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Construct validity of the Developmental Test of Visual-Perception Third Edition (DTVP-3) in Western Australian primary school children

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Construct Validity of the Developmental Test of Visual-Perception Third Edition (DTVP-3) in Western Australian Primary School Children

Kirsten Clarke

A report submitted in Partial Fulfilment of the Requirements for the Award of

Bachelor of Science (Occupational Therapy) Honours,

Faculty of Health, Engineering and Science

Edith Cowan University

September 2015

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Construct Validity of the Developmental Test of Visual-Perception Third Edition (DTVP-3) in Western Australian Primary School Children

Abstract

Visual perception is the ability to identify, organise, make meaning of and provide sense to what is seen in the world in which we live. Visual perceptual skills continuously develop in primary school children as seen in academic performance. If visual perceptual difficulties are unaddressed, the cumulative academic result can be detrimental throughout life. Thus, visual perceptual difficulties must be identified using tests that possess sound measurement properties to allow for early intervention. The purpose of the research was to determine the construct validity of the Developmental Test of Visual Perception Third Edition (DTVP-3). The DTVP-3 was designed and standardised in the United States (U.S.) and thus, its measurement properties should be assessed in the cultural contexts where it will be used. A pilot study was conducted using a quantitative non-experimental cross-sectional exploratory design with a non-probability convenience sample (n=91) of typically developing 6-10 year old Western Australian (WA) children. Preliminary parametric factor analysis (paired t-test) and correlations (Pearson’s) confirmed the two constructs of Visual Motor Integration and Motor Reduced Visual Perception. However, the copying subtest exhibited factor complexity within the population tested thus therapists should use the results of the Copying subtest with caution when determining Visual Motor Integration ability. The results add to the body of knowledge and provide evidence for confident use of the DTVP-3 in WA.

Kirsten Clarke

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I would like to thank Dr. Janet Richmond for her expert advice, encouragement and support.

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Construct Validity of the Developmental Test of Visual-Perception Third Edition (DTVP-3) in Western Australian Primary School Children

Introduction

In Australia, 288 348 (7%) children have a disability which restricts their schooling (Australian Bureau of Statistics [ABS], 2012). Within this population of school aged children with a disability, 60% reported having learning difficulties (ABS, 2012). Other researchers have estimated that the number of children in Australia with learning difficulties is as high as 30% (Brown, Unsworth & Lyons, 2009B). Thus, learning difficulties become a priority (Pienaar, Barhorst & Twisk, 2014) for paediatric occupational therapists who assist children by facilitating or enhancing their ability to participate in all areas of occupational performance including academic performance at school (American Occupational Therapy Association [AOTA], 2014). When academic performance difficulties are not identified and addressed children may be limited in their occupational participation (Goldstand, Koslowe & Parush, 2005). Many childhood occupations, including learning and cognitive development draw on the performance skill of visual perception (VP) (Aral, Ayhan, Gümüş, Zeytinli & Arslan, 2011; Bezrukikh & Terebova, 2009; Martin, 2006; Richmond, 2010).

Literature Review

Evidence shows that visual-information processing (i.e., visual perception and visual-motor integration) plays an important role in the performance of academic tasks such as reading, comprehension, writing, spelling, mathematics and social skills (Aral et al., 2011; Barnes & Raghubar, 2014; Brown & Hockey, 2012; Cheng, Poon, Leung & Wong, 2005; Goldstand et al., 2005; Guntayuong, Chinchai, Pongsakri & Vittayakorn, 2013; Lachmann & Geter, 2003; Lategan, 2002; Martin, 2006; Meng, Cheng-Lai, Zeng, Stein & Zhou, 2011;
Pienaar et al., 2014; Richmond, 2010; Riitano & Pearson, 2014; Santos, Mello, Bueno & Dellatolas, 2005; Sorter & Kulp, 2003; Visser, Cronje’, Kemp, Scholtz, van Rooyen & Nel, 2012; Zivani, Copley, Ownsworth, Campbell & Cummins, 2008). These basic learning areas are considered paramount to academic success (Pienaar et al., 2014) as “approximately 80% of what a person processes, comprehends and remembers is dependent upon the visual system” (Thornburgh, 2006, p. 4). In fact, all Australian occupational therapists (OT’s) (n=30) participating in a survey listed visual perceptual abilities and over half also included visual-motor integration as the performance components they would assess in a child with a learning disability (Goldstand et al., 2005). As a result, OT’s recognise visual perception as essential to academic performance and consequently a domain of practice (AOTA, 2014).

Visual perception (VP) is the ability to identify, organise, make meaning of and provide sense to what is seen (Martin, 2006). It is a highly sophisticated and integrative ability that incorporates interrelated sub-skills (Martin, 2006). The sub-skills are visual-motor integration (VMI) and motor-reduced visual perception (MRVP) which involve various sub-components, such as eye-hand coordination, copying, visual closure, form constancy, spatial concepts and figure ground (Hammill, Pearson & Voress, 2014). The visual perceptual link to academic performance is reflected in the Model of Visual Skills, Visual Perceptual Skills and Visual Motor Skills (Richmond, 2010) and is based on open systems theory. This open systems model describes input as information with may come from an external sensory source or driven from within as a thought, need or desire (Richmond, 2010). The input is managed by visual attention, visual discrimination and visual memory prior to interpretation. Interpretation occurs through the non-motor visual perceptual concepts (constancy, spatial concepts, direction, sequencing, closure, figure ground) which allow interpretation of letters, words, sentences, numbers and calculations (Richmond, 2010). The output phase involves
understanding results in occupational performance, whether in leisure, play, verbal or oral expression, self-care or productivity in educational activities (Richmond, 2010). Throughout this process, feedback informs higher centres on how to adjust outgoing information (Richmond, 2010).

Although visual perceptual skills begin to develop from birth and continue to evolve into adolescence, the critical period for visual perceptual development is between the ages of four to around seven or eight years of age (Aral et al., 2011; Bezrukikh et al., 2009; Frostig & Horne, 1964; Vlok, Smit & Bester, 2011). It is at this age that school children begin their academic journey and are expected to grasp everyday academic tasks of reading, comprehension, writing, spelling, mathematics and social participation (Erhardt & Duckman, 2005; Kirk, Gallagher & Anastasiow, 2000; Martin, 2006; Richmond, 2010). Therefore students at this phase should be monitored for potential difficulties and receive appropriate intervention where necessary. The importance of visual perceptual skills is recognised in Australia in the National Assessment Program Literacy and Numeracy (NAPLAN) where in particular, the Year 3 instrument contained a high proportion of tasks that required visual processing skills (Logan & Lowrie, 2013). However, the new Australian Curriculum provides scarce attention to the development of spatial reasoning and visual imagery skills (Logan et al., 2013).

