CHAPTER 2

LITERATURE REVIEW

This chapter delineates the review of the literature, providing a relevant conceptual framework for the study. The literature review is comprised of the following parts:

2.1 Definitions of visual perception

2.2 Development of visual perception in children and influence of culture

2.3 Measurement of visual perception

2.4 Impact of visual perception problems on occupational performance

2.5 Occupational therapist roles in visual perception problems

2.6 Forward-backward translation

2.7 Cross-cultural research

2.8 Relevant studies of visual perception

2.1 Definitions of visual perception

Koppitz (1970) defined visual perception as a multifaceted, highly integrative activity which involves the comprehension of something perceived.

Visual perception, according to Zaba (1984), deals with the reception (sensory functions) and cognition (specific mental functions) of visual stimuli. Relatively, the sensory function, or visual receptive component, pertains to the procedure of drawing out and consolidating data generated from the environment. This includes the particular cognitive functions that establish the perception to enable interpretation and usage of something physically visualized. Together, sensory function and visual perception are two necessary components to enable a person to grasp what is seen for purposeful vision. Visual perceptual skills are the skills involved in the recognition and identification of shapes, objects, colors, and other qualities. Additionally, in visual perception, an individual formulates precise conclusions based on the magnitude, formation, and spatial relationship of objects.

Another definition was developed by Bouska (1990), visual perception is a process of information reception brought about by the situation or environment. It is the result of sensory impulses which are converted into meaning in accordance with a previously established interpretation of the environment.

Likewise, Warran's (1993) definition of visual perception is conceptualized as a hierarchy of skill levels interfacing with one another for the efficient integration of information.

Hence, based on these definitions, visual perception is regarded as the manner by which the brain infers a specific visual perception for the presented stimuli through the collaboration of visual receptive functions and visual cognitive functions.

2.2 Development of visual perception in children and influence of culture

As an individual develops, visual perception changes continuously from birth to adulthood. The infancy period is when most visual perception developments occur; however, they also develop strongly in the childhood and adolescent stages. According to Schneck (2001), the visual receptive function, visual cognitive function and development comprise the visual perception functions. Below is a discussion of each area:

Visual receptive functions:

Since the oculomotor system facilitates the visual stimulus response through a visual receptive process, the visual receptive functions of visual fixation, pursuit and saccadic eye movements, acuity, accommodation, binocular fusion and stereopsis, and convergence and divergence all necessarily work together.

The preconditioning skill required for other oculomotor responses such as changing eye movements between objects in a form of scanning or tracking, is visual fixation on a motionless object. It is occur when both eyes shift by means of synchronized actions involving the six extraocular muscles, which are supplied by the oculomotor, trochlear and abducens nerves (cranial nerves III, IV, and VI). Involuntary consolidated eye movements such as lateral, vertical and convergence eye movements depend on oculomotor nuclei to regulate eye position relative to the position of the head. The superior colliculus transmits the most information to the nuclei.

There are two types of eye movements which draw out information from the environment: pursuit eye movements or tracking and saccadic eye movement or scanning. In order to sustain the image on the fovea, visual pursuit or tracking must employ continuous fixation on a moving object. The existence of deliberate smooth movements eventually results in a smooth pursuit system. Tracking takes place with both of the eyes and the head moving jointly or with independent movement of the eyes, whereas scanning or saccadic eye movement entails a quick shift of fixation from one point to another point in the visual field. This can be either voluntary while focusing on a rapidly relocated stimulus or reading activity, or it can be involuntary at some point during the fast periods of vestibular nystagmus. Although the existence of minor overshoots or undershoots is normal, precision of saccadic eye movements is possible. Aside from the voluntary control of eye movements, there are vestibulo-ocular pathways which automatically manage eye movements corresponding to head movement and location in space. Even as the head and body move, these pathways permit the eyes to stay focused on a still object.

Beside visual fixation functions, pursuit movements, and saccadic movements, there are also the following visual receptive components:

- Acuity refers to the capacity to discriminate between objects in the visual field with a measurement of 20/20 vision. This is defined as the ability to see a small object as a person with normal vision is able to perceive from a distance of 20 feet.
- Accommodation allows each eye to compensate for unclear figures. This is utilized in obtaining clear vision, i.e., focusing on an object at varying distances. It occurs when there is contraction of the internal ocular muscle, the ciliary muscle. This causes an alteration in the eye lens, particularly for the purpose of adjustment for objects at different distances. Focusing must occur capably at all distances, including the ability of the eyes to change their focus between near points, such as from the teacher to the blackboard, and back again. The process of accommodation happens in a split second.
- Binocular fusion refers to the ability of the mind to combine the images perceived by each of the eyes. The following capabilities are required: Firstly, the

eyes must be parallel to the viewed object, which is known as motor fusion. It necessitates not only the synchronization of the six extraocular muscles of each eye, but also precision between the two eyes. The compatibility between the size and clarity of the two images is secondary, which is called sensory fusion. Basically, these two rudiments allow the brain to unite what each of the two eyes perceive into one mental concept.

- Stereopsis is known as three-dimensional vision or binocular depth perception.
- Convergence and divergence are the inward and outward rotations of both eyes.

Developmental sequence of visual receptive functions

The functions of visual perception start to develop in the womb. Within 24 weeks of pregnancy, the gross anatomical structures are positioned for the completion of a visual pathway. Between 24 to 40 weeks of pregnancy, there occurs a broad maturation differentiation and alteration of the visual system made up of the retina and visual cortex. Eye movements are caused by vestibular influences in the first stage of the fifth month of pregnancy. Basic visual fixation and brief reflexive tracking abilities have already been acquired by the infant upon birth.

In addition, accommodation, convergence, and oculomotor subsystems are defined close to the end of the second month. By 5 years old, a child attains a maximum level of accommodation. Likewise, for prolonged periods at a predetermined distance, a child can maintain his or her exerted effort in the accommodation process. Skills in controlled tracking take a developmental pattern characterized by eye movements starting from horizontal to vertical, diagonal and circular directions. Necessarily, the child should be competent in moving his or her eyes in all directions by means of smooth control and coordination by kindergarten.

Visual cognitive functions

The visual cognitive functions are comprised of the following components of visual attention, visual memory, visual discrimination, and visual imagery.

Visual attention involving the selection of visual input, offers a suitable structure of time for visual information to pass through the eye via the main visual cortex of the brain where visual perception processing takes place. Voluntary eye movements classified as localization, fixation, ocular pursuit, and gaze shift lay the foundation for optimal operation of visual attention (Hyvarinen, 1994). Visual attention has four components:

1. Alertness, which reflects the normal state of arousal, refers to the change in state from being awakened to being attentive and ready, signifying an essential condition for energetic learning and flexible behavior.
2. Selective attention is the skill of selecting important visual information and disregarding less significant information at the same time; thus, the child shows awareness and undivided attention.
3. Visual vigilance is the mental work involved in concentration and persistence towards a visual function. This is manifested as a child attentively engages himself or herself in playing with a toy or writing a letter.
4. Divided, or shared attention is the competence of being responsive to two or more tasks which take place at the same time. As a skill, it is shown when a child is doing one habitual task as he or she perceptibly monitors another task.

Visual memory deals with the integration of visual information from past experience. Long-term memory, known as the stable storehouse, differs from short-term memory because it comprises an extensive faculty. On the other hand, short-term memory relies on unconnected fragments of information for a period of around 30 seconds.

Visual discrimination refers to the ability to detect features through recognition, matching, and categorization. Considered as an ability, recognition allows a child to distinguish the essential characteristics of a visual stimulus and to connect them to their memory. To be able to note the similarities among visual stimuli refers to a specific ability called matching. In categorization, a child determines a quality or category by noting similarities or differences. Recognition, matching and categorization necessitate the competence of noting similarities and differences between and among forms and symbols, together with escalating intricacy and connecting conclusions drawn from these data to previously accumulated information in long-term memory.

Since the definition of visual perception is not consistent among researchers, varied terminologies and classifications are used by resources in the literature on visual perception in order to delineate similar visual perceptual abilities.

Likewise, it is imperative to establish that there is a difference between object or form vision (ventral stream) and spatial vision (dorsal stream). For better understanding, we must consider that object vision pertains to visual identification of objects by features such as their color, texture, shape, and size (what kind of objects they are). Spatial vision, in contrast, emphasizes the visual location of objects in space (where the objects are).

These two classes of functions are mediated by separate neural systems. The cortical regions for object vision and spatial vision are both projected towards the primary visual cortex; the object vision pathway is directed towards the temporal lobe, and the spatial vision pathway is directed towards the inferior parietal lobe (Goodale, 2000; Goodale & Milner, 1992). Optical information regarding the characteristics of an object forms a lasting representation to aid in identifying the object and learning from specific visual cues. On the other hand, spatial vision delivers information pertaining to the location of an object, which is a necessary ability in guiding an action, for example, in adjustment of the hand during an attempt to reach for something and having the correct object orientation.

As indicated in studies of people suffering from brain damage, these two tasks were found to involve separate abilities (Milner & Goodale, 1993; Newcombe & Ratcliff, 1989). As an explanation, the occurrence of disturbances in object recognition does not indicate a spatial disability arising with the common perception of an object (Dutton, 2002). Object (form) and spatial-perceptual skills are independently defined. At the same time, skills are categorized even though they may not be taken as separate units.

