Section 1:

Introduction



The *TVPS-3* assesses an individual's visual perceptual abilities without requiring (as much as possible) motor involvement when making a response. It is designed for both diagnostic and research purposes. The test is intended to be used by occupational therapists, school psychologists, education specialists, optometrists, and other professionals who may need a reliable and valid measure of the various aspects of visual perceptual ability in school-age children up to age 18.

A number of tests intending to measure visual perception also require at least some motor responses such as drawing shapes and figures. This motoric requirement may confound the measurement of visual perceptual processes. While visual perceptual and motor skills develop in parallel and are often closely related, the two systems are indeed separate (Ball, 1962; Parush, Yochman, Cohan, & Gershon, 1998; Leonard, Foxcraft, & Kroukamp, 1988, 1989). A child who has a motor problem does not necessarily have a visual perceptual problem; children with cerebral palsy, for example, often show no evidence of visual perceptual disorders whatsoever (Bortner & Birch, 1962; Rosenblith, 1965; Newcomer & Hammill, 1973). Any comprehensive assessment of a child's visual perceptual skills should include results from both a visual perceptual test that does not require motor skills, as well as a test of visual-motor integration so that perceptual deficits can be identified accurately.

Structure of *TVPS-3*

The *TVPS-3* utilizes 112 black and white designs chosen from both levels of the previous edition (*TVPS-R*, Gardner, 1996; *TVPS-UL*, Gardner, 1997). Each of the seven subtests starts with two example items (not scored) that are followed by 16 test items arranged in order of difficulty. The presentation of the items and the responses are mostly untimed; only in two subtests,

Visual Memory and *Sequential Memory*, are the items' presentations timed, while the responses to those items are untimed. The *TVPS-3* retains the familiar multiple-choice format; the child merely needs to indicate an answer choice verbally or by pointing (or by some other agreed-upon method of communication). Subtest raw scores are reported as scaled scores, percentile ranks, and age-equivalent scores; the total raw score is reported as a standard score and percentile rank.

TVPS-3 Subtest Descriptions

The seven *TVPS-3* subtests are arranged in order of difficulty starting with *visual discrimination* (a very basic skill) and ending with *visual closure* (a much more difficult task). The subtests are as follows:

- ***Visual Discrimination:*** the child is shown a design and is then asked to point to the matching design among the choices shown below.
- ***Visual Memory:*** the child is shown (for 5 seconds) a design on one page, the page is turned, and the child is asked to choose the same design from among the choices shown on the following page.
- ***Spatial Relationships:*** the child is shown a series of designs on a page and then asked to choose the one that is different from the rest; it may differ in a detail or in the rotation of all or part of the design.
- ***Form Constancy:*** the child is asked to find one design among others on the page; the design can be larger, smaller, or rotated.
- ***Sequential Memory:*** the child is shown (for 5 seconds) design sequences comprising increasing numbers of elements, the page is turned, and the child is asked to choose the matching design from among the choices on the following page.
- ***Visual Figure-Ground:*** the child is asked to find one design among many within a complex background.
- ***Visual Closure:*** the child is shown a completed design on the page and is asked to match it to one of the incomplete patterns shown on the page.

TVPS-3 Scoring Structure

Children indicate answer choices verbally by saying the number underneath the answer choice shown on the page. They may also point to the answer or may utilize any other communication mode that has been agreed upon. The examiner records the child's responses on the Record Form. Each correct answer is scored as 1; the correct answers are shown in parentheses on the Record Form next to the item numbers. (Example item responses are recorded but are not scored.) Raw scores are recorded at the end of each subtest and also on the front of the Record Form. Subtest raw scores are then converted to scaled scores and percentile ranks. The overall score and optional indices are derived from the sum of scaled scores; those are reported as standard scores and percentile ranks. Age equivalent scores are also provided.

Purpose and Use of *TVPS-3*

The *TVPS-3* is intended to give occupational therapists, school psychologists, education specialists, optometrists, and other professionals a reliable measure of a child's perceptual abilities. Since visual perceptual processes are used in a number of academic pursuits, including learning to read, it is important to know which process the child may be having difficulty with before any remediation may be implemented.

The *TVPS-3* may also be used to track progress within a therapeutic and/or educational program. The *TVPS-3* is ideal for use in research studies.