Specific learning problems occur when visual perceptual (VP) skills are underdeveloped (Bezrukikh et al., 2009; Zivani et al., 2008). Thus, identification of VP difficulties through accurate assessments and subsequent evidence based intervention should be implemented as early as is practical (Richmond, 2010; Vlok et al., 2011). If VP difficulties are not addressed, the cumulative impact on educational advancement
throughout primary and secondary years can be detrimental placing substantial economic burdens on schools, society and parents to provide therapy interventions post primary school or alternate academic options (Goldstand et al., 2005; Richmond, 2010; Riitano & Pearson, 2014; Vlok et al., 2011).

Hence, many professionals such as OTs assess visual perception (Brown, Rodger & Davis, 2008) and for that reason it is essential that “professionals use tests that possess sound measurement properties in order to accurately assess the presence and impact of visual perceptual and visual motor integration dysfunction in children” (Brown & Hockey, 2013, p.427). In order for a test to be sound, it must undergo procedures that establish its reliability and validity (Brown & Hockey, 2013; Brown, Rodger & Davis, 2008; Richmond & Holland, 2011). OT’s can then be confident that the test accurately and consistently assesses what it purports to measure (Brown & Hockey, 2013; Brown, Rodger & Davis, 2008). A common assessment that has previously been used to assess visual perception is the Developmental Test of Visual Perception Second Edition (DTVP-2) (Brown & Hockey, 2013; Brown, Rodger & Davis, 2008; Hammill et al., 2014). However, this test edition has been superseded by the Developmental Test of Visual Perception Third Edition (DTVP-3) (Alfonso, Wissel & Lorimer, 2015; Hammill et al., 2014).

The DTVP-3 was designed and standardised in the United States (U.S.) (Alfonso et al., 2015; Hammill et al., 2014) hence, its measurement properties should be assessed in the cultural contexts where it will be used (Brown, Elliot, Bourne, Sutton, Wigg, Morgan, ...Lalor, 2011; Brown & Hockey, 2012; Cheung, Poon, Leung & Wong, 2005; Chien, Brown & McDonald, 2011; Lai & Leung, 2012; Lim, Tan, Koh, Koh, Guo, Yusoff, See & Tan, 2014; Pienaar et al., 2014; Santos et al., 2005; Visser et al., 2012).
Cross-cultural studies have shown that visual perceptual development can be altered by a child’s environment. Researchers in South Africa have identified developmental delays and academic performance difficulties in children who live in high-risk, impoverished or lower socio-economic environments. Such environments subject children to environmental stressors that may interfere or impinge on visual perceptual skill development. Other aspects of poverty that may affect visual perceptual outcomes are limited educational and learning resources, “exposure to environmental toxins, deficient schooling, poor parenting strategies, health problems and disorganized or unstimulating home environments” (Pienaar, Barhorst & Twisk, 2013, p.371) resulting in reduced academic performance (Santos et al., 2005). Frequently, children in low socio-economic areas may not attend a readiness year or pre-school programme where attention is focussed on visual perceptual development (Pienaar et al., 2013; Santos et al., 2005). Additionally, a culture, the family’s individual lifestyle or childhood learning practices may raise various expectations of the child. These expectations can have an influence on cognitive visual perceptual development (Cheung, Poon, Leung & Wong, 2005; Guntayuong et al., 2013; Pienaar et al., 2013).

Other studies, such as those involving previous versions of visual perceptual assessment such as the Developmental Test of Visual Perception Second Edition (DTVP-2) conducted in Singapore, provide empirical evidence to the argument above. Occupational Therapists (OTs) in Singapore found that there was a difference in VMI performance when compared to American children suggesting that culture may have an impact on a child’s VMI performance (Cheung et al., 2005; Lim et al., 2014). Particularly since culture affects the types of occupations a child participates in according to the culture’s specific practices and beliefs. Mao’s research found that Taiwanese children achieved better scores on the Beery VMI-5 rather than that of the American normative sample, implying that cultural practice or
biological influence may have accounted for their enhanced VMI (as cited in Lim et al., 2014).
Such studies clearly indicate that a child’s motor skill development may be influenced by their cultural upbringing (Lim et al., 2014; Santos et al., 2005).

Further examples of this cultural influence are seen in the lives of young Australian children in which sporting activities (such as football, cricket, tennis and rugby) are a major occupation (Chien, Brown & McDonald, 2011, p.636). In other cultures however, there may be less opportunities for sporting activities due to structural-environmental limitations or parental and teacher expectations to partake in pre-writing activities (Chien et al., 2011). These cultural differences may account for slight discrepancies in the difficulty level of some VP assessment activities that children complete (Chien et al., 2011). Chien and colleagues (2011) report that Australian education is more flexible with limited time pressures when carrying out academic performance tasks. Therefore, Australian children may vary in their academic performance compared to other cultures where certain academic skills are valued (Chien et al., 2011).

Additional cultural factors such as the age at which children enter school; the length of school days; and the complex characters within the alphabet have resulted in a tendency for Thai children to score higher on the visual motor speed (VMS) subtest of the DTVP-2 when compared to US children (Guntayuong et al., 2013). These results are similar to a study conducted in Hong Kong, where children reached ceiling levels in the eye-hand coordination, position in space and spatial relations subtests (Cheung et al., 2005). Likewise, Lai & Leung (2012) found that Chinese-speaking children performed better than English-speaking children on general visual perceptual abilities due to a higher VMI score but similar MRVP scores. The differences were attributed to written language format (Lai & Leung, 2012). These authors concur that “clinicians should exercise caution when using an assessment in
The consequences of using an assessment standardised in another country can result in an over-estimation or under-estimation of abilities (Lim et al., 2014). Over-estimation can lead to the postponement of intervention and under-estimation may result in unnecessary assistance (Lim et al., 2014). Such concerns emphasise the importance of investigating the varying levels of VP skill development amongst cultures (Cheung et al., 2005; Guntayuong et al., 2013; Lim et al., 2014, p.214; Santos et al., 2005).

Thus, testing whether the DTVP-3 measures the true abilities of children in Western Australia will ensure that these children’s performance is accurately assessed according to their cultural context (Brown, Elliot, Bourne, Sutton, Wigg, Morgan, … Lalor, 2011; Brown & Hockey, 2013). The purpose of this research was to examine the measurement properties of the DTVP-3 for Western Australian children to determine its construct validity for this population. This information adds to the body of knowledge about this test and its usefulness in Western Australia (Brown & Hockey, 2013).

**Western Australian Population: A Diverse Culture**

Western Australia (WA) is described as one of the most culturally diverse states with its population rapidly growing due to migration. Migration has resulted in a range of cultures, religions, languages (270 languages and dialects) and countries of origin (190 countries) with which Western Australians identify (Department of Local Government and Communities [DLGC], 2013). The 2011 Census showed that there were approximately 2.2 million people in WA, which has been named the ‘state of migrants’ as the proportion of people born overseas continues to increase (DLGC, 2013, p.2). WA’s capital city Perth
accounts for more than three quarters (78%) of the total WA population with the majority living within the Greater Perth area (87%) (ABS, 2014). Thus, Perth has the ‘highest proportion of overseas born’ (35%) of all Australian capital cities. In recent years, the number of people born in non-main English speaking countries (NMESC) within WA has increased by 15 percent resulting in an increase in the proportion of people speaking a language other than English (LOTE) at home. Nearly 30 percent of migrants speak a LOTE however the majority (53%) are from primarily English speaking countries such as the United Kingdom, New Zealand and South Africa (ABS, 2013-14; DLGC, 2013). Therefore, the highest proportion of cultural and linguistic diversity across WA is in Perth (DLGC, 2013).