Object (form) perception

Form constancy is the facility of recognizing similar forms and objects when identifying them in the context of different environments, positions, locations and sizes. Form constancy does not only assist a person to improve his or her state of stability and consistency in the visual world, but it also empowers him or her to assume how big or small the object is regardless of visual stimuli which may change according to various situations. In comparison, the size of an object's image at a distance is smaller than that of the same object located at a closer range. In spite of the apparent difference, a person has an idea that both images (distant and close) have equal sizes. For instance, a young child is able to recognize the letter "A" in many forms such as type written in manuscripts, cursive, italics, or written in upper or lower-case letters.

Visual closure refers to the skill of identifying forms or objects even if they have an unfinished presentation. In this case, a person can rapidly identify objects, shapes and forms through mental completion or through matching the image with what is stored in his or her memory. In other words, the person can formulate suppositions about the object without seeing its whole presentation. As an example, a child can discriminate a pencil from a pen even when both writing implements are partially hidden beneath some papers.

Figure-ground refers to the abilities of discriminating foreground from background forms and objects, separating important data from confusing information in the environment and attending to a single feature in the visual field and recognizing it simultaneously in connection with other fields. It is also a skill of being perceptive of what is significant. As an illustration, a child is perceptibly capable of finding his or her preferred toy among other toys in a box.

Spatial perception

Position in space determines the spatial relationship of images and objects among other forms and objects. The position of an object in connection with the observer or the perception of directions is provided. This perceptual skill is vital in terms of understanding directional terminologies and concepts, for example, up and down; in and out; in front, behind, and between; and left and right. Additionally, the perception of position in space offers the capability to distinguish letters and their sequences in words or sentences (Frostig, Lefever & Whittlesey, 1966). For instance, a child is knowledgeable in putting letters with the same spaces between each other and writing them on the baseline. Besides, the child can identify letters extending below the baseline. These are letters p, g, q, and y.

Depth perception determines the comparative space between objects, figures, or landmarks, the observer and deviations in place of surfaces. As a perceptual ability, it offers cognizance of an object's range and precise movement in a specific space, for example, when walking down a staircase.

Topographic orientation defines the position of objects, backgrounds and directions. Way-finding is dependent on a mental diagram of the location. These mental diagrams or maps are comprised of information such as endpoints, spatial information, instructions for implementing travel plans, recognizing places, tracking one's location, and anticipating certain features.

There are certain essential ways of monitoring one's movement from one place to another (Dutton, 2002; Garling, Book & Lindberg, 1984). Furthermore, the images seen by a person must be recognized when forming an idea of what is seen or when finding a way (Dutton, 2002). A child, for example, is capable of leaving the classroom to go to the water fountain down the hall as well as to return to the classroom.

Visual imagery or visualization denotes the skill of picturing people, ideas, and objects in the mind's eye even though they do not tangibly exist in the visual field. In the developmental stage, the child can primarily picture objects producing specific sounds, including those which he or she is familiar with in terms of smell or taste. The skill to visualize spoken words is the secondary stage. Therefore, the foundation for reading comprehension and spelling proficiency is provided in visual and verbal matching.

Developmental sequence of visual-cognitive functions

At the time of birth, several visual-cognitive capacities are already present, but the development of other higher skills of visual-cognition is not complete until the adolescent stage. These developmental changes take place by means of perceptual learning, which is basically a process to extract information generated from the surroundings. Thus, perceptual learning can be improved by means of experience and training, which includes stimulation brought about by the environment.

Object (form) vision

One-week-old infants display a degree of responding to differences in patterns made of confusing designs, and particularly in human faces which get more attention than simple figures such as circles and triangles. Specifically, newborn babies become familiar with the significant facets of visual stimuli. They learn to discriminate and to make inferences in accordance with what they experience.

As a child undergoes maturity, his or her visual perception also develops and goes through the peak of developmental changes which normally takes place around age 9. Likewise, children differ in degree in terms of attaining perceptual skills.

During childhood, skills in analyzing and discriminating objects escalate consistently. Visual perception is essentially considered to develop through methods which are general to specific, whole to part, concrete to abstract and familiar to novel.

There has not been proof given for these sequences, but differing aspects may occur in any uncertain cases. As an example to this contradiction, visual growth progresses begin from the particular to general method. Primarily, a child identifies a thing in reference to its total physical aspect instead of any particular aspect. Since the child can categorize things, he or she can apparently take out characteristics to place the things into a fraction of the categorized group based on the study by Mussen, Conger and Kagan (1979). For instance, a toddler is able to categorize vehicles as being of specific kinds or to classify animals as to their genus. Maturity of the chief visual perceptual abilities emerges during the developmental ages (Table 2.1) projected by Williams (1983).

Table 2.1 Estimated developmental ages of visual perceptual abilities (Williams, 1983)

Perception	Developmental Ages
Object (form) Figure-ground perception	Develops between ages 3 and 5; growth is stable by age 6 to 7
Form constancy	Shows remarkable development between ages 6 and 7; a reduced amount of progress from age 8 to 9
Spatial Position in space	There is complete progress from ages 7 to 9.
Spatial relationships	Develops at about age 10.

Spatial vision

Within the progression of systematizing spaces, a toddler basically obtains theories of vertical and horizontal dimensions. Slanting or oblique elements are intricate; thus the ability to perceive them occurs soon after. At age 3 to 4, children are able to distinguish perpendicular and parallel lines; however they cannot differentiate between tilted or slanting lines until they reach the age of 6 (Cratty, 1970). Ilg and Ames (1981) supposed that for some children, the skill of establishing differences among inverted or reversed (mirror) pictures or images of numbers and letters, like for instance in the case of p and q or b and d, is not developed until they reach the age of 7.

Laterality refers to the orientation of human beings as to which side of their body they prefer to use more. Examples of laterality include the use of left hand or right hand according to a child's preference. This development takes place by the time a child reaches 6 or 7. A child has no readiness in handling spatial perceptions before the age of 7. It is essential for a child to establish the connections between spatial perceptions and his or her body. At about the age of 8, a child starts to comprehend the aspects of directionality and directions in space as a significant skill for visualizing letters and numbers utilized in writing and reading activities. Therefore, learning the related concepts is crucial. In achieving such knowledge about themselves, a child is able to convert the concepts into symbols and words.

While it is true that the rearing of a child shows differences in cultures, the culture itself has a great impact on the total development of a child. Several studies in connection with cultural influences and diversities in child rearing have been conducted and supported by prevailing literature reviews. Cintas (1995) concluded that children with different cultural backgrounds manifest an unusually identical order of growth and development. However, children have varying forms of development which are possibly influenced by factors present due to their corresponding environment and culture. Additionally, researchers have established the uniqueness of every culture in terms of how children learn. Each child has an individual style, distinct behavior and attitude in learning, as well as skills that should be motivated and enhanced. The developmental domains of cognitive, gross motor, fine motor, personal-social and language, are all feasibly affected by cultural differences (Teresi, Cross & Golden 1989).

The Miller Assessment of Preschoolers (MAP) which was administered to Israeli and American kindergarten children indicated differences in performance; it found that Israeli children's performance was below U.S. standards (Schneider, Parush, Katz & Miller, 1995). In comparison with American children, Australian children demonstrated essential differencea in terms of their entire performance on the MAP (Hickey, Froude, Williams, Hart & Summers, 2000). On the Movement Assessment Battery for Children (Movement ABC), Hong Kong Chinese children performed well in the areas of manual skill and active balance; however, American children showed better accomplishment in projecting and perceiving objects in motion (Chow, Henderson & Barnett, 2001).

In the assessment of Crowe, McClain and Provost (1999), the motor development of Native American children who have been through normal developmental stages was evaluated through the utilization of the Peabody Developmental Motor Scales. The researchers identified a number of substantial differences between the Native American children's scores and the PDMS's normative sample. Likewise, a comparative research study utilizing the Bayley Scales of Infant Development II, evaluated the motor development of typical two-year-old

Native American children. The results showed that the Native American children's scores were considerably less than the normative data ($p < 0.001$) (McClain, Provost & Crowe, 2000).

The enumerated research studies illustrate the effects of culture on the performance of children. Therefore, differences in culture and child-rearing have been found to have an impact on children's performance on the assessments.

Aside from these results on the influences of culture on children's performance, there have also been findings about the effect of culture on visual perception. Let us take, for instance, a comparative study concerning Australian aboriginal children and Amazon Indian children. These young aborigines from Australia and Indian children from the Amazon demonstrated considerably better abilities in visual-spatial memory than Western children with the same characteristics. Such inferiority of their counterparts could possibly be linked to the limited ability of their surroundings to allow for the enhancement of their skills in way finding. A comparative investigation on Ethiopian immigrants, Bedouins (nomadic Arabs), and typical Israeli children surfaced differences in performance of the subjects during the assessment of processing ideas and visual motor organization. In the study, the performance of Ethiopian immigrants and Bedouins on most sections of the test was lower than the performance of typical Israeli children (Katz, Kizony & Parush, 2002). Moreover, there was a comparison between Palestinian and Israeli children in the areas of visual perceptual and visual motor abilities (Josman, Abdallah & Engel-Yeger, 2006), and relevant differences were found between the groups.

