary visual cortex). As the hierarchy is ascended, the information becomes more multimodal, culminating in the tertiary zones, which are responsible for complex supramodal processing. There are two supramodal processes: simultaneous and successive.

Simultaneous processing involves the synthesis of separate elements into a whole. This gestalt-like integration may involve the direct perception of a stimulus, the completion of an image through memory, or complex processing of separate elements into a whole. Simultaneous processing is required on form reproduction tests such as the Copy Forms[13] and the Developmental Test of Visual Motor Integration.[19] In order to accurately reproduce each form, the patient must understand the relationship of the parts to the whole, maintaining a visual "gestalt." This is a developmental skill, as evidenced by the 6-year-old who characteristically segments several of the forms. This age- appropriate behavior represents the more limited simultaneous processing skills available to the child.

Successive processing involves solving problems in a linear fashion. Information is processed bit by bit, and the solution to the problem requires proper sequencing. Successive processing can occur at the same three levels as simultaneous processing; direct perception of the stimulus, integration with or organization of information in memory, and complex processing of the relationships between successive stimuli. Perceptual tests which require successive processing include the Visual Span Test developed by Groffman for Computer Orthoptics,[20] the ITPA Subtest of Visual Sequential Memory,[A] and Digits Forward.[B] All require the proper sequencing of a response.

The dichotomy of simultaneous and successive processing provides a framework for understanding certain academic difficulties. Successive processing is essential in learning to read, when words must be learned as a series of sounds (phonetic analysis). Spelling, mathematical calculations, and the ability to follow instructions are other academic skills associated with successive processing.

Simultaneous processing is essential to reading comprehension, i.e., reading to learn. In order to derive meaning from language, a succession of words must form a single concept. For example, "my mother's brother" becomes "uncle." Luria described the product of this supramodal process as "simultaneous perceptibility."[18] Other academic skills related to simultaneous processing include understanding mathematical concepts (especially geometry), reading maps, utilizing graphs and diagrams, and retention of a sight word vocabulary.

Research has shown that learning-disabled children rely on simultaneous processing when learning to read while successive processing skills are more appropriate at this time.[21] Dyslexics have been differentiated from normal readers by poor scores on successive processing tests.[22] The implication is that both modes of processing are necessary for academic success, although the relative importance of each may vary with the problem at hand. For example, the learning-disabled child who has poor successive processing skills, or applies simultaneous processing skills inappropriately to decoding, is certainly at a disadvantage.

Determining whether deficits exist in either or both modes of cognitive processing is essential to the perceptual assessment. A deficit in one mode of processing may be responsible for poor performance on several perceptual tests, across several subdivisions, representing a common final pathway. Often this correlates with academic difficulties in many areas, not just reading.

## Perceptual Speed

In 1938, Bender[23] described the tachistoscopic process as an act of visual perception which requires a measurable amount of time to integrate the stimulus with previous experience. The time required is called the temporal factor. If the time available is less than the temporal factor, the perceptual process will be incomplete or immature, resulting in a primitive response.

Thirty-six years after Bender described the temporal factor in visual perception, LeBarge and Samuels[24] characterized reading as a complex process composed of component subskills. If the component subskills cannot be performed automatically, then performance of the complex skill, e.g., reading, becomes impossible.

In a series of studies designed to evaluate the relationship between visual perceptual skills and reading in grades kindergarten through five, perceptual speed was measured with the tachistoscope.[25,26] At all grade levels, the correlation between reading and perceptual speed was statistically significant. The ability to accurately record the digits improved with age, indicating that perceptual speed is a developmental skill, proceeding from accuracy to automaticity.

These concepts of accuracy and automaticity can be applied to any perceptual test which is timed, such as the Grooved Pegboard[1] and the Divided Form Board.[1] Given enough time, most patients would be able to complete the Divided Form Board or fill the Grooved Pegboard. In other words, they would perform the task with accuracy. Accuracy alone, however, is not a sufficient criteria to judge performance. The ability to perform these tasks automatically becomes critical in determining whether the patient is at risk for learning problems.