**Construct Validity**

Validity of an assessment is determined by examining the unitary concept identified as construct validity (American Educational Research Association [AERA], American Psychological Association, & National Council on Measurement in Education, 2014; Brown et al., 2008). Construct validity is described in the Standards of Educational and Psychological Testing as “the degree to which all the accumulated evidence supports the intended interpretation of test scores for the proposed use” (AERA et al., 2014, p.11). Hence, it is the most comprehensive and multifaceted form of validation (DePoy & Gitlin, 2011). A construct is an abstract concept based on theoretical principles that cannot be measured directly and therefore is defined by appropriate measurable factors that each represent separate components (Portney & Watkins, 2009). According to the construct validity evidence reported in the DTVP-3 manual, there are two constructs: Visual Motor Integration (VMI) which constitutes components such as eye-hand coordination and copying; and Motor Reduced Visual Perception (MRVP) which constitutes components such as visual closure,
figure ground and form constancy. To establish construct validity, researchers administer the assessment to a large group of participants and then factor analyse the scores (Portney & Watkins, 2009). Factor analysis provides factors that should fit with the original theoretical principles upon which the assessment was based (Portney & Watkins, 2009). Hence, if an assessment demonstrates construct validity then it is measuring the abstract concept that it was intended to measure (DePoy & Gitlin, 2011; Hammill et al., 2014; Liamputtong, 2013; Portney & Watkins, 2009). Construct validity testing should be replicated on numerous samples (Portney & Watkins, 2009) and is therefore gathered over time (AERA et al., 2014; Liamputtong, 2013). Thus, the aim of this study was to add to the construct validity of the DTVP-3 related to the diverse WA population.
Methods

Purpose

The purpose of this research was to provide preliminary evidence for the Developmental Test of Visual Perception Third Edition’s (DTVP-3) construct validity in Western Australia. A factor analysis using principal components analysis was conducted to gain evidence based on the internal structure of the DTVP-3 (AERA et al., 2014).

Design

The pilot study was a quantitative non-experimental, cross-sectional exploratory design used with a non-probability convenience sample of typically developing 6-10 year old Western Australian children to explore the construct validity of the Developmental Test of Visual Perception Third Edition (DTVP-3) (Brown et al., 2011). Logical positivism with deductive reasoning was used as the research approach in order to obtain one universal truth from the data (DePoy & Gitlin, 2011).

Research Question

Does the DTVP-3 have construct validity for 6-10 year old Western Australians?

Independent Variable/s: The DTVP-3 and its subscales (standardised with the American population)

Dependent Variable/s:

1. Raw scores of the DTVP-3, adapted Parent Questionnaire and adapted Teacher Checklist in a Western Australian primary school population.
2. Raw scores of the DTVP-3 U.S./American primary school population as reported in the manual.

*Extraneous Variable/s:* Concentration levels, motivation and other observations noted in the Clinical Observations Record (e.g. inattentiveness or fatigue).

**Hypothesis:**

\[ H_0 = \text{The DTVP-3 does not demonstrate construct validity when assessing a Western Australian population of primary school children.} \]

**Aims:**

To determine construct validity of the DTVP-3 for a Western Australian population, the following questions were posed:

1. Does the DTVP-3 measure the same constructs within Western Australian children as it does in United States children?
2. Does the DTVP-3 correlate to visual perceptual skills measured by parents’ observations (in the Parent Questionnaire) and teacher’s observations (in the Teacher Checklist) of academic performance?
3. Are the patterns of visual perception related to demographics in Western Australia similar to what is reported in the DTVP-3 manual?

**Participants**

Ninety-one children (aged 6-10 years old; enrolled in Year one through Year four) were recruited through non-probability convenience sampling from two mainstream primary schools in the northern suburbs of Perth, Western Australia. Both schools were allocated by the Association of Independent Schools of Western Australia (AISWA). The sample size
allowed for exploratory construct confirmation of the DTVP-3 for the Western Australian population (AERA et al., 2014; DePoy & Gitlin, 2011; Liamputtong, 2013). The two schools came from areas of similar socio-economic status (see Table 1). Principals from both schools were approached and invited to be in the study. Inclusion criteria were: informed consent from parents (see Appendix B), both genders aged between 6 and 10 years old and with academic functional English language skills. Children who had a medical condition or diagnosis were also included due to the expected normalised distribution of the data. Exclusion criteria were: students with a corrected visual acuity of less than 20/60 and/or hearing difficulty requiring a translator as reported by their teacher or parent/guardian.

<table>
<thead>
<tr>
<th><strong>Table 1:</strong> School Comparisons</th>
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<tbody>
<tr>
<td><strong>Cultural and Linguistic Background</strong></td>
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<tr>
<td>78% of students from a language background other than English.</td>
</tr>
<tr>
<td><strong>Index of Community Socio-Educational Advantage (ICSEA)</strong></td>
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<tr>
<td><strong>SEA Quarters (Appendix A)</strong></td>
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<tr>
<td>Percentage in the ‘Bottom Quarter’</td>
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<tr>
<td>Percentage in the ‘Lower Middle Quarter’</td>
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<td>Percentage in the ‘Upper Middle Quarter’</td>
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<td>Percentage in the ‘Top Quarter’</td>
</tr>
<tr>
<td>Indigenous students</td>
</tr>
<tr>
<td>Australian Distribution</td>
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</tbody>
</table>

"A value on the index corresponds to the average level of educational advantage of the school’s student population relative to those of other schools" (Australian Curriculum Assessment and Reporting Authority [ACARA], 2013A, p.1).
**Ethics**

Prior to the commencement of this study, ethical approval was granted by the Edith Cowan University (ECU) Human Research Ethics Committee - Faculty of Health, Engineering and Science (Approval number 13018). AISWA gave permission for the study to be conducted within their schools. Participant involvement in the study was confidential, unpaid and voluntary. Participants were free to withdraw at any time prior to final completion of all activities, without reason, or consequence. There were no foreseeable risks to participants identified. Parents/guardians of the children who provided consent returned completed consent forms and parent questionnaires to their child’s teacher. Teachers then provided the forms to the school’s administration office to be collected by the researchers. All of the children provided verbal and/or written assent (see Appendix C) prior to completing the assessment.