2.3 Measurement of visual perception

Researchers, including clinicians, extensively utilize several standardized assessments and tests to evaluate visual perception and visual motor performance. These measurement tools which are normally used by pediatric therapists, the experts who provide diagnoses or interventions for children, were reviewed by Burtner, et al. (1997). These tools for assessment include the following:

(1) Motor-Free Visual Perception Test – Third Edition (MVPT-3) (Colarusso, Ronald, Hammill & Donald, 2003) is suitable for people from ages 4 – 94 years old. It measures the visual perceptual skill of a person, excluding motor involvement for the

purpose of making a response. It is comprised of 5 subtests on visual discrimination, spatial relationships, visual closure, visual memory and figure-ground.

(2) Test of Visual Perceptual Skills (non-motor) (TVPS) (Gardner, 1982) is utilized for people from ages 4 – 94 years old. To standardize the test in 7 areas, 926 children in San Francisco underwent the assessment. It was designed to identify the visual perceptual strengths and weaknesses of children based on the following categories: visual memory, visual discrimination, visual form constancy, visual-spatial relationships, visual figure-ground, visual closure and visual sequential memory.

(3) Test of Visual Motor Skills (TVMS) (Gardner, 1986) was constructed to evaluate children's abilities in terms of visual perception and visual motor assimilation. Designed to be administered to children aged 2 to 13, the TVMS necessitates that a child indicate visual recognition and imitation by using his or her hand. There are 26 forms in the TVMS, including detailed characteristics for assessing different categories of motor performance. The standardization of the TVMS was established after it was administered to clusters of children from the ages of 2 to 12 years and 11 months old in the San Francisco Bay area. A sample of 1,009 children coming from 13 schools and hospitals was used to determine the norms of the TVMS.

(4) The Beery-Buktenica Developmental Test of Visual-Motor Integration – Fifth Edition (Beery VMI) (Beery & Beery, 2004), was developed to evaluate an individual's degree of integrating his or her visual and motor skills (synchronization of eye and hand), and it is presented in a full form and a short form. There are 30 items included in the full form, which is utilized for children from 2 to 18 years old through to adults of 100 years old. The short form contains 21 items, and it is administered to children from 2 to 7 years old. Having a sample of 2,512 children from the ages of 2 to 18 years old in the United States of America, the Beery VMI consequently established its normative values. Thus, the Beery VMI Visual Perception Test and the Beery VMI Motor Coordination Test are the two standardized tests that were produced.

(5) The Developmental Test of Visual Perception – Second Edition (DTVP-2) (Hammill, Pearson & Voress, 1993) contains 8 areas or subtests to assess the distinction existing between interconnected visual perceptual and visual motor capabilities. The DTVP-2 is an assessment tool constructed for children from 4 to 10 years old. Having a normative sample of 1,972 children living in 12 states in the United States of America, the DTVP-2 serves as a more recent edition of The Marianne Frostig Developmental Test of Visual Perception, Frostig et al. (1966) and Frostig et al. (1964). Additionally, experts such as occupational therapists, psychologists, diagnosticians, educators, and other professionals who would like to analyze the visual perceptual condition of children can use the DTVP-2. The time allotment for administering the DVPT-2 is 30 to 60 minutes. The eight subtests consist of the following:

*Subtest 1.*Eye-hand coordination. In this subtest, children must draw a line inside a straight wide band. The following bands are increasingly narrowed down as angles or curves;

Subtest 2. Position in space. A figure as a stimulus is shown to the children. From a sequence of identical but varied figures, children choose the correct one. Hence, this entails a task of matching;

Subtest 3. Copying. Children are presented with figures to be drawn on a piece of paper after presentation. The succeeding figures to be drawn gradually become more intricate;

Subtest 4. Figure-ground. The children are presented with figures which serve as stimuli. The children are to locate as many figures as they can find on the page which are concealed in a complicated, puzzling backdrop;

Subtest 5. Spatial relations. A grid of uniformly spaced dots is presented to the children. Likewise, lines which link a number of the dots and form a pattern are drawn. Children are guided to an empty grid having an identical quantity of dots. By connecting the appropriate dots, the children must reproduce the pattern shown on the previous grid;

Subtest 6. Visual closure. A stimulus in the form of a figure is presented to the children. From a sequence of partially drawn figures, they choose the right one. In completing the matching task, the children need to provide the missing portions of the figures in the sequence. Providing the missing portions is performed mentally by the children;

Subtest 7. Visual-motor speed. The following figures are presented to the children: (a) four varied geometric designs where two of these designs contain particular marks, and (b) a page containing the four full designs without marks, the children must sketch as many suitable designs as they can within the allocated time;

Subtest 8. Form constancy. Children are presented with a figure as a stimulus, and their task is to find the figure shown previously among the figures in the series. Concealed in a confusing background, the figure which the children will find has a distinct magnitude, position, and/or shade.

To determine the norms of the DTVP-2, it was administered to 1,972 children coming from 12 states in the United States of America (California, Florida, Indiana, Louisiana, Maryland, New York, Ohio, Pennsylvania, Tennessee, Texas, Utah and Virginia). The standardized samples were categorized into the following clusters: for 4 years old, 100 children; for 5 years old, 240 children; for 6 years old, 244 children; for 7 years old, 309 children; for 8 years old, 324 children; for 9 years old, 467 children; and for 10 years old, 288 children.

Focus on the DTVP-2

Reliability and validity of the DTVP-2

Reliability

Internal consistency. By utilizing the data from 100 children with a one year-age interval (4 through 10 years), the Cronbach's alpha reliability coefficient known as the index of reliability was calculated. Randomly chosen, their subjects came from the normative sample as shown in Table 2.2 In all subtests, the mean alphas showed an acceptable range of .83 to .95, whereas the mean alphas for all composites are .90 as indicated in Table 2.2

Table 2.2 The Cronbach's alpha coefficients of the DTVP-2 (Hammill, Pearson & Voress, 1993)

DVPT-2 Values	Age (in years)							Average ICC
	4	5	6	7	8	9	10	
Eye-hand coordination	96	93	89	89	85	90	86	90
Position in space	93	92	86	89	87	82	84	88
Copying	89	93	91	91	91	91	93	91
Figure-ground	89	83	80	80	80	81	83	83
Spatial relations	97	97	93	91	94	91	85	94
Visual closure	89	88	88	88	87	87	86	88
Visual-motor speed	93	94	94	95	95	95	96	95
From Constancy	91	91	87	86	87	89	89	89
Motor-reduced	95	95	93	94	93	93	93	94
Visual perception	97	97	96	96	95	96	95	96
Visual-motor integration								
General visual perception	98	98	97	97	96	97	96	97

Test-retest reliability. There were 88 children with an age range of 4 to 10 years who underwent testing in two settings at an interval of two weeks. The test-retest correlations for every subtest showed a range of .80 to .95. Based on the test-retest coefficients, the DTVP-2 exhibited an evidently high level of high test-retest reliability.

Inter-scorer reliability. Within the scores of the objective tests, the reliability was noted to be high. Completing the DVPT-2 guidelines or protocols given to children involved in the test-retest study, two people separately got a score of 88. An expansive range of perceptual skill was demonstrated by the sample. Additionally, those involved in scoring were PRO-ED research staff with a sufficient background in the process of scoring the DVPT-2. The correlations of score results of all subtests of the DVPT-2 were established. Each of the subtests had the following coefficients, respectively: .93 (Eye-hand coordination), .97 (Position in space), .92 (Copying), .97 (Figure-ground), .94 (Spatial relations), .98 (Visual closure), .95 (Visual-motor speed), and .99 (Form constancy). With regards to their indexes, they were high and acceptable, considered as proof of the DVPT-2's inter-scorer reliability.

Validity

The manual contains three types of validity. These are the following: (1) content validity; (2) criterion-related validity; and (3) construct validity.

Content validity

For the subtests in the DTVP-2, two sections of content validity were provided. The first section contained the rationale related to the content and format of the subtests. The second section was comprised of the validity of item analysis procedures which were utilized when the test was constructed and developed, particularly in light of selecting items.

Rationale for content and format of the subtests

The discussion of content validity for the subtests is found in this section, including the careful selection of perceptual concepts or constructs assessed on the DTVP-2, and the essential format to be utilized in testing the constructs. Frostig and her colleagues (Frostig, Lefever & Whittlesey, 1961, 1966; Frostig, Maslow, Lefever, & Whitlesey, 1964) clearly elaborated their findings about visual perceptual constructs, and these were also developed and expounded in the research studies of Thurstone (1944), Wedell (1960), and Cruicksank, Bice, and Wallen (1957). Finally, Chalfant and Scheffelin (1969), Gabbard (1992), and Stephens and Pratt (1989) concluded the previous findings which later became the foundation of the content which was integrated into the subtests of the DVTP-2.