Specific Advantages of the *TVPS-3*

The *TVPS-3* has the same advantages as the previous editions. A primary advantage of this test is that more than one response mode may be employed. The child may identify the answer choice by pointing to one of the designs on the page, by saying the number of the answer choice, or by any other means that is understood by the examiner. The tasks are not language-related (other than there must be some way to communicate with the child), and, therefore, all children have an equal chance for success. The test can be administered to children in regular classes (with no diagnosed disabilities), as well as to children with speech, cognitive, neurological, motor, or other impairments. The test illustrations utilize black lines to form the designs against a white background, making them easy to see and eliminating any performance deficit that could be caused by color-blindness.

Background

Visual Perception Defined

Visual perception allows us to process visual stimuli in order to identify what we see and, thus, understand world the world in which we live. Visual perception has been variously defined as a highly complex integrative activity involving the understanding of what is seen (Koppitz, 1970, cited in Hudgins, 1977), a composite skill encompassing a number of subskills (Ritter & Ysseldyke, 1976), and a hierarchy of skill levels that interface with one another to integrate visual information efficiently (Warren, 1993). A number of current views on the nature of perception stress the continual interplay between perceptual processes and comprehension (Hendee, 1997). It is the process by which meaning is attached to visual stimuli (Lieberman, 1984; Todd, 1993) and is a primary factor in cognitive development, learning, and many of our daily activities (Kattouf & Steele, 2000).

To devise a test of visual perception, it was first necessary to define the skills that constitute this construct. Chase (1986) suggests that the central issue in visual perception is how people perceive real objects in real world

settings, and indeed, that is the focus of the *TVPS-3*. To perceive objects, a person needs to be able to:

- identify an object correctly, even when that object may be seen in a different orientation or if only part of it is seen;
- identify one object among others in close proximity; and
- know where an object is in relation to oneself and/or other objects.

Chalfant and Scheffelin (1969) categorized visual perceptual abilities using generic headings that include: visual discrimination, spatial relationships, visual memory, figure-ground, and visual closure. These five categories represent theoretical constructs of visual perception that continue to be utilized in the current literature and are recognized as important clinically. The processes identified by Chalfant and Scheffelin (1969) and assessed by the *TVPS-3* are:

- ***Visual discrimination:*** the ability to discriminate dominant features of objects; for example, the ability to discriminate position, shape, form, and color.
- ***Spatial relationships:*** the ability to perceive the positions of objects in relation to oneself and/or other objects (e.g., figure reversals or rotations).
- ***Visual memory:*** the ability to recognize one stimulus item after a very brief interval.
- ***Figure-ground****:* the ability to identify an object from a complex background or surrounding objects.
- ***Visual closure:*** the ability to identify a whole figure when only fragments are presented.

Theories of Visual Perception

Currently there is not just one comprehensive perspective regarding visual perceptual processes, but a number of theories have been put forth.

- Template theory proposes that recognition comes about when the perceived object is matched to stored memories of objects.
- Prototype theory suggests that we construct category representations in order to identify objects; these categories are based on and reflect the complexity of our understanding of the world.
- Feature theory argues that detecting distinctive individual features of an object ("feature extraction") is integral to recognizing what is seen.
- Gestalt theory proposes that perception involves more than just detecting objects, that the organization of the perceived object is key to understanding what is seen. Gestalt theorists identified form constancy and visual closure among several principles of perceptual organization that allow us to make sense of the world. Some of those perceptual processes were the basis for the pioneering work by Bender (1938) and Frostig, et al. (1961) that provided the groundwork for all current tests of visual perception.

- Witt, Elliott, Gresham, and Kramer (1988) proposed that perception is a process intermediate to sensation and cognition. Perception, in this view, deals with concrete properties of what is seen, not the symbolic or problem-solving processes. As pointed out by Colarusso and Hammill (1996) and Hammill, Pearson, and Voress (1993), this is somewhat artificial since perception often involves thought.

Current perceptual theories (reviewed by Hendee, 1997) recognize that visual perception both influences—and is influenced by—cognition, the understanding of objects in our world. This understanding utilizes past experiences and enables us to predict objects' visual characteristics and behaviors so, for example, it is not necessary to see an entire object or to see it in just one particular orientation in order to identify it. The detection and recognition of objects necessitates a continuous interplay between perception and comprehension (Hendee, 1997). *Perception, then, is not merely a collection of discrete independent processes, it is the interpretation and organization of what is seen*.