Deficits in perceptual speed are apparent not only during the perceptual evaluation, but during the primary vision evaluation as well. These patients respond slowly during many subjective procedures, such as refraction, phoria and vergence measurements, and determination of stereoacuity. Often they score poorly on both the horizontal and vertical subtests of the DEM (Developmental Eye Movement Test).[27] This type of performance, classified as either Type III or Type IV, is indicative of an automaticity problem which effects language, including the rapid naming of numbers on this ocular-motor test.[27] (Type III has only an automaticity problem and Type IV has an ocular-motor dysfunction as well).

Does the perceptual speed deficit cause the poor responses during the vision examination, or does the visual skills dysfunction cause poor performance on measures of perceptual speed? Koslowe,[28] an optometrist and educational psychologist, found a high correlation between failure on a timed coding test and failure on the binocular vision portion of a vision screening. He concludes that children with low coding scores should be referred for a complete vision evaluation. Instead of attempting to ascertain which came first, the chicken or the egg, the optometrist needs to evaluate both aspects of visual performance and address all deficits in the management plan.

The patient with poor perceptual speed is often "left in the dust" in the classroom. When lower order perceptual skills demand significant attention, less attention remains for higher order cognitive skills. Thus, while classmates with mental 60 MHz processors are pondering the resources they will require to complete an assignment, the patient with the mental 25 MHz processor is still attempting to understand what is expected of him or her.

## Conclusions

The definition of learning disabilities provides a framework for the optometric evaluation of the patient with academic difficulties by posing the clinical question: is there a visual and/or visual perceptual deficit, and if so, does it relate to the chief complaint? In order to address this clinical question, the problem-oriented optometrist selects the most appropriate tools from several at his or her disposal.

The visual perceptual evaluation can provide significant insight into understanding the academic difficulties. The concepts discussed here can provide a more comprehensive view of the patient's perceptual profile. The visual-motor hierarchy, supramodal processing, cognitive style, and perceptual speed are all factors which contribute to the quality of performance in all perceptual skills. Balancing qualitative judgments with the quantitative results of standardized tests allows the optometrist to get the most out of each testing procedure.

The ultimate goal of the visual perceptual evaluation is the development of a problem-oriented management plan. Therapy should address those skills which are deficient and are viewed as contributory to the learning problem. The definition of learning disabilities reminds us that the academic difficulties may manifest in listening, speaking, reading, writing, reasoning or mathematics. As we all race down the information superhighway, all of

*Continued on page 140*

*The Use of Behavioral Parameters Continued from Page 118*

these skills will have greater impact on our patients' abilities to compete in a high tech society. Although he didn't write it with a word processing program, Getman taught us to "gain enough clinical insights today to guide patients to the visual abilities demanded by tomorrow."[29]

## Acknowledgement

A special thank you to Harold Solan, O.D., who has been a constant source of motivation and insipration.