Analysis of items

The quantitative proof for the validity of the test content was established through an item-discrimination analysis. Anastasi (1988) defined item discrimination as the extent to which a test item can acceptably be used to differentiate and measure. In determining item discrimination, which is considered as item validity, or to explain the power of an item to differentiate between good and bad items; the point-biserial correlation, a technique to correlate every item with the total test score, was efficiently utilized. The DTVP-2 had two phases: the formulation of the preliminary test version, and the analysis of the items of the preliminary version necessary to identify the best items and to reject the void items. As for valid or good items, they were arranged according to the degree of difficulty, i.e., from easy to difficult; consequently, the valid items were combined with the recent test items.

In establishing the quality of the items in the concluding test version, a final examination of the items was conducted. As part of the research, there was a random selection from the normative cluster represented by a sample of 100 children from every age interval from 4 to 10 years old. A report on item discrimination coefficients was substantially presented. However, the entire set of test items was void due to an inability to comply with the formerly defined requisites, and to provide proof of content validity as shown in Table 2.3

Table 2.3 **Item discrimination coefficients of the DTVP-2** (Hammill, Pearson & Voress, 1993)

Subtests of the DTVP-2	**Ages (in years)**						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Eye-hand coordination	55	44	35	34	31	36	32
Position in space	64	51	43	46	42	36	38
Copying	51	62	55	59	55	54	61
Figure-ground	56	41	35	31	41	44	34
Spatial relations	63	66	49	41	52	42	31
Visual closure	47	47	52	51	50	49	48
Visual-motor speed	73	75	58	55	61	62	57
Form constancy	54	50	49	45	46	52	47

Criterion-related validity

An investigation of the existing validity of the DTVP-2 was made by means of drawing out the connection between the DTVP-2 subtests and composite scores through the total scores of the Motor-Free Visual Perception Test (MVPT) (Colarusso & Hammill, 1972). The MVPT is a standardized test to evaluate visual perception and motor coordination abilities. There are no subtests involved in these mentioned standard tests; henceforth, only one score is generated.

This study involved 49 students suffering from neurological disabilities. The coefficients which illustrated the extent of correlations among these tests, the DTVP-2, the MVPT and the VMI, are shown in Table 2.4

Table 2.4 The criterion-related validity among the DTVP-2, the MVPT and the VMI (Hammill, Pearson & Voress, 1993)

DTVP-2 Values	**MVPT**	**VMI**
Eye-hand coordination	27	76
Position in space	74	69
Copying	67	95
Figure-ground	65	49
Spatial relations	65	84
Visual closure	58	62
Visual-motor speed	82	55
Form constancy	59	41
Motor-reduced visual perception	73	67
Visual-motor integration	72	89
General visual perception	78	87

Presented in Table 2.4, the coefficients seemed to be large enough to validate the fact that the DTVP-2 contained criterion-related validity. The average of coefficients present in the subtests of the DTVP-2 and the entire scores of the MVPT and the VMI were calculated. From this calculation, the results of both instances were .65, which designated a high correlation (MacEachron, 1982). A higher relationship with the standard measures was indicated in the composite scores of the DTVP-2. In addition, the VMI composite score, which was 89, showed a significant relationship with the overall VMI score. Out of the results and analysis, a recommendation of equivalence was important to consider. The total composite score of the DTVP-2 (that is, General Visual Perception) equated with the total scores of the MVPT and the VMI. As concluded in the test-retest analyses, they were equally high as these standard measures correlated with one another.

As an explicit explanation of the occurrence of correlations, the three composite standard scores of the DTVP-2 and the overall standard scores of the MVPT and the VMI were based entirely on statistical distribution, having 100 as the average and 15 as the standard deviation. In addition, based on the sample, these scores (referring to the quotients) were over 70. The scores with a 5% confidence level were not distinctive in terms of statistics. This simply proposes that the tests assess identical constructs of visual perception and that the definite scores on the three tests by children are necessarily close.

Construct validity

From different sources, an evaluation of construct validity was achieved. The data showing differences in age explained that the mean of the DTVP-2 raw scores increased along with age. The results of the correlations of these scores corresponding to the ages of children for EH, PS, CO, FG, SR, VC, VMS, and FC were .54, .61, .61, .43, .65, .58, .50, and .49, respectively. Therefore, all of the coefficients are very significant ($p < .01$).

Inter-relationships among DTVP-2 values

By utilizing the normative sample, the DTVP-2 values referring to the raw scores of subtests were subjected to an inter-correlation procedure. The effects of age were partialled out from every coefficient. Application of the part-whole-correction procedure was performed when it was suitable to be done. Consequently, the entire set of coefficients was considerable ($p < .01$). The coefficients of correlations of subtests had a range of .10 to .57. The average coefficient, which was .36, signified a low extent of correlations of all subtests. These basic data had sustained a certain concept that, although the subtests were interconnected to some extent, they assessed various facets of visual perception. The primary essential data of visual perception tests showed a significant correlation; however the degree of their correlation was comparatively low, containing assessments of intelligence, language, and school subject matter (see Arter & Jenkins, 1977; Colarusso & Hammill, 1972; Hammill & McNutt, 1981; Hammill & Wiederholt, 1973; Larsen & Hammill, 1975). These findings brought about the connection between scores on the DTVP-2 and scores on the cognitive tests, which ranged from .20 to .60. This range, based on the justification of MacEachron (1982), indicated a “low” to “moderate” degree of correlation. Furthermore, the studies were conducted to probe the correlation between measurements of achievement and intelligence, and the DTVP-2.

In the initial assessment of this type of validity, the scores of the DTVP-2 and the scores of the Comprehensive Scales of Student Abilities (CSSA) were correlated (Hammill & Hresko, 1994). The normative sample considered as the subjects of the study included 411 children. They were studying at separate schools, two city parochial schools located in San Antonio and Austin, Texas, and one countryside public school located in New Bremen, Ohio, respectively. Of the children, 31% were Hispanic, and 52% were male. Additionally, the age range was 6 to 10 years of age, and the average age was 8.

The CSSA, a 66-item teacher report using a Likert Scale, assesses an extensive level of abilities that can be detected in classroom circumstances. The CSSA also contains items that are clustered into nine areas to be assessed, namely Verbal Thinking, Speech, Reading, Writing, Math, Science/ Social Studies/ Everyday Facts, Social Behavior, Handwriting, and Gross Motor Generalization.

Correlation coefficients, which showed the connection between the scores in the DTVP-2 and scores in the CSSA, confirmed that DTVP-2 scores and CSSA scores were found to be significant in terms of statistical implication, though only to a small degree. A different study, which was conducted to assess achievement at school, used the Comprehensive Test of Basic Skills (CTBS) (CTB/ McGraw-Hill, 1989) and the DTVP-2. Both tests were administered to 115 Caucasian students who came from an urban area and who were enrolled at the Hebrew Academy in Westminster, California. Fifty five percent (55%) of the students in the sample group were male. As a procedure, the entire set of scores in Reading, Language, and Math and the overall Battery score of the CTBS were correlated to the eight subtests and three composite scores of the DTVP-2. In reference to the computation of the 44 correlations, 41 of these had no statistical significance with only a 5% confidence level. Besides, the significant coefficients were correspondingly .24, .28, and .42.

By using a sample with neurological impairment, a study on the relationship between the DTVP-2 and the measurement of intelligence was conducted. Recently, twenty-four subjects were administered the Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974). The correlations between the WISC-R values and the DTVP-2 values were shown in the construct validity of DTVP-2 in various ways. Initially, the values for the DTVP-2 showed a diminutive correlation with the WISC-R Verbal Scale. The DTVP-2 contained no language, verbal reasoning, or speech, so a weak relationship was predictable. Secondly, a strong relationship with the WISC-R Performance Scale was established by the DTVP-2.

The DTVP-2 and the WISC-R Performance Scale evaluated nonverbal skills, and the latter used test formats that engaged eye-hand coordination, visual closure, and manipulation of blocks. With these conditions, their correlation was extremely high. Nonetheless, the conclusions generated pertaining to the WISC-R should be analyzed cautiously since they were only based on 24 subjects as the focus of the study. Indisputably, there is a need to conduct further investigation into the relationship. On the other hand, although ongoing, the outcomes of this study revealed that the DTVP-2 contained construct validity. The DTVP scores of 49 children suffering from neurological disabilities were analyzed to find the discriminant validity. For this sample composed of children who were neurologically impaired, the average standard score was less than normal. Hence, it can be considered as supporting evidence for the DTVP-2's construct validity.

Factor analysis

Factor analysis, considered as a numerical process, was applied in investigating the DTVP-2's construct validity. Construct validity is regarded as the extent to which the fundamental qualities of the test can be recognized, and it replicates the hypothetical model as the basis of the test. As a restatement, construct validity investigates which aspects are assessed by the DTVP-2.

Based on the factor analysis utilizing the method of promax rotation, the two factors with eight values higher than one were formed and named to be "Motor-Reduced Visual Perception (Factor 1) and Visual-Motor Integration (Factor 2). On the contrary, both factors were evenly composed of figure-ground and spatial relations. For that reason, the validity of figure-ground and spatial relations was arguable. Out of eight subtests, only six subtests exhibited noticeable validity.

Item validity

Employing item-test correlation, the item validity is one element of construct validity. The relationship between each item and the entire test was studied to obtain data in relation to the validity of the items.