Interrelatedness of Perceptual Skills

The various types of perceptual skills are not considered to be completely independent of each other in normally-developing individuals, and most real-world perceptual tasks involve simultaneously using a number of the processes. Ritter and Ysseldyke (1976) showed that figure-ground and visual recognition skills are closely intertwined and are not distinctly separate skills. The designation of "types" of visual perceptual skills is, however, functionally descriptive and is the basis for clinical observations that are currently used when describing a person's abilities and/or difficulties. This type of operational categorization is, nonetheless, artificial in terms of how visual perception actually operates in normally-developing persons (Boyd & Randle, 1970; Colarusso & Hammill, 1996; Hammill, et al., 1993).

Although individual visual perceptual skills may be considered, theoretically, to be discrete entities, from a practical point of view they are inseparably meshed within individuals. When constructing the *Developmental Test of Visual Perception,* Frostig, et al. (1961) elaborated on Thurstone's (1944) early work that defined various types of visual perceptual skills. Frostig's work and that of others have shown that visual perceptual subtest scores are very highly intercorrelated, reinforcing the idea that the various perceptual constructs are closely interrelated. Because of those high intercorrelations, it should be recognized that any one subtest may not measure discretely just one perceptual ability. For example, a subtest designed to evaluate figure-ground ability directs the examinee to find figures hidden within a background of distracting forms; yet, to do that one must also depend considerably on visual discrimination, spatial relationship, and form constancy abilities. In fact, one could argue that *visual discrimination* is the basic ability underlying all of the various types of visual perceptual tasks. As we understand it, then,

visual perception in normally-developing individuals requires a seamless interplay of various abilities. In children with learning disabilities who were described clinically as "clumsy", visual perceptual and visual-motor skills appear to behave more as separate, yet related, functions (Daniels & Wong, 1993; Parush, Yochman, Cohen, & Gershon, 1998).

Development of Perceptual Skills

While the development of visual perceptual abilities in infants has received much attention, relatively few studies have been devoted to the refinement of perceptual skills in toddlers and young children. Gollin (1960) compared visual closure in children and adults using incomplete line drawings of common objects. Children under 4 years of age needed more completeness in the drawings in order to identify objects than did older children (4.5 to 5.5 years old) whose performance was nearly adult-like. Similarly, Prather and Bacon (1986) showed that 3-year-olds have difficulty integrating parts to the corresponding whole figures of common objects. Up until the age of 11, children primarily identify whole objects, not fragments (Menken, Cermak, & Fisher, 1987). The same types of developmental trends were noted for other visual perceptual skills as well. Figure-ground ability in 5-year-olds was markedly less than that in 8-year-olds (Goodenough & Eagle, 1963). Spatial relationships and form discrimination in 5-year-olds is also less than that of older children and adults (Benton, 1969; Rudel & Teuber, 1963; Huttenlocher, 1967; Enterline, 1970). These developmental differences are attributed to the interface of visual perception (visual closure) and the cognitive processes that allow access to the background information that is needed to identify incomplete objects.

While infants and toddlers focus primarily on the *whole* object, by later childhood, *parts* of objects can be interpreted in terms of the whole object. Even in adulthood, persons may revert to the earlier orientation of whole-object identification when figure complexity increases since perception of a whole is faster and simpler—it presents less of a cognitive load—than analysis of individual parts (Aslin & Smith, 1988).

Perception in Everyday Activities

The relationship of perceptual abilities to performance of everyday activities is subtle, but all-encompassing (Pratt & Allen, 1989; Trombly, 1995). Assessing activities of daily living is the focus of occupational therapists and other professionals who use visual perceptual tests such as the *TVPS-3*. Numerous daily tasks rely heavily on visual perceptual abilities. In a number of contexts we must be able to separate objects from their surroundings in the visual field: letters and words must be separated from the rest of the page when reading and/or writing; driving skills rely on separating relevant stimuli from other objects in the field of view and when judging the speed and

distance of moving objects. Visual perception plays a role when planning motor actions, when utilizing a sequence of letters or numbers that are presented visually (such as when reading, writing, or calculating), or when differentiating between representations of objects seen in various orientations. It is not surprising, then, that persons with impaired visual perceptual abilities have shown deficits in reading, writing, meal preparation, feeding oneself, dressing, and recreational activities (Brown, Rodger, & Davis, 2003; Maki, Voeten, & Poskiparta, 2001; Parush, Yochman, Cohen, & Gershon 1998; Niestadt, 1993).

Even moving through space requires perception in that one needs to be able to judge distance and discern objects when moving among objects in a room or knowing where one is in relationship to objects or people. Strong relationships were found between power wheelchair maneuvering ability and visual perceptual test performance (Massengale, Folden, McConnell, Stratton, & Whitehead, 2005).