**Measures**

Measures included the 1). Developmental Test of Visual Perception Third Edition (DTVP-3; Hammill, Pearson & Voress, 2014), a standardised norm-referenced test that provides information about a child’s visual perceptual abilities and has demonstrated adequate reliability and validity (Alfonso et al., 2015 & Lawrence, 2015; see Appendix D & E). 2). An adapted Teacher Checklist that provided information regarding the child’s academic level compared to class performance. This has demonstrated usability from a previous small pilot study (Richmond & Holland, 2010; see Appendix D, F & G). 3). An adapted Parent Questionnaire that provided demographic information (such as age, gender, year level, diagnoses) and observations of the child’s performance in frequency ratings: mostly/daily; often/1x/week; seldom or never. This has shown effectiveness in rating performance
(Richmond, & Holland, 2010; see Appendix D & H). The categories within the Parent Questionnaire aligned with the subtests of the DTVP-3 (see Appendix I). The adapted materials were used as a supplement to the research question in order to provide further evidence of the DTVP-3’s construct validity in a typically developing Western Australian primary school population between the ages of 6 and 10 years old (Portney & Watkins, 2009). A Clinical Observations Record (adapted from the Parent Questionnaire) was used by assessors to document potential extraneous variables which may have affected the child’s performance on the DTVP-3 (e.g. fatigue or impulsivity; see Appendix K).

**Developmental Test of Visual Perception Third Edition (DTVP-3)**

The DTVP-3 is the most current version of the original assessment of The Marianne Frostig Developmental Test of Visual Perception, 1963 (Hammill, Pearson & Voress, 2014). It is a standardised norm-referenced test that provides information about a child’s visual perceptual abilities. The DTVP-3 claims to identify, define the severity and validate the efficacy of intervention for children who have visual perception or visual motor integration problems (Hammill et al., 2014).

The DTVP-3 has five subtests that measure theoretically different but highly interrelated visual perception and visual motor abilities. Authors endeavoured to show empirically established reliability and validity (Hammill, Pearson & Voress, 2014). Two reviews described the assessment as a well-designed and valuable resource for clinicians and practitioners (Alfonso, Wissel & Lorimer, 2015; Lawrence, 2015). The DTVP-3 includes; updated normative data collected during 2010 and 2011, which has been stratified by age; floor and some ceiling effects have been eliminated in the DTVP-3’s composite scores; the study of the item bias has been expanded; three subtests in the previous DTVP-2 version
were excluded from the test (position in space, spatial relations and visual-motor speed) and the age range for which the test is appropriate has been extended to include children who are 12 years of age (Hammill, Pearson & Voress, 2014).

Raw scores of the five subtests are converted to scaled scores (mean of 10 and a standard deviation (SD) of 3) with corresponding age equivalents, percentile ranks and descriptive terms when using age-based normative tables (Hammill, Pearson & Voress, 2014). The five subtests scaled scores make up two composite indexes; visual motor integration and motor reduced visual perception. The two composite indexes’ scores combine to form a general visual perception composite index score, providing a total of three composite index scores (Hammill, Pearson & Voress, 2014). Differences between the VMI and MRVP composite indexes scores are calculated to determine a statistical (12 or above) or clinical (28 or above) discrepancy (Hammill, Pearson & Voress, 2014). Authors of the DTVP-3 state that subtest scores provide an indication of the child’s strengths and weaknesses; however, should not be used to make interpretations, diagnoses and judgments as they will contain more error than the composite index scores. Composite index scores should be used instead as they have higher reliability (Hammill et al., 2014). Therefore composite percentiles were chosen to be used throughout this study as they account for chronological age and can be compared with other percentile ranks within the DTVP-3 and across other measures (i.e. the Teacher Checklist and Parent Questionnaire).

The DTVP-3 was normed on a sample of 1035 children living in 27 states across the U.S. (Hammill et al., 2014). Although the DTVP-3 has adequate levels of reliability and validity data reported in the manual (Alfonso et al., 2015; Hammill et al., 2014; Lawrence, 2015), it is still a relatively new instrument; therefore limited construct validity evidence has
been reported in the professional literature to date. Thus, determining whether the items of the five subtests load on two separate factors (VMI and MRVP) would provide valuable information for practitioners and further evidence about the construct validity of the DTVP-3 (Brown, Rodger & Davis, 2008).

**Reliability of the DTVP-3**

Authors of the DTVP-3 report three types of reliability: *coefficient alpha*, *test-retest* and *interscorer*. This is to ensure that the test is consistent in measuring ability and yields accurate results (Hammill et al., 2014; see Appendix D). Internal consistency reliability resulted in an averaged correlation coefficient of .92 for the VMI and MRVP composites across all ages suggestive of near perfect reliability (Hammill et al., 2014). The averaged correlation coefficient for the VMI and MRVP composites across subgroups was .96 and .95 respectively (confidence level SEM = 4) with 81% of the entire standardisation sample receiving .90 or above (Hammill et al., 2014). This proposes that the assessment contains little to no bias relative to those subgroups. *Test-retest* correlation coefficients (r) for the composites were: VMI .88, MRVP .87, GVP .90 and those for the subtests ranged from .70-.85 all of which are strong. The *Interscorer* reliability correlation coefficients for the composites were strong: VMI and MRVP .97 and GVP .98 (Hammill et al., 2014; see Appendix D).

**Validity of the DTVP-3**

Authors of the DTVP-3 report three types of validity: *content-description*, *criterion-prediction* and *construct-identification*. Adequate content validity (described by Frostig and colleagues), item discrimination (0.27-0.47), item difficulty (0.21-0.95) and differential item functioning has been established by the authors (Alfonso, Wissel & Lorimer, 2015; Hammill
et al., 2014; Lawrence, 2015). Hence, it was concluded that the assessment is unbiased to race, gender, handedness and ethnicity (Hammill et al., 2014; see Appendix D).

There are three types of criterion-prediction validity presented in the DTVP-3 manual. The DTVP-3 was correlated with two other visual perception assessments: the Test of Visual Perceptual Skills-Third Edition (TVPS-3; Martin, 2006) and the Beery-Buktenica Developmental Test of Visual-Motor Integration-Fifth Edition (VMI-5; Hammill et al., 2014) and the average correlation coefficients of the three composites were strong: VMI (.74), MRVP (.69) and GVP (.76) (Hammill et al., 2014). A comparison of the means and standard deviations (SD) of the DTVP-3 and criterion tests indicated average correlations of the DTVP-3, to the TVPS-3 and the VMI-5 criterion tests (mean=106; SD=12 and mean=105; SD=14 respectively). The DTVP-3 t-test was 2.27; p= .05 and a small effect size of r=0.2 when correlated with criterion tests (Hammill et al., 2014). Binary classification and Receiver Operating Characteristic/Area Under the Curve (ROC/AUC) analyses were conducted in order to determine the DTVP-3’s sensitivity (adequate; Sn=.70) and specificity indexes (high; Sp=.94) as well as its overall diagnostic performance (excellent; ROC/AUC=.92; Hammill et al., 2014; see Appendix D).