From the latest editions of the Measurements Yearbook (1996), reliable information was taken. Also, a review of the Developmental Test of Visual Perception – Second Edition (DTVP-2*)* was made. The DTVP-2 is the latest revised edition of the first test designed by Marianne Frostig and colleagues in 1961. In this edition there is the provision of a well prepared guidebook starting with a hypothetical model of visual perception, including the rationale for assessing the development of this skill. In the context of this test, perception involves the functions of the brain to infer and categorize stimuli's physical elements, instead of the stimuli's sensory or symbolic features (Examiner's Manual, p. *2*). Thus, the DTVP-2 has no provision of measuring sensory or cognitive skills; it is analogous to the first version of the test which was originally designed by Frostig and colleagues. In reference to the original version by Frostig and colleagues, eight subtests in the DTVP-2 that assess the four categories of visual perception (such as form constancy, figure-ground, position in space, and spatial relations) were selected and included. Each type of perceptual skill has subtests designated as 'motor reduced' or 'motor enhanced' so that an additional systematic distinction can be provided. There exist two motor reduced subtests of form constancy; however, a motor enhanced subtest of position in space is not indicated.

Administration of the DTVP-2

The time allotment for a complete administration of the DTVP-2 is 30 to 60 minutes. The DTVP-2 is consistently given in isolation; therefore, it does not apply to group administration. As stipulated in the manual, the DTVP-2 can be given to non-English-speaking children or to those who have hearing impairments, since every subtest has brief directions which can be interpreted simply through gestures. There is no provision of norms set for these unique individuals, though the preceding case may possibly occur in the test administration.

In each case, every subtest starts from Item 1 which goes on until a criterion number of mistakes are made (excluding subtests 1 and 7 whose items are completely administered). Printed in capital letters in the manual of the examiner, the directions are verbally provided. A test booklet which is well-designed and easy-to-use is utilized for the answers or responses made.

Scoring

Instructions and examples for scoring, and definite criteria for every item or subtest are provided in the manual. There are norms for children 4 years and 0 months of age to 10 years and 11 months of age, with intervals of 6 months. For every subtest, the raw scores are changed into percentiles and standard scores which are necessarily merged to generate two composite factor scores, namely Motor-Reduced Visual Perception and Visual-Motor Integration, and a general composite score which is called General Visual Perception.

The test materials include the Profile/Examiner Record Form, which is used for noting down the performance on individual items as well as the subtest and composite scores. A profile can be created through a graphic presentation with a clear marking of normal ranges. Additionally, a space for other results of the test is provided in this form. Sections used for elaborations on the test data and administration situations (for example noise level, interruptions, distractions, etc.) are also found in the form.

Reliability and validity

The historical background of the development of the the DTVP-2 is written in the manual. In reference to the author of the manual, the first version of the DTVP had gained immediate popularity, until it was reviewed in a considerable amount of literature (Hammill & Wiederholt, 1973) which challenged the subtests in the areas of reliability and independence. An article published in A Consumer's Guide to Tests in Print (Hammill, Brown & Bryant, 1992) rated the DTVP’s reliability, validity, and normative data as 'unacceptable'. To deal with these problems, the contemporary edition of the DTVP-2 was constructed. The author of the critical reviews mentioned is the same author of the DTVP-2.

Because the original assessment tool was already published, the manual for the DTVP-2 itemizes the seven areas which were modified and enhanced:

1. Reliability of the subtests was raised to an acceptable level.
2. Sufficient evidence pertaining to content validity, criterion-related validity, and construct validity was given.
3. Factorial validity analysis was conducted to reinforce the test's validity.
4. Studies which showed a lack of racial, gender, and handedness biases were made.
5. The basis of normative data is a large, stratified sample having similar demographic characteristics to those involved in the 1990's school-age population census.
6. Motor-Reduced Visual Perception and Visual-Motor Integration, as the two new composite scores, were created in order to make analyses possible.
7. The ages suited for test administration were extended to include 10 year old children.

The new normative sample, and reliability and validity studies are individually described in the manual. The normative sample is made up of 1,972 children who underwent test administration between February and June 1992. Likewise, tables containing the sample's demographic characteristics and arrangement by age, gender, geographic region, race, and residence (rural vs. urban) are presented.

A report of three forms of reliability is stated in the manual, and Cronbach's alpha was evaluated using a sample of 100 children derived at random from every age cluster (with a 1-year interval) of the normative database. For any subtest at any age level, there was no reliability coefficient which was less than .80. The range of the eight subtest reliability coefficients was from .83 to .95, regarded as the average for all ages. As projected, the three composite scores contained a stronger measure of stability. At any age level, there was no composite score coefficient which was under .93. The range of alpha coefficients pertaining to the General Visual Perception score (a composite score of the entire set of subtests) for the seven age groups was from .96 to .98. The test-retest reliability was evaluated based on a group of 88 students (from one place). Their age range was from 4 to 10 years old. With an interval of two weeks between each test administration, the students underwent testing at two times. Since the evaluation of the sample was done as a whole, the outcomes of age were split using a statistical method.

The range of stability coefficients (test-retest with age outcomes partialled out) was from .71 to .86 for the eight subtests, and from .89 to .93 for composite scores. Interrater reliability was also measured based on a sample composed of a sample of 88. In every instance, a score on each administered test was made by two independent individuals. The range of reliability coefficients was from .87 to .94 for the subtests, and .95 to .97 for composite scores.

In addition, the explanations of the content validity, criterion-related validity, and construct validity of each subtest and composite score of the DTVP-2 were made by the author of the manual. Numerous tables illustrated the following: inter-correlations among all subtests and ages, correlations between subtests and composites of the DTVP-2 with scores from the National Teacher Assessment and Referral Scales, and correlations with the Wechsler Intelligence Scale for Children-Revised. To sustain the validity of composite scores, the results of factor analyses are given. Conceivably, the weakest link is contributed by the part on group differentiation, wherein the discriminant validity is conducted by testing 49 children who were examined to have a 'neurological impairment,' 'autism,' or 'cerebral palsy' as a comparison with the normative sample. Specific details of this group are not provided. To provide clear understanding, further effort is required to provide information related to performance associated with pathology before this instrument can be used in assessing populations with special cases. On the other hand, the comparison which has been made presents various proofs to vouch for the usability of the test with a 'normal' performance index.

The table below contains a detailed comparison of the DTVP-2 with other tests reviewed by Burtner et al. (1997). Particular essential information of the tests is also illustrated in the tables 2.5-2.6 as follows:

Table 2.5 Descriptions and psychometrics properties of visual perceptual norm-referenced tests

Test	Descriptions		Psychometric properties			
	Purpose	Age range	Test construction	Standardization	Reliability	Validity
MVPT-3[1]	To assess visual perceptual skills without requiring motor responses	4 to 94	- Made up of 65 items in a multiple choice system (29 items are added to the original MVPT-R 40 items) - Inclusion of 5 areas of visual perception (spatial relation, visual discrimination, figure-ground, visual closure and visual memory)	- Normative data accumulated from 1,856 individuals - Normative sample from 118 cities in 34 states across the continental United States of America and Alaska; weighted based on the US's census: geography, gender, ethnicity, residence, and disability	- Interrater = not completed - Test-retest = .87 for 34 days (for 4-10 yrs.); .92 for 34 days (for 11-84+ yrs.) - Internal consistency (Cronbach's alpha) = .69-.87	- Content Validity is based on analyses of items. - Construct Validity = age differentiation - Concurrent Validity = .38-.60 through DTVP (Frostig); .27-.74 through DTVP-2 (The correlation is at a 0.1 level)** - Evidence of discrimination for group differentiation

Table 2.5 Descriptions and psychometrics properties of visual perceptual norm-referenced tests (cont.)

Test	Descriptions		Psychometric Properties			
	Purpose	Age range	Test construction	Standardization	Reliability	Validity
TVPS[2]	To evaluate the visual perceptual strengths and weaknesses of children	4 to 12	- 112 items in multiple choice styles. - Inclusion of 7 areas of visual perception (visual discrimination, visual memory, visual-spatial relationships, visual form constancy, visual sequential memory, visual figure-ground, and visual closure)	- Normative data accumulated from 962 children - Normative sample from the San Francisco area only; Weighted based on the US's census: gender and ethnicity. SES representation has not been reported.	- Interrater = not completed - Test-retest = .33-.78 (for subtest); .81 (for overall test) - Internal consistency (Cronbach's alpha) = .66-.80 (for subtest); .83-.92 (for composite) - SEM = 2 on subtests; 3 on entire test	- Content Validity is based on analyses of items. - Construct Validity = age differentiation, internal consistency - Concurrent Validity = .48 using Bender Gestalt; .59 using VMI; .52 with Picture Completion WPPSI*** and WISC-R**** - Evidence of discrimination for group differentiation

Table 2.5 Descriptions and psychometrics properties of visual perceptual norm-referenced tests (cont.)