Visual Perception in Special Populations

The fact that various visual perceptual abilities emerge at different times in development and yet are integral to many daily activities allows the *TVPS-3* to be used for a variety of purposes and in diverse settings. Educators find assessment of visual perceptual processing useful when determining the nature and extent of functional problems that may coexist with learning disabilities, dyslexia, and/or developmental delay in children. When the *TVPS* was administered to two groups of children, those with learning disabilities made more errors and took longer to complete the test than did those without disabilities (Hung, Fisher, & Cermak, 1987). Similarly, when the *TVPS* was administered to two groups of young men, those with learning disabilities made more errors and took longer to complete than those without disabilities (Hung, Fisher, & Cermak, 1987).

Low birth-weight children are known to experience a number of school-related problems. Studies have shown that a majority of such children with average-range IQs also exhibited visual perceptual scores significantly lower than what was expected for their age (Hard, Niklasson, Svensson, & Hellstrom, 2000; Davis, Burns, Wilderson, & Steichen, 2005).

Some preterm children are born with lesions to the posterior visual pathways; those children showed marked visual perceptual disabilities, scoring below the 3rd percentile on the *TVPS* (Hard, Aring, & Hellstrom, 2004).

Children with developmental coordination disorder (DCD) routinely scored lower than expected on tests of visual perceptual skills (Van Waelvelde, DeWeerdt, DeCock, & Smits-Engelman, 2004; Schoemaker, van der Wees, Flapper, Verheij-Jansen, Scholten-Jaegers, & Geuze, 2001). Children with learning disabilities who were described as "clumsy" often showed significantly lower scores on visual perceptual tests than did learning disabled children who were not so described (O'Brien, Cermak, & Murray, 1988; Murray, Cermak, & O'Brien, 1990).

A high percentage of children with learning disabilities have visual perceptual problems even though their visual acuity is not impaired at all (Seiderman, 1976). Harnadek and Rourke (1994) noted visual perceptual deficits in children with non-verbal learning disability but not in those with dyslexia. Recent research (Wright, Bowen, & Zecker, 2000) has shown that persons with dyslexia exhibit deficits in one particular neural system (the magnocellular stream in the lateral geniculate nucleus) that is essential for making sense out of rapidly changing visual input (such as the neural signals generated when one is reading). That research provided a connection between basic mechanisms of perception and an educational concern (reading performance).

Occupational therapists cite visual perceptual function as a major therapeutic focus (Warren, 1993). Assessment of perceptual processing is especially pertinent when tracking a client's progress within a therapeutic rehabilitation program, when analyzing skill strengths and weaknesses in order to plan remediation activities, and when recertifying adults for driving or returning to work after stroke or other head injury.

Perception and Visual Scanning

The interdependence of visual perceptual ability and visual scanning has been a topic of concern for both educators and rehabilitation professionals. Persons who have been diagnosed with various types of disabilities show differences when performing visual scanning tasks (Gale, 1997). Efficient visual scanning is necessary for pattern or object recognition; those skills, in turn, affect one's ability to separate one object from other surrounding objects in the visual field (figure-ground) and to identify a figure when only part of it is seen (visual closure). In children and adults with learning disabilities, difficulties in a number of visual perceptual skills have been noted (Warren, 1993). Children and adults with perceptual difficulties are more accident-prone, have difficulty reading, and need more help with self-care (Hier, Mondock, & Caplan, 1983). Irregular and unsystematic visual scanning patterns, along with fewer visual fixations, are seen in persons who have had strokes in either hemisphere (Locher & Bigelow, 1983). The disorganized visual search patterns that are seen in persons with head injuries contribute to a marked inability to construct accurate visual models of the world (Chedru, et al., cited in Warren, 1993). As visual tasks increase in complexity, persons with head injury often have difficulty attending to the critical features of an object and are not able to impose order on ambiguous stimuli.

Visual Perception and Dyslexia

A number of studies (Fischer, Hartnegg, & Mokler, 2000; Biscaldi, Fischer, & Hartnegg, 2000; Rayner, 1998; Kulp & Schmidt, 1996; Fischer,

Biscaldi, & Otto, 1993; Fischer & Weber, 1990; Leisman, 1976) have examined the relationship between reading ability, eye movements, and visual perceptual processes. Those studies indicated that dyslexics experience more perceptual problems than do proficient readers in that visual fixation, visual tracking, and figure-ground abilities are compromised.