Construct-identification validity was demonstrated in six ways: (1) relationship to age (strong to very strong correlation coefficients), (2) relationships among the subtests and the composites (correlation coefficients ranging from r=0.33-0.52 across subtests; median coefficient of r=0.43; VMI and MRVP composite correlation was r=0.53); (3) differences among groups (average range, 90-110), (4) relationship to school achievement (coefficients of r=0.52 VMI, r=0.42 MRVP and r=0.48 GVP), (5) confirmatory factor analysis (producing two strongly correlated factors: VMI and MRVP r=0.74) and (6) item validity with strong item
discrimination (Hammill et al., 2014). Furthermore, VMI factor loadings (Eye-Hand Coordination [EHC] .62 and Copying .80) and MRVP factor loadings (Figure-Ground [FG] .72, Form Constancy [FC] .65 and Visual Closure [VC] .69) are high (Hammill et al., 2014; see Appendix D). In summary, the evidence supports adequate to strong reliability and validity of the DTVP-3 (Brown, Rodger & Davis, 2008, p. 505; Hammill et al., 2014) with the exception of test retest age range of samples which is inadequate (Alfonso, Wissel & Lorimer, 2015).

**Procedure**

Approximately 220 envelopes (with invitation, information, consent and parent questionnaire forms) were delivered to the two schools. Parents were provided with three weeks to return all forms to the school’s administration office. Once parental consent had been received, teachers were approached to provide suitable times for children in their class to be assessed. In general, younger children were assessed earlier in the day. Teachers were provided with the required number of Teacher Checklists to complete for each child assessed. Verbal assent was obtained from each child following rapport building and an explanation of the testing procedure in plain English. Two assessors (OT Honours students trained in the use of the assessments) administered assessments at both schools over a period of 10 days. Both assessors administered the DTVP-3 as well as the Beery VMI-6 (Beery & Beery, 2010) which was collected for a parallel project; however only data regarding the DTVP-3 was retained for this study. The two assessments were alternated to reduce test order effect. Prior to assessing children at the two schools, a practice study was conducted with three children known to the researchers. The practice study provided the assessors with administration and scoring practice as well as indications of time required to carry out the assessments. It also provided information about any probable errors in data collection.
e.g. in the parent questionnaire. Practice data were excluded from the final analysis. At School One, the two assessors were in separate rooms however at School Two the assessors shared a room. The DTVP-3 was administered on an individual basis within a mean time of 33.44 minutes. The rooms were quiet and distraction-free. Most children (85.7%) performed the assessment in one sitting with breaks provided as necessary. Assessment administration adhered to specifications provided in both test manuals (Hammill et al., 2014; Beery & Beery, 2010). Both assessors used the examiner record sheet (see Appendix E) and clinical record of observations sheet during the assessment process (Hammill et al., 2014; Richmond, & Holland, 2010; see Appendix K). On completion, children were given a sticker/stamp in thanks for their participation. An individual summary of their child’s results (see Appendix L) was offered to parents on request. Data were entered into the Statistical Package for the Social Sciences Version 22 (SPSS; IBM Corp., 2013). Data were validated for accuracy and to alleviate missing data (Brown & Gaboury, 2006). Information was de-identified on the test forms, parent questionnaires, teacher checklists and clinical observation record sheets; with the child’s assigned code. The child’s assigned code on the forms coincided with the demographic section of the child’s parent questionnaire; however; this section was kept separate from the observational data to ensure privacy. All forms, including teacher checklist and parent questionnaires, were transported in a secure manner and are stored on the ECU premises in a locked cupboard in a locked office. De-identified electronic data was entered and stored on a password protected computer. Data will be kept for seven years according to regulations.
Data Analysis

The Statistical Package for the Social Sciences Version 22 (SPSS) was used for data entry, analysis, storage and retrieval of the scores from the DTVP-3, Parent Questionnaire and Teacher Checklist (IBM Corp., 2013). Construct validity evidence of the DTVP-3 was supported by a number of statistical analyses. Firstly, the DTVP-3’s construct multidimensionality was evaluated using Principal Components Analysis (PCA) with orthogonal Varimax rotation and Kaiser Normalisation of the item scores within the Western Australian primary school population (Brown, Rodger & Davis, 2008). PCA, a type of factor analysis, determines linear relationships of variables mathematically to explain the variance in the data (Brown, Rodger & Davis, 2008). In this case, it was used to determine whether the items from the five subtests relate to two hypothesised constructs (VMI and MRVP). Varimax rotation is “an orthogonal rotation of the factor axes to maximise the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix...” (Brown, Unsworth & Lyons, 2009B, p714). By applying the varimax rotation, researchers are able to identify variables within a factor more easily. Hence, varimax rotation is of preference amongst many researchers. (Brown, Unsworth & Lyons, 2009B). In this study, factor loadings that were smaller than 0.30 were not considered to be a part of the underlying latent trait. The general rule is that factor loadings should be ≥0.7 however; several researchers state that this is a high criterion that real life data may not meet (Brown, Unsworth & Lyons, 2009B).

Secondly, correlational analysis was used to examine “the extent to which two variables are related to each other across a group of subjects” (DePoy & Gitlin, 2011, p.253). As the sample size was over 30 and normally distributed, parametric analysis was conducted.
Thus, Pearson’s correlation was used ($r = \pm 0 – 1$) for correlations in and between the DTVP-3, Teacher Checklist and Parent Questionnaire (DePoy & Gitlin, 2011) to provide additional construct validity evidence. Significance testing was determined using a $p$ value of $< 0.05$ (DePoy & Gitlin, 2011), where $p=0.000$ was highly significant.

Thirdly, descriptive statistics and correlational tests were utilised to analyse demographic data and to provide information on the patterns of visual perception within the WA population tested. Histogram graphs were used to indicate the fit of the data to normal distribution (Portney & Watkins, 2009). Missing data were accounted for using an assigned discrete value within SPSS and valid percentages were used when describing data.
Results

Evidence based on Internal Structure

Participants

Participants (n=91) involved in this study were aged 6-10 years old and enrolled in years 1 to 4. They came from two independent schools in the northern suburbs of Perth, Western Australia. Perth’s cultural diversity (DLGC, 2013) was reflected in the sample as one third (35.2%) of the primary school sample spoke English as a second language (ESL; see Figure 1).

Figure 1: Proportion of entire sample that are English Second Language (ELS)
Approximately, 49.5% of the total sample was Caucasian, 20.9% Asian and 12.1% African (see Figure 2). Majority of the sample identified as Australian nationality (71.4%), followed by Burmese (8.8%) and Vietnamese (6.6%; see Table 2).