## References

1. Solan HA, Mozlin R, Rumpf D. Selected perceptual norms and their relationships to reading in kindergarten and the primary grades. J Am Optom Assoc, 1985; 56(6): 458-66.
2. Proceedings of the National Conference. Revised Definition of Learning Disabilities, 1988.
3. Groffman S. The relationship between visual perception and learning. In: Scheman MM, Rouse MW, Ed. Optometric management of learning-related vision problems. St. Louis: Mosby-Year Book, Inc., 1994.
4. Simpson E. Reversals. Boston: Houghton-Mifflin Co., 1979.
5. Skeffington AM. Clinical optometry in theory and practice. Duncan, OK: Optom Extension Prog, 1963; Ser. 36, No. 2.
6. Cotter SA, Scharre JE. Optometric assessment: case history. In: Scheiman MM, Rouse MW, Ed. Optometric management of learning- related vision problems. St. Louis: Mosby-Year Book, Inc., 1994.
7. Solan HA, Suchoff IB. Tests and measurements for behavioral optometrists. Santa Ana, CA: Optom Extension Prog, 1991, Cur. II.
8. Groffman S. Perceptual assessment. In: Groffman S, Solan HA: Developmental and perceptual assessment of learning-disabled children: theoretical concepts and diagnostic testing. Optom Extension Prog, 1995.
9. Holmes JM. Evaluation and neuropsychological assessment: testing. In: Rudel RG. Assessment of developmental learning disorders. New York: Basic Books, 1988.
10. Birch HG. Dyslexia and the maturation of visual function. In: Money J, Ed. Reading disability. Baltimore: Johns Hopkins University Press, 1962.
11. Weinstein M. A rationale of vision and vision behavior. J Am Optom Assoc, 1967; 38(12): 1029-33.
12. Kephart NC. The slow learner in the classroom. Columbus: Charles Merrill Publishing Co., 1971.
13. Suchoff IB. Visual spatial development in the child; an optometric theoretical and clinical approach. New York: SUNY State College of Optometry, 1978.
14. Kagan J. Reflection-impulsivity: the generality and dynamics of conceptual tempo. J Abnormal Psych, 1966; 71(1): 17-24.
15. Kagan J. The Matching Familiar Figures Test. Cambridge, MA: Harvard University, 1964.
16. Messer SB. Reflection-impulsivity: a review. Psych Bulletin, 1976; 83(6): 1026-52.
17. Rouse MW, Scheiman MM. Development of an overall management plan. In: Scheiman MM, Rouse MW, Ed. Optometric management of learning-related vision problems. St. Louis: Mosby-Year Book, Inc., 1994.
18. Luria AR. The working brain. New York: Basic Books, 1973.
19. Beery K. The developmental test of visual motor integration. Cleveland: Modern Curriculum Press, 1967.
20. Groffman S, Solan HA. Developmental and perceptual assessment of learning-disabled children. Santa Ana, CA: Optom Extension Prog, 1994.
21. Kirby JR, Robinson GL. Simultaneous and successive processing in reading-disabled children. JLD, 1987; 20: 243-52.
22. Hooper SR, Hynd GW. Performance of normal and dyslexic readers on the Kaufman Assessment Battery for Children (KABC): a discrimination analysis. JLD, 1986; 19: 206-10.
23. Bender L. A visual motor gestalt test and its clinical use. Research Monograph No. 3. New York: Am Orthopsych Assoc, 1938: 47-54.
24. LeBarge D, Samuels SJ. Toward a theory of automatic information processing in reading. Cog Psych, 1974; 6(2): 293- 323.
25. Solan HA, Mozlin R. The relationship of perceptual motor maturation to readiness and reading in kindergarten and the primary grades. J Am Optom Assoc, 1986; 57(1): 28-35.
26. Solan HA. Perceptual norms in grades four and five: a preliminary report. J Am Optom Assoc, 1987; 58(2): 979-982.
27. Garzia RP, Richman JE, Nicholson SB, Gaines CS. A new visual- verbal saccade test: the Developmental Eye Movement Test (DEM). J Am Optom Assoc, 1990, 61: 124-35.
28. Koslowe KC. Binocular vision, coding tests, and classroom achievement. J Behav Optom, 1991; 2: 16-19.
29. Getman GN. Developmental optometry. Santa Ana, CA: Optom Extension Prog, 1992.

## Sources

A. Illinois Test of Psycholinguistic Abilities. University of Illinois, Urbana, IL 61801.
B. Test of Auditory Perceptual Skills. Psychological and Educational Publications, 1477 Rollins Rd., Burlingame, CA 94010.

Corresponding author:
Rochelle Mozlin, O.D.
State University of New York
State College of Optometry
100 East 24th Street
New York, NY 10010
Date accepted for publication:
March 12, 1995