Test	Descriptions		Psychometric properties			
	Purpose	Age range	Test construction	Standardization	Reliability	Validity
TVMS[3]	To assess visual perception and visual motor integration of children	2 to 13	- 26 geometric forms are to be copied and arranged in increasing difficulty. - Item difficulties have a range of .38 to .98 - The correlation of item/overall test score has a range of .34 to .86.	- Normative data accumulated from 1,009 children - Normative sample from San Francisco Bay area only; Weighted based on US's census: gender, and ethnicity; SES representation has not been reported.	- Interrater = .80-.89 - Test-retest = not completed - Internal consistency (Cronbach's alpha) = .31-.90 - SEM = .88-2.99 (median r = 2.08)	- Content Validity is based on analyses of items. - Concurrent Validity = .48-.77(median r = .75) using Bender Gestalt; .25-.76 (median r = .92) using VMI

Table 2.5 Descriptions and psychometrics properties of visual perceptual norm-referenced tests (Cont.)

Test	Descriptions		Psychometric properties			
	Purpose	**Age range**	**Test construction**	**Standardization**	**Reliability**	**Validity**
Beery VMI[4]	To assess the individual's dexterity to integrate visual and motor skills	2 to 80 (Short form: 2 to 7 yrs.; Full form: 2 to 18 yrs.; and Adult up to 100 yrs.)	- Inclusion of 2 forms: Full Form with 30 items and Short Form with 21 items	- Normative data accumulated from 2,512 children across 4 major regions of the US - Weighted based on age, ethnicity, residence and Parental Education Representation	- Interrater = .92 (The Beery VMI); .91 (Visual Perception); .90 (Motor Coordination) - Test-retest = .89 for 10 days (The Beery VMI); .85 (Visual Perception); .86 (Motor Coordination)	- Content Validity is based on analyses of items. *** - Construct Validity = age differentiation - Concurrent Validity = .52 using WRAVMA**** (Drawing test) ; .66 using WISC-R - Predictive Validity = prediction of reading difficulties by school entry

Table 2.5 Descriptions and psychometrics properties of visual perceptual norm-referenced tests (cont.)

Test	Descriptions		Psychometric properties			
	Purpose	Age range	Test construction	Standardization	Reliability	Validity
DTVP-2[5]	To assess visual perception and visual motor skills	4-0 to 10-11	- Inclusion of 8 subtests such as Motor Reduced Visual Perception (Subtests 2, 4, 6, and 8) and Visual Motor Integration (Subtests 1, 3, 5, and 7)	- Normative data accumulated from 1,972 children of 12 states of the US - Weighted based on age, ethnicity, residence and Parental Education Representation	- Interrater = not completed - Test-retest = .80-.95 (for subtest) - Internal consistency (Cronbach's alpha) = .83-.95 (for subtest); .90 (for Composite)	- Content Validity is based on analyses of items. - Construct Validity = age differentiation - Concurrent Validity = .65 using MVPT-R; = .89 using VMI

Table 2.6 Strengths and weaknesses of visual perceptual norm-referenced tests

Test	Strengths	Weaknesses
MVPT-3[1]	- Items with analogous directions are quickly and simply grouped for screening visual perception. - Minimal motor response is required. - It is appropriate for a broad range of populations.	- There is no content analysis mentioned by assessment experts, but there exists a report of item analysis. - Concurrent validity is based on the first edition; however, there is no report from this edition. - Test-retest reliability is derived from a small sample (n=28). - It is designed only for screening potential visual perception problems, but there are no data on specific discrepancy or problem sources. - There is a lack of interrater reliability.
TVPS[2]	- It is administered easily. - It provides the standard error of assessment found in the manual. - There is reported discriminative power to support that the test can differentiate visual perceptual abilities from intelligence and school performance.	- It is only based on a sample from San Francisco; Socio-economic conditions are not mentioned. - There is a lack of interrater reliability. - There are no test-retest reliability studies included in the manual - There are low reliability coefficients on subtests, and the composite score is for recommended use only.

Table 2.6 Strengths and weaknesses of visual perceptual norm-referenced tests (cont.)

Test	Strengths	Weaknesses
TVMS[3]	- Every item is provided on a separate page, which is useful for testing young children who get easily distracted by various stimuli. - A white paper is used to make it more suitably functional for children with visual disabilities. - The manual provides the standard error of measurement.	- It is only based on a sample from San Francisco; there is no information on ethnicity and socio-economic conditions. - It has low internal consistency at age 2. - There are no studies on test-retest reliability integrated in the manual.
Beery VMI[4]	- Administration and scoring procedures are clear. - Provides the milestones of developmental progress which help parents track the child's growth and development	- Internal consistency which was reported on the third version has 3 added items to the fifth edition. - Content validity which was reported on the fourth edition does not include the 3 items added to the fifth edition. - There is no concurrent validity given for the test for younger children (ages 2 and above), but it is reported to have the DTVP-2 for ages 4 and above and the WRAVMA for ages 3 and above.

Table 2.6 Strengths and weaknesses of visual perceptual norm-referenced tests (cont.)

Test	Strengths	Weaknesses
DTVP-2[5]	- It is well designed with an easy to follow manual and booklets. - It is simple to administer. - It provides the level of visual perception difficulties of every child. - It provides a separate subscore for every subtest.	- It is based on a minimal sample; the norms are based from a selective sample.

MVPT-3[1] = Motor-Free Visual Perception Test – Third Edition;

TVPS[2] = Test of Visual Perceptual Skills (Non-Motor)

TVMS[3] = Test of Visual Motor Skills

Beery VMI [4] = The Beery-Buktenica Developmental Test of Visual-Motor Integration – Fifth Edition

DTVP-2[5] = Developmental Test of Visual Perception – Second Edition

Summary

The researcher has chosen the DTVP-2 to assess children because it has found to be more advantageous than other assessment tools. It is capable of providing the level of visual perception problems and giving a distinct subscore in every subtest. Additionally, the DTVP-2 has commonly been used in Thailand.

2.4 Impact of visual perception problems on occupational performance

The successful completion of various learning activities and daily living activities entails an integration of developed skills, namely vision, visual perception and visual motor functions. Visual perception as one of these vital capabilities underscores one's ability in interpreting or inferring, analyzing and conferring meaning to what is perceived. Problems related to visual perception are widespread among children. They occur when the brain becomes unable to absorb what the eyes see and to transform that into functional data in relation to the visual world. These issues in perception are connected to cognitive problems influencing everyday life. A child is confronted with problems in various areas of work if his or her perception is not accurate (Chaikin, Downing-Baum, 1997; Gentile, 1997; Erhardt, Duckman, 2001; Werner, Rini, 1976; cited in Scheiman, 2002). Hence, visual perception has a crucial position in the daily performance and work-related performance of children in many areas.

Visual perception difficulties have several effects on a child's educational performance, or on a child's daily living and social activities. They are manifested in the following conditions:

- problems in identifying disparity among identical forms such as circles, ovals, squares, rectangles, etc.;
- issues with similar letter symbols such as u/v; r/n; p/q/g;
- reversing letters and numbers such as b/d, problems in categorizing things (struggling to distinguish similarities and differences);
- misreading words, word substitution or words omission when reading;
- losing a place when copying from the board in the classroom;
- problems in locating words in a lexicon or places on a map;
- trouble in sketching a straight line in the middle of two borders;

- poor understanding of spatial expressions such as in, out, over, in between, below;
- poor execution of spacing in writing;
- slow motor pace in writing;
- incorrect reading from right to left, for instance, tap for pat, mad for dam;
- being confused by the arrangement of vowels in words, such as, ou/uo, oa/ao;
- poor skills in drawing (with disorganized parts or wrong orientation);
- problems in story telling;
- incapable of correctly buttoning up;
- lack of skill in utilizing a spoon;
- distracted and confused while walking;
- incapable of recognizing objects;
- poor participation in sports and problems with depth perception.

Thus, these problems reduce the self-esteem and self-concept of children and deter from their achievement on age-connected developmental tasks (AOTA 1991, 1994; cited in Schneck, 2001).

2.5 Occupational therapist roles in visual perception problems

An occupational therapy intervention is a program given to a child who has been found to have visual perception problems. Before the intervention stage takes place, occupational therapy starts with an assessment process. The assessment process generally implements a standardized assessment (with the aid of standardized tests) and/or non-standardized assessment (through observation of the child doing his or her routine tasks). At present, a growing number of pediatric occupational therapists use standardized assessments as tools in determining the suitability of therapy services, monitoring improvement and concluding which treatment approach is necessary. Regarded as helpful assessment instruments, standardized tests gauge the performance of a child, focusing on a particular aspect under a set norm or average for a specific age level. The intervention conducted over a series of sessions adheres to the "principle of giving intervention". It is governed by approaches in occupational therapy treatment, such as motor control approaches, neurological developmental approaches, perceptual processing functions, Sensory Integration Theory, and Vision

Theory related to Visual perception. After going through a preliminary procedure, the therapists can select which treatment approach to utilize (Richmond, 2010). They can conduct individual and group treatments in every area; for example, eye-hand coordination, position in space, copying, figure ground, spatial relations, visual closure, visual motor speed and form constancy. Kurtz (2006) suggested several efficient activities or strategies for managing and guiding children. Examples of these activities are provided below.