![Ethnicity Pie Chart]

**Figure 2:** Proportion of the entire sample according to Ethnicity

The total sample consisted of Year 1 (n=25), Year 2 (n=31), Year 3 (n=23) and Year 4 (n=12) students. The mean age across both schools were 7.10 years, range 6.1-10.0 years, SD 12.728. Approximately 61.5% of the entire sample was Year 1 and 2 students which negatively skews the data according to school year level (see Figure 3). There was an equal number of boys and girls across the entire sample (female, n=46; male, n=45; Figure 4). The majority of the participants were right hand dominant (n=82, 90%). It took children on average 34.44 minutes (SD=6.991) to complete the assessment (see Table 2). Other descriptive data are outlined in Table 2.
Table 2: Descriptive Statistics
(According to Parent Questionnaire Demographic Section)

<table>
<thead>
<tr>
<th>Demographic Information</th>
<th>School 1:</th>
<th>School 2:</th>
<th>Total from both Schools:</th>
</tr>
</thead>
</table>
| Students per Year Group | Year 1 N=12  
Year 2 N=15  
Year 3 N=12  
Year 4 N=8        | Year 1 N=13  
Year 2 N=16  
Year 3 N=11  
Year 4 N=4        | 61.54% of the sample was Year 1 and 2’s.  
The total sample consisted of Year 1’s (n=25), Year 2’s (31), Year 3’s (23) and Year 4’s (12). |
| Chronological Age:      | 6.0-6.5=3  
6.6-6.11=5  
7.0-7.5=10  
7.6-7.11=5  
8.0-8.5=4  
8.6-8.11=10  
9.0-9.5=5  
9.6-9.11=3  
10.0-10.5=2 | 6.0-6.5=6  
6.6-6.11=6  
7.0-7.5=6  
7.6-7.11=9  
8.0-8.5=9  
8.6-8.11=3  
9.0-9.5=2  
9.6-9.11=3  
10.0-10.5=0 | The highest number of participants were between the ages of 7.0-7.5 years (n=16) with almost 55% (54.9%) of the sample between the ages of 6.0-7.11 years. |
| Gender:                | Female:22  
Male:25        | Female:24  
Male:20        | There were more females than males across the younger age group (6.0-7.11 years) than the older age group (8.0-10.5 years). However, overall there was almost equal Female (n=46) to Male (n=45) ratio. |

Figure 3: Proportion of the entire sample according to chronological age and gender

Figure 4: Proportion of entire sample according to grade and gender
Table 2:  
Descriptive Statistics Continued...  
(According to Parent Questionnaire Demographic Section)

<table>
<thead>
<tr>
<th>Demographic Information</th>
<th>School 1:</th>
<th>School 2:</th>
<th>Total from both Schools:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handedness:</td>
<td>38 Right Handed</td>
<td>44 Right Handed</td>
<td>82 Right Handed</td>
</tr>
<tr>
<td></td>
<td>9 Left Handed</td>
<td></td>
<td>9 Left Handed</td>
</tr>
<tr>
<td>English Second Language:</td>
<td>N=22 (46.8%)</td>
<td>N=10 (22.7%)</td>
<td>N=32 (35.2%)</td>
</tr>
<tr>
<td>Ethnicity:</td>
<td>Asian (34%), Caucasian (29.8%) and African (21.3%)</td>
<td>Caucasian (70.5%)</td>
<td>49.5% Caucasian, 20.9% Asian and 12.1% African.</td>
</tr>
<tr>
<td>Nationality:</td>
<td>57.4% identify as Australian Nationality</td>
<td>86.4% identify as Australian Nationality</td>
<td>71.4% Australian, 8.8% Burmese and 6.6% Vietnamese</td>
</tr>
<tr>
<td>Diagnosis:</td>
<td>N=1</td>
<td>N=4</td>
<td>N=5 children had diagnoses: ASD, ADHD, Verbal Dyspraxia + Intellectual Disability, APD and ASD + APD.</td>
</tr>
<tr>
<td>Individual Education Plan:</td>
<td>N=3 (6.4%)</td>
<td>N=5 (11.4%)</td>
<td>N=8 (8.8%)</td>
</tr>
<tr>
<td>Medical Conditions:</td>
<td>N=5 (10.6%)</td>
<td>N=6 (13.6%)</td>
<td>N=11 12.1% have Asthma or Anaphylaxis and Asthma Combined</td>
</tr>
<tr>
<td>Length of Pregnancy:</td>
<td>Full-Term:35Premature:7Late:5</td>
<td>Full-Term:33Premature:5Late:6</td>
<td>74.7% of the sample was born at full-term, 13.2% were born premature and 12.1% were born late.</td>
</tr>
<tr>
<td>Vision/Hearing Tested:</td>
<td>Vision Not Tested:20Hearing Not Tested:19</td>
<td>Vision Not Tested:12Hearing Not Tested:13</td>
<td>35.2% of the total sample had not had their eyes or hearing tested.</td>
</tr>
<tr>
<td>Tutoring:</td>
<td>N=4</td>
<td>N=3</td>
<td>7.7%</td>
</tr>
<tr>
<td>Special Education:</td>
<td>N=5</td>
<td>N=6</td>
<td>12.1%</td>
</tr>
<tr>
<td>Health Professional:</td>
<td>N=8</td>
<td>N=13</td>
<td>23.1% (52.4% saw a Speech Pathologist, Psychologist or Physiotherapist. Speech Pathologists saw approximately 33.3% of all the children who receive assistance from Health Professionals)</td>
</tr>
<tr>
<td>Developmental Milestones:</td>
<td>Before:7Same Time:33After:4</td>
<td>Before:8Same Time:29After:5</td>
<td>68.1% of the total sample reached their developmental milestones at the same time as other children.</td>
</tr>
<tr>
<td>Concerns about their child's development:</td>
<td>Yes: 8 (17%)No:39</td>
<td>Yes: 8 (18.2%)No:36</td>
<td>17.6%</td>
</tr>
<tr>
<td>Statistical and Clinical Difference between the VMI and MRVP Composites.</td>
<td>N=28 (59.6%)</td>
<td>N=32 (72.7%)</td>
<td>N=60 (66%)</td>
</tr>
<tr>
<td>% of Students Recommended for Further OT Assessment:</td>
<td>N=17 (36.2%)</td>
<td>N=20 (45.5%)</td>
<td>N=37 (40.7%) (based on DTVP-3 scores)</td>
</tr>
</tbody>
</table>
Developmental Test of Visual Perception Third Edition (DTVP-3) Factor Analysis:

DTVP-3 Subtest Raw Scores: The mean subtest raw scores for the five subtests for children aged 6-10 years are reported in Table 3. The VMI consists of 24 dichotomous and 54 polytomous scored items (a total of 60 items for EHC; 18 items for Copying). The MRVP consists of 26 dichotomous and 47 polytomous scored items (23 for Figure-Ground, 26 for Visual Closure and 24 for Form Constancy). All of the participants had perfect scores for Eye-Hand Coordination Item 1.5; Figure-Ground Items 1,3,4 and Visual Closure Items 1,2 and 3, therefore they were excluded from the factor analysis as they did not add to the variance.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>DTVP-3 Subtest 1 (EHC) Raw Scores</th>
<th>DTVP-3 Subtest 2 (Copying) Raw Scores</th>
<th>DTVP-3 Subtest 3 (FG) Raw Scores</th>
<th>DTVP-3 Subtest 4 (VC) Raw Scores</th>
<th>DTVP-3 Subtest 5 (FC) Raw Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=91</td>
<td>Mean 160.40 SD 19.408</td>
<td>Mean 24.30 SD 5.536</td>
<td>Mean 35.15 SD 11.784</td>
<td>Mean 11.65 SD 3.014</td>
<td>Mean 24.75 SD 8.091</td>
</tr>
<tr>
<td>6</td>
<td>166.77 17.706</td>
<td>29.43 5.835</td>
<td>37.10 8.458</td>
<td>14.33 3.284</td>
<td>25.53 9.077</td>
</tr>
<tr>
<td>7</td>
<td>172.38 14.648</td>
<td>31.50 5.928</td>
<td>41.96 12.334</td>
<td>14.77 3.933</td>
<td>29.27 10.471</td>
</tr>
<tr>
<td>9</td>
<td>185.00 7.071</td>
<td>34.00 5.657</td>
<td>45.50 3.536</td>
<td>17.00 2.828</td>
<td>39.50 10.607</td>
</tr>
<tr>
<td>Note: EHC= eye-hand coordination; SD= standard deviation; FG= figure-ground; VC= visual closure; FC= form constancy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DTVP-3 Factor Analysis Results:

The total variance explained from PCA with Varimax rotation resulted in 34 factors with an eigenvalue over 1. The DTVP-3 exhibited multidimensionality as expected; however the percentage of variance was low throughout the dataset. The scree plot indicated a slight inflection point at an eigenvalue of approximately 5.2-6.5; therefore factors corresponding to eigenvalues of more than 5 were retained (see Figure 5).
Factor analysis was set to 3 factors as per these data. Using the factor loading cut off of 0.30, 93.75% of the items from the Copying subtest, 100% of the items from the Figure-Ground subtest, 70.6% of items from the Visual Closure subtest and 94.4% of items from the Form Constancy subtest loaded onto factor one. However, for the Eye-Hand Coordination (EHC) subtest, 60% of the items loaded onto factor two and 40% loaded onto factor three. As the proportion of EHC items were similarly distributed across the two factors (two and three) items within each component were tallied according to the strength of their factor loadings.

According to Costello and Osborne (2005), a desirable and solid factor can only be indicated if there are five or more strongly loaded items (i.e. 0.50 or better; Costello &
Osborne, 2005). Component One had approximately 14 strongly loaded items, component Two had seven strongly loaded items and component Three had only one strongly loaded item. Thus, component Three was rejected as a possible construct and the items were set to load onto two factors (as reported in the manual). The rotated component matrix for two factors provided a clearer indication into the factor loadings for the EHC subtest. Using the factor loading cut off of 0.30, 84.4% of items from the EHC subtest loaded onto factor two, 100% of the items from the Copying subtest, 100% of the items from the Figure-Ground subtest, 94.7% of items from the Visual Closure subtest and 100% of items from the Form Constancy subtest loaded onto factor one.

Thus, factor one was identified as MRVP and factor two was identified as VMI as per the DTVP-3 manual and as such the null hypothesis was rejected and the first research aim answered. However, from this sample a more accurate labeling for factor one would be visual perception (VP) and for factor two eye-hand coordination (EHC). Factor One (VP) had 38 items with factor loadings over 0.40 and of those 15 were 0.50 or over. Factor Two (EHC) had 12 items with factor loadings over 0.40 and of those seven were 0.50 or over. The two factors accounted for 15.641% of the total variance. Factor One (MRVP) accounted for 10.03% and Factor Two (VMI) accounted for 5.61% (see Table 4).

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>2</td>
<td>6.511</td>
<td>4.521</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Although, the factor loadings from the Copying subtest were noteworthy as they did not load onto the same construct as EHC i.e. the VMI construct. Additional confirmatory factor analysis showed that VMI factor loadings (EHC = 0.865 and Copying = 0.712) and MRVP factor loadings (FG=0.848, VC= 0.633, FC= 0.829) are high. The percentage variance for the VMI composite was 44.598% and the MRVP composite was 35.508%.

**Evidence based on Relations to Other Variables**

**DTVP-3 Correlational Results:**

**Parent Questionnaire to DTVP-3 Composite Percentiles:**

There were significant positive correlations found between the Parent Questionnaire Subtest Section Totals and the DTVP-3 Composite Percentiles indicating that components performed similarly. However, correlations were mostly of weak to moderate strength with some non-significant correlations present (see Table 5).

| Table 5: Parent Questionnaire to DTVP-3 Composite Percentiles (Only significant correlations shown) |
|---------------------------------|---------------------------------|------------------|------------------|------------------|
| Composite 1=VMI; Composite 2=MRVP; Composite 3=GVP |
| Component 1 | Component 2 | Significance | Correlation | Strength of Correlation |
| SumPQ1: EHC Section | DTVP-3 Composite Percentile Ranks | Composite 1: p=0.029* | Composite 1: r= 0.242 | Weak |
| SumPQ2: Copying Section | DTVP-3 Composite Percentile Ranks | Composite 1: p=0.002* Composite 2: p= 0.038* Composite 3: p=0.005** | Composite 1: r= 0.348 Composite 2: r= 0.235 Composite 3: r= 0.318 | Weak to Moderate |
| SumPQ3: Figure-Ground Section | DTVP-3 Composite Percentile Ranks | Composite 1: p=0.031* Composite 3: p=0.027* | Composite 1: r= 0.238 Composite 3: r= 0.244 | Weak |
| SumPQ4: Visual Closure Section | DTVP-3 Composite Percentile Ranks | Composite 3: p=0.025* | Composite 3: r= 0.272 | Weak |
| SumPQ5: Form Constancy Section | DTVP-3 Composite Percentile Ranks | Composite 1: p=0.013* Composite 2: p= 0.037* Composite 3: p=0.004** | Composite 1: r= 0.285 Composite 2: r= 0.240 Composite 3: r= 0.327 | Weak to Moderate |

* Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)
Teacher Checklist to DTVP-3 Composite Percentiles:

There were significant positive correlations found between the Teacher Checklist and the DTVP-3 Composite Percentiles indicating that components performed similarly. However, correlations were mostly of weak to moderate strength. Correlation coefficients for teacher checklist subjects to social skills were positive and moderate in strength. Results show that VMI correlated to academic subjects to a higher degree than MRVP (see Table 6).