Accurate and efficient visual perceptual processes are necessary when learning to read. One study (Leisman, 1976) suggested that severe reading disability appears to correspond with an inability to conceptualize form and direction (i.e., the abilities of form discrimination and spatial relationships, respectively). When examining spatial and temporal processes and reading scores in children (with and without disabilities), Rudel and Denckla (1976) showed that visual perceptual processing skills reached a plateau at about age 12. For children without visual perceptual or learning difficulties, this normal developmental plateau was not problematic, but for those who had learning disabilities as a result of perceptual problems, it meant that they did not "catch up" to their peers since the plateau occurred (and was maintained) when they were at a lower level of reading proficiency (Rudel & Denckla, 1976).

Another study (Seiderman, cited in Leisman, 1976) also found that children with known reading difficulties did not conceptualize letter form and direction as well as children with grade-appropriate reading ability. That study reported that deficits in figure-ground ability, in particular, were seen in 90 percent of the children with reading difficulties. The rate of development of some visual perceptual abilities in children with learning disabilities lagged significantly behind those of age-matched peers without such disabilities (Rudel & Denckla, 1976). Likewise, young adults with learning disabilities showed increased reading errors, decreased accuracy, and an increase in the time it took to complete a reading task (Hung, Fisher, & Cermak, 1987); visual memory and visual closure are the abilities that most reliably discriminated between the groups studied. It is important to note that while visual perceptual difficulties are noted in children with dyslexia, there is no direct evidence that visual perceptual difficulties *cause* dyslexia. **Any diagnosis of dyslexia should not be made solely on the basis of the presence of visual perceptual difficulties**.

Visual Perceptual Ability and Head Injury

Assessing the type/s of visual perceptual deficit/s is recognized as an important component when planning rehabilitation therapy for brain-injured persons of any age (Cooke, McKenna, & Fleming, 2005). Some preterm children have been shown to have lesions in the posterior visual pathways; it is common for those children to score significantly lower—below the 10th percentile—on the *TVPS* than age-peers without lesions (Hard, Aring, & Hellstrom, 2004). Even preterm children without such diagnoses score significantly lower on the *TVPS* than do age-peers (Hard, Niklasson, Svensson, & Helstrom, 2000).

TVPS scores have reliably differentiated between adults with and without strokes (Su, Chang, Chen, Su, Chien, & Huang, 2000; Su, Chien, Cheng, & Lin, 1995; Titus, Gall, Yerxa, Roberson, & Mack, 1991). York and Cermak (1995) noted that injury to either hemisphere may result in some types of visual perceptual disabilities. Locher and Bigelow (1983) reported that even stroke patients who showed no evidence of hemifield visual neglect (an inability to attend to visual space contralateral to the side of injury, common to right parietal strokes) showed errors when choosing answers for the *MVPT*, a widely-used visual perceptual screener that utilizes the same horizontally-positioned answer choice format as used in the *TVPS-3*. However, perceptual errors were not evident when choosing answers presented vertically at midline (Mercier, et al., 1997).

A number of studies have examined specific types of visual perceptual deficits in head-injured adults. *Figure-ground* difficulties are seen in persons with various types of brain injury, although persons with injury to the left hemisphere appear to be more impaired than persons with right-hemisphere injury (Trombly, 1995). Likewise, Boucart and Humphreys (1992) saw *visual closure* deficits in persons with head injury even though their other perceptual abilities were intact. Others (Wasserstein, Zapulla, Rosen, Gerstman, & Rock, 1987) studying *visual closure* showed that while adults without head injury could identify 100 percent of objects seen as fragmented outlines, those with left-hemisphere injury identified only slightly less than those without any injury, and persons with right-hemisphere injury correctly identified only 50 percent of such figures. Adults with subcortical vascular dementia (as the result of subacute ischemic and/or hemorrhagic damage) also show decreased visuo-spatial skills (Graham, Emery, & Hodges, 2004).

Conclusion

Perception and cognition go hand in hand; perception, as actually seen in everyday tasks (versus laboratory exercises), involves combinations of perceptual skills. While we understand the functional uses of individual perceptual constructs, we realize that such task isolation is not usually possible. Because of that, it is expected that some overlapping of constructs will be seen in the tasks employed by the *TVPS-3*. The constructs identified by Chalfant and Scheffelin (1969) and assessed by the *TVPS-3* are the same as those used in the previous editions of this test: discrimination, memory, spatial relationships, sequential memory, form constancy, figure-ground, and visual closure.