- Giving the child an opportunity to engage in playing outside, and habitually providing him or her with motor activities such as team sports, martial arts classes, tennis, swimming, bike riding, volleyball, dancing, or anything that offers enjoyment and active participation
- Taking the child outside to do the following activities: playing catch, playing basketball, playing baseball, and running and kicking a soccer ball as practice
- Letting the child do sit ups and push-ups, and executing a wheelbarrow walk
- Providing time to read to the child each day, and having him or her sit and glance at the book during the reading
- Letting the child play on swings to improve eye fixation and rotation
- Having the child play marbles, jacks, and other games that practice eye-hand skills
- Letting the child play with toy cars on a lazy eight (sideways) speedway path on a chalk board like surface or on the floor
- Allowing the child to play with tennis balls, either with a racket or with hands
- Letting the child jump on a mini-trampoline while catching small beanbags and tossing them at targets around the room
- Having the child blow bubbles
- Letting the child play concentration games by turning cards over and finding cards' pairs or matches
- Having the child play "What's different"?, which is done by telling you which item has special qualities
- Having the child perform this game: Placing a covered tray with objects (a dozen or so) on a table; and let the child spend 30 seconds looking at it, put a cover on the tray, and write down or tell you all that he or she recalls

- Letting the child do lacing, beading, coloring, and cutting activities; playing with mazes; connecting lines from dot to dot; and performing tracing activities
- Letting the child sketch and paint while he or she stands at an easel
- Getting the child involved in weaving and sewing
- Letting the child involve himself or herself in the game, "What's different in the picture?
- Letting the child put jigsaw puzzles together
- Having the child sort things for you, such as socks and silverware
- Letting the child do the nesting and stacking of toys is helpful in promoting recognition of patterns, which is vital for learning the shapes of letters
- Letting the child play connect four, tic tac toe, and make a square
- Having the child hide things in an indoor sandbox or fill a big container with beans, rice, packing pellets, etc.
- Having the child hide small toys to find, or to move these toys out to the garden to hide things in the grass or plants
- Letting the child play the “I Spy Game” with drawings when reading a picture book together
- Letting the child focus on something you describe and have him or her try to find it in the picture according to your description; and then let the child find something and describe it to you for you to find
- Letting the child sit on a therapy ball while doing any of these: watching television, doing homework or reading a book (as slight postural corrections stabilize and reinforce the back and eyes of the child)
- Letting the child recline on the floor on his or her elbows while working for a short period to strengthen his or her neck (to make the eyes stable)

Additional study has discovered that a number of visual perceptual problems can be treated immediately and efficiently in the absence of extensive or lengthened therapy. As for whatever results the therapy can generate, they are considered by the perceptible transformation manifested in the performance of the child. If the child cooperates with specialists or if the child receives assessment and therapy for visual perceptual problems from eligible professionals, the child will demonstrate his or her improved performance regularly (Smith, 2010).

2.6 Forward-backward translation

One item on the agenda of WHO (World Health Organization, 2011) is providing technical support to countries on matters regarding global health issues and research. Along with these schemas are standardized research instruments translated into different languages to cater to the needs of participating research centers across the globe. Therefore, the process of translation and adaptation of instruments is geared towards having research tools in different language versions of the original English instrument by considering the countries and their culture, and by making these translated tools function naturally and effectively, in the same way as in the original version. The emphasis is mainly on cross-cultural and theoretical translation, disregarding the linguistic/literal equivalence. To achieve this goal, a polished functional process uses the forward-translation and back-translation method. The guidelines of this method were developed by WHO as the result of several studies; these involve forward translation, expert panel back-translation, pre-testing and cognitive interviewing, and reaching the final version.

Before the back-translation of an instrument is made, a forward translation must be applied. This requires a translator who is a health professional, who knows the terminology used in the instrument and who has interview skills. Aside from this, the translator should be familiar with the English-speaking culture; however, his or her mother language is the chief language of the target culture.

The forward translation must chiefly emphasize the concepts, which should be natural and acceptable. It means to say that the definition of the original phrase or word must be considered. It is imperative that the formulated questions are stated simply, clearly and concisely. For better understanding, the target language is addressed to the most common audience or typical respondents who will use the instrument. Jargons, technical terms, colloquialisms, idioms or vernacular terms that cannot be understood by common people in their everyday life should be avoided by the translator. In addition to this, translators must be aware of gender issues and age applicability. Thus, any terms that may offend the target population should not be used.

After the forward translation stage is completed, a panel of experts which is basically bilingual, using English and the target language for translation, should be organized by a chosen editor-in-chief. It is necessary to establish a bilingual panel in order to recognize and resolve the expressions and concepts that remain insufficient after translation and the inconsistencies existing between the forward translation and the current or previous version. Normally, the experts are able to question the terminology and propose some alternative options.

Provided with materials by collaborators to establish consistency with previous translations, the panel will be made up of translators, health experts and testing experts with experience in instrument development and translation. Thus, with this process, a complete translated version of the questionnaire is produced.

After completing the previous steps, back-translation of the instrument is made possible. This involves an independent translator who will translate the instrument back to English. Having English as his or her mother tongue, the translator must have no knowledge of the questionnaire.

Back-translation is confined to selected items which are identified in two ways: Firstly, the items selected by WHO are based on the key terms and concepts of the instrument or the terms and concepts which are sensitive to translation issues regarding different cultures. Secondly, additional items and identified words or phrases are identified as problematic by participating countries after review and approval by WHO.

Therefore, the back-translation stage should consistently emphasize conceptual and cultural equivalence, rather than linguistic equivalence. Aside from this aspect, any inconsistencies or discrepancies should be thoroughly discussed with the editor-in-chief and further work like forward translations, discussion by the bilingual expert panel, etc. should be reiterated until a satisfactory version is achieved.

2.7 Cross-cultural research

Hsiu-Lin, Yueh Chen & Kun Chin (2005) conducted a study on issue of cross-cultural research and back-translation. A study was developed to provide researchers with ideas about the issues concerning cross-cultural research and the adaptation or translation of an instrument. In this course of action, the researchers included practical guidelines and possible methods that can detect such problems in cultural and linguistic differences. They also pointed out the prevalent global explosion in many fields such as business, public affairs and the extensive research conducted in varied subjects such as education, governance, health, etc.

Thus, the recurrent interface and alliance in this field of research will result in greater interest in cross-cultural and international research globally. Several tests and questionnaires developed for the population in the United States have been translated or adapted by many researchers in non-English speaking countries. Although, some biases, including construct bias and item bias can arise when translating or adapting an instrument. Under these circumstances, validity may be one of the problems causing inaccurate results. Therefore, a more careful examination of these issues is needed when a researcher translates or adapts existing tests or questionnaires from another language.

Bias in cross-cultural studies and possible remedies

With the purpose of examining the potential issues that might be encountered by researchers when they are adapting instruments from another language, it is necessary to identify bias in cross-cultural studies. These types of bias include construct bias, method bias, and item bias which are elaborated below:

Construct bias

A construct bias takes place when the construct being measured by an instrument shows non-negligible incongruity across cultures. For instance, the construct of "filial piety", meaning obedience to parents, differs greatly between Western cultures and Eastern cultures. One probable solution of alleviating construct bias is to use a team to translate an instrument, in which the team members possess expertise in multi-cultural and multi-lingual contexts.

Method bias

Method bias is influenced by the administration process of measurement, and by a variety of other factors, such as social desirability among and between groups, respondents' non-familiarity with measurement and the physical conditions in which an investigation is administered, etc. These affect most or even all of the items in the measurement. Additionally, if method bias is found to exist, the distinction in scores between groups could result from bias in the administration procedure of the test as opposed to intrinsic differences of the groups studied. To examine for the presence of method bias, confirmatory factor analysis can be utilized to compare the equivalence of factor structures in different cultural settings. Another process to examine method bias is the use of multitrait-multimethod matrices (MTMM). In this method, "the inter-correlations among several traits each measured by several methods are assessed for verification of validity". Repeated test administrations and measurements of social desirability can also be used.

Item bias

Item bias is occasionally referred to as differential item functioning. Item bias occurs when problems like poor wording, inaccurate translations, and inappropriateness of item content for a cultural group exist at the item level of measurement. In particular, differential item functioning is present when two people with the same ability or level of a trait differ in their responses due to cultural differences. To detect item bias, the statistical techniques are divided into two main types: The Mantel-Haenszel procedure, which was proposed by Holland (1985), can detect whether items function differently for two groups of examinees by means of a 2×2×K contingency table, along with the MH-CHISQ test statistic proposed by Mantel and Haenszel. The ANOVA is used for detecting differential item functioning in test scores with interval-scale properties based on the analysis of variance. Moreover, another extensively used method to identify item bias is an independent back-translation (Brislin, 1970).

As defined by Geisinger (1994 cited in Hsiu-Lin, et al., 2005), an independent back-translation means that the original translation would render items from the original version of the instrument to a second language by a second translator who is not familiar with the instrument, and then translate the instrument back into the original language. The item response theory (IRT) used in translated tests offers the possibility of solving the problem of measurement inequality, as well as discovering any cultural and/or linguistic differences

Practical guidelines for cross-cultural research

There are practical guidelines for cross-cultural researchers to follow to ensure satisfactory reliability and validity for cross-cultural studies. The following guidelines and principles are adapted from Geisinger and Van de Vijver and Hambleton (cited in Hsiu-Lin, et al., 2005).

- Avoid construct, method, and item biases is the general guideline for a cross-cultural study. If unable to eradicate these totally, the researcher should at least minimize them.
- Validity should be given importance when multi-lingual/multi-cultural research is conducted. Back-translation does not ensure that validity can be achieved. Therefore, other methods including multiple group confirmatory factor analysis should be utilized.
- Avoid use of slang, jargon, and colloquialism.
- Carefully examine the accuracy of the translated instrument and the equivalence of all language versions.
- The physical environment for the administration of an instrument should be modified to be as similar as possible to the local reality.
- The score differences among samples of target populations should not be just explained at the face value, the researcher should interpret the outcomes impartially and provide information on the factors affecting the scores.
- Documentation is required for information on using the assessment tool and accumulating responses from users, participants, and subjects.

Hsiu-Lin, et al. (2005) reported on cross-cultural studies that have been conducted by researchers over many years. Because of the cross-cultural circumstances, translated instruments are necessary tools for conducting these studies. The author pointed out that the literal translation of instruments does not measure the same constructs as in the original version due to the existence of linguistic and/or cultural differences across samples. They suggested that cross-cultural researchers should be aware of possible problems such as construct, method, and item biases which may affect the results of studies. In their study, Hsiu-Lin, et al. (2005) recommended that cross-cultural researchers should use appropriate statistical analysis techniques like confirmatory factor analysis and item response theory (IRT) to examine and to avoid or at least reduce the presence of partiality or bias. In addition, cross-cultural researchers should also look into the details of the test, such as the physical conditions affecting the administration of the measurement. Some critical factors like the use of slang, jargon and colloquialism and the manner of interpreting the score differences across samples could undermine the quality of a study.

Brislin (1970) investigated two aspects of translation: (1) factors affecting the quality of translation, and (2) how similarity between source and target versions can be evaluated. In analyzing the variance design, he focused on the variables of language, content, and difficulty. In addition, 94 bilinguals from the University of Guam, who represented ten languages, were involved in the translation or back-translation of six essays integrating three content areas and two levels of difficulty.

The five criteria for equivalence were based on comparisons of meaning or predictions of similar responses to original and translated versions. However, the factors of content, difficulty, language and content-language interaction were significant, and the five equivalence criteria proved to be workable. The researcher concluded that the translation quality can be predicted, and that a functional equivalent translation can be established when reactions to the original and target versions are examined.

2.8 Relevant studies of visual perception

Chow, Henderson & Barnett (2001) compared 4-6 year old children from Hong Kong and the United States, using the Movement Assessment Battery for Children. The Hong Kong Chinese children performed better than the American children on the items requiring manual dexterity which involved the preferred hand, but did not differ from their American counterparts when using the non-preferred hand. The explanation for this is that the Chinese children learn to use a writing implement at 3 years of age. They are coached on the use of chopsticks, but the practice effect does not transfer to the non-preferred hand. Hong Kong children also performed better on all three of the items in the dynamic balance sections. American children performed better on the items involving projection and reception of moving objects. This finding is attributed to the fact that American children are introduced to ball games much earlier than Chinese children.

Crowe, McClain & Provost (1999) conducted a comparative study on the motor development of Native American (Pueblo) children on the basis of the Peabody Developmental Motor Scales with US normative data. The researchers found that both Native American boys and girls in the 24-29 month age group and boys in the 30 month age group scored significantly lower than the normative sample on the Fine Motor Scale. The outcome implied that fine motor activities were not strongly encouraged, culturally expected or practiced among the Pueblo. Girls in the younger age group scored significantly lower than the normative sample on the Gross Motor Scale. The explanation for this result is that gross motor practice was encouraged more among young boys than among young girls among the Pueblo.

As the study found, scores on the Bayley Scales of Infant Development II, Motor Scale for typically developing Native American children at 2 years old were compared with the normative data (US samples) (McClain, Provost & Crowe, 2000). The scores of the Native American children were significantly lower than the normative data. These results were attributed to cultural differences in child rearing and environmental differences, such as living in a rural environment.

In their study of cultural influence, Balakrishnan & Rao (2007) reported that the normative sample from the US showed a significantly better performance than the Indian children in the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). These results may be attributed to nutritional, socio-cultural and environmental factors, including the schedules for physical education activities in schools.

Hickey, Froude, Williams, Hart & Summers (2000) stated that Australian children obtained higher scores on the Miller Assessment for Preschoolers (the MAP) on the Foundations, Non-verbal and Complex Tasks indices and a higher total score. They did obtain lower scores in the Coordination Index in comparison to US children. The result of the higher scores of Australian children implicates that the MAP featuring norms from the US may be less sensitive for detecting developmental delay in Australian children. The lower score of Australian children in the Foundations Index was caused by cultural effects, such as experience in motor skills. There was no significant difference for the Verbal Index between the Australian children and the US children. As an implication of the study, US norms can be used a valid screening tool for detecting speech and language delays in Australian children.

Relative to the aforementioned research studies and findings, Josman, Abdallah & Yeger (2006) compared the visual perceptual and visual motor skills of Palestinian and Israeli children. They found that the Israeli children achieved significantly higher scores than the Palestinian children on the Motor-Free Visual Perception Test-Revised (MVPT-R), The Developmental Test of Visual-Motor Integration (VMI) and Bruininks-Oseretsky Test of Motor Proficiency. This finding is due to political and cultural influences. Educational programs among Israelis and Palestinians are not similar: Israeli children enter the educational system early, at 3 years of age; whereas Palestinians enter the system at 5 or 6 years of age.

Dankert, Davies & Gavin (2003) studied the effects of occupational therapy on visual motor skills in preschool children. They provided an occupational therapy intervention program to preschool children with and without developmental delays for a school over a duration of 1 year. Children without disabilities were randomly assigned either to the treatment or the no treatment (control) group. The study found that the preschool children with developmental delays who received occupational therapy made significant improvement in visual motor skills, and they developed skills at a rate faster than expected in comparison with the typically-developing children in the area of Visual-motor integration (VMI).

Moreover, Burtner, Dukeminier, Ben, Qualls & Scott (2006) compared visual perceptual skills and school functions in children with hemiplegic cerebral palsy with typically developing children. The outcome showed that both groups of children with right and left hemiplegia scored significantly lower than the control group of children when the test required the use of more complex fine motor control to draw figures (DTVP-2 Visual Motor Integration scores). However, on the test that only required the children to point to the correct answer (MVPT-R, DTVP-2 Motor-Reduced Visual Perception), the children with left hemiplegia scored significantly lower than the control children, whereas the children with right hemiplegia showed no significant difference as compared to the control children. Both groups of children with right and left hemiplegia scored significantly lower in the School Function Assessment (SFA) subtest of using materials and written work than the control children. There is no significant difference found between the children with right and left hemiplegia in the SFA subtest.

Chan & Chow (2005) reported on the reliability and validity of the Test of Visual Perceptual Skills (Non-Motor)-Revised for Hong Kong Chinese preschoolers. A panel review by experts was used to evaluate the content validity, which included four occupational therapists and two clinical psychologists. The mean rating assigned by the panel members on the relevance and comprehensiveness of each of the seven subtests ranged from 3-3.67. At least 83.3% of all ratings were 3 or above. The intraclass correlation coefficient (ICC) of the test-retest reliability for total scores was 0.88. The ICC for each subtest ranged from 0.38-0.77. Only one subtest (visual-sequential memory) showed good stability over time. The reliability of the other six subtests was moderate to poor. The internal consistency was excellent with a Cronbach's alpha of 0.90, but the subtest total correlation was only moderate to good (0.53-0.86). The standard error of measurement of the total score was 1.53. There was little evidence supporting the test's validity, including a significant age effect, (F=0.77, p=0.97) but there was no gender bias (F=0.04, p=0.84) and positive known-group differentiation (Wilks's lamda=52.42, p<.001). The correlation of the TVPS-R composite score and the Motor-Free Visual Perceptual Test-Revised composite score was moderate at r=0.60

Brown & Gaboury (2006) presented the measurement properties and factor structure of the Test of Visual Perceptual Skills-Revised. The sample of this study consisted of 365 typically developing children aged 5-11. The authors reported that the reliability coefficient for the total group varied between 0.74-0.84. The TVPS-R perceptual quotient reliability coefficient for the seven age levels ranged between 0.79-0.91. The perceptual quotient for the TVPS-R total group reliability coefficient was 0.96. Criterion and convergent validity were explored by examining the correlation between the TVPS-R subscales and the VMI, MVPT-R, and DTVP-2. The TVPS-R perceptual quotient showed a more moderate relationship with the MVPT-R total and DTVP-2 visual perceptual quotient. The TVPS-R perceptual quotient exhibited a weak relationship with the VMI, the five MVPT-R subscales, and the four DTVP-2 subscales.

The conclusions from the principal component analysis indicated that the majority of the test items across the seven TVPS-R subscales loaded on a dominant first factor. Confirmatory factor analysis models were assessed using four different goodness-of-fit indices. Two of the fitness indices supported the unidimensional assumption (the Root Mean Square Residual and the Comparative Fit Index), whereas two of the fitness indices did not support the TVPS-R one-factor model of motor-free visual perception (Chi-square and the Root Man Square Error of Approximation).