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Component 2</th>
<th>Significance</th>
<th>Correlation</th>
<th>Strength of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Checklist: Reading</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>Composite 1: p=0.018**, Composite 2: p= 0.017**, Composite 3: p=0.006**</td>
<td>Composite 1: r= 0.248</td>
<td>Weak</td>
</tr>
<tr>
<td>Teacher Checklist: Writing</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>Composite 1: p=0.000**, Composite 2: p= 0.000**, Composite 3: p=0.000**</td>
<td>Composite 1: r= 0.416</td>
<td>Moderate</td>
</tr>
<tr>
<td>Teacher Checklist: Spelling</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>Composite 1: p=0.000**, Composite 2: p= 0.007**, Composite 3: p=0.000**</td>
<td>Composite 1: r= 0.373</td>
<td>Weak to Moderate</td>
</tr>
<tr>
<td>Teacher Checklist: Mathematics</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>Composite 1: p=0.000**, Composite 2: p= 0.005**, Composite 3: p=0.000**</td>
<td>Composite 1: r= 0.396</td>
<td>Weak to Moderate</td>
</tr>
<tr>
<td>Teacher Checklist: Social Skills</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>Composite 1: p=0.000**, Composite 2: p= 0.015**, Composite 3: p=0.000**</td>
<td>Composite 1: r= 0.460</td>
<td>Weak to Moderate</td>
</tr>
<tr>
<td>Teacher Checklist: Reading</td>
<td>Teacher Checklist: Social Skills</td>
<td>p= 0.001**, p= 0.000**, p= 0.000**, p= 0.000**</td>
<td>r= 0.337</td>
<td>Moderate</td>
</tr>
<tr>
<td>Teacher Checklist: Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Checklist: Spelling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Checklist: Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)
Patterns of VP skills in WA:

Demographics:

There were significant positive correlations of varying strengths between subtest raw score means to age (weak to moderate).

**Figure 6:** Line graph of the DTVP-3’s subtest mean raw scores against age.

**Figure 7:** Line graph of the DTVP-3 eye-hand coordination subtest mean raw score against age.
There were no significant correlations found for gender, ethnicity, nationality, handedness or ESL status when correlated against DTVP-3 Composite percentiles. There were no significant correlations found between the schools and Composite percentiles; or between the assessors and DTVP-3 Composite percentiles (see Table 7).

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Component 2</th>
<th>Significance</th>
<th>Correlation</th>
<th>Strength of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in Years</td>
<td>DTVP-3 Subtest 1</td>
<td>p=0.022*</td>
<td>r=0.239</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td>Raw Score Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DTVP-3 Subtest 2</td>
<td>p=0.000**</td>
<td>r=0.507</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Raw Score Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DTVP-3 Subtest 3</td>
<td>p=0.034*</td>
<td>r=0.223</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td>Raw Score Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DTVP-3 Subtest 4</td>
<td>p=0.002**</td>
<td>r=0.319</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Raw Score Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DTVP-3 Subtest 5</td>
<td>p=0.005**</td>
<td>r=0.289</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Raw Score Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

*DTVP-3*

There were significant moderate to strong positive correlations found between Composite percentiles to assessors recommending further OT assessment as well as between the time taken to complete the DTVP-3 and assessors recommending further OT assessment. There was a significant weak negative correlation found between the time taken to complete the DTVP-3 and significance. There was no significant correlation found between which assessment was administered first and DTVP-3 Composite percentiles (see Table 8).
**Table 8:**
Table of Significant Correlations

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Component 2</th>
<th>Significance</th>
<th>Correlation</th>
<th>Strength of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>Recommended Further OT Assessment</td>
<td></td>
<td>Composite 1:</td>
<td>Moderate to Strong</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Composite 1:</td>
<td>r= 0.485</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(VMI):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>p=0.000**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Composite 2:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(MRVP):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>p=0.000**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Composite 3:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(GVP):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>p=0.000**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time taken to complete the DTVP-3</td>
<td>Recommended Further OT Assessment</td>
<td>p=0.000**</td>
<td>r= 0.403</td>
<td>Moderate</td>
</tr>
<tr>
<td>Time taken to complete the DTVP-3</td>
<td>Significance on DTVP-3</td>
<td></td>
<td>r= -0.242</td>
<td>Weak</td>
</tr>
<tr>
<td>Time taken to complete the DTVP-3</td>
<td></td>
<td>p= 0.021*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VMI= Visual-motor integration; MRVP= Motor-reduced visual perception; GVP= General visual perception

* Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

There were no significant correlations found between whether hearing or vision had been tested and DTVP-3 Composite percentiles; whether parents had concerns about their child’s hearing or vision and DTVP-3 Composite percentiles; or between children having a medical condition (asthma and/or anaphylaxis) and DTVP-3 Composite percentiles. There was a significant weak positive correlation found between seeing health professionals and DTVP-3 Composite percentiles. A significant positive correlation was found between health professionals and recommending further OT assessment. There was no significant correlation found between the mother’s length of pregnancy and Composite percentiles. There was a significant weak negative correlation between developmental milestones and DTVP-3 Composite percentiles (see Table 9).
### Table 9: Table of Significant Correlations

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Component 2</th>
<th>Significance</th>
<th>Correlation</th>
<th>Strength of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td>Individual Education Plan (IEP)</td>
<td>p=0.000**</td>
<td>r=0.605</td>
<td>Moderate</td>
</tr>
<tr>
<td>Health Professionals</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>p=0.007**</td>
<td>Composite 1: r= 0.279</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p= 0.023*</td>
<td>Composite 2: r= 0.238</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>p=0.006**</td>
<td>Composite 3: r=0.288</td>
<td></td>
</tr>
<tr>
<td>Health Professionals</td>
<td>Recommending Further OT Assessment</td>
<td>p=0.024*</td>
<td>r=0.237</td>
<td>Weak</td>
</tr>
<tr>
<td>Developmental Milestones</td>
<td>DTVP-3 Composite Percentile Ranks</td>
<td>p=0.049*</td>
<td>Composite 1: r= -0.213</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p= 0.016**</td>
<td>Composite 2: r= -0.259</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>p=0.018**</td>
<td>Composite 3: r= -0.255</td>
<td></td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

There was a significant positive moderate correlation found between those children who had a diagnosis and having and Individual Education Plan (IEP). Children with a diagnosis and/or an IEP did not correlate significantly with DTVP-3 Composite scores. Children with Auditory Processing Disorder (APD), Verbal Dyspraxia and Intellectual Disability had below average or poor visual perception ability; whereas children with Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD) or ASD and APD combined had average or above average visual perception ability (Hammill et al., 2014; see Table 10).
Table 10:
DTVP-3 Scores of Children with a diagnosis

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Component 2:</th>
<th>DTVP-3 Mean Composite Percentile Rank</th>
<th>Descriptive Term (as per DTVP-3 Manual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without a Diagnosis:</td>
<td>Composite 1</td>
<td>65.59%</td>
<td>Above Average</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>35.69%</td>
<td>Below Average</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>48.94%</td>
<td>Average</td>
</tr>
<tr>
<td>Autism Spectrum Disorder:</td>
<td>Composite 1</td>
<td>50%</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>14%</td>
<td>Below Average (Low)</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>25%</td>
<td>Average</td>
</tr>
<tr>
<td>Attention Deficit/Hyperactivity Disorder</td>
<td>Composite 1</td>
<td>50%</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>47%</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>47%</td>
<td>Average</td>
</tr>
<tr>
<td>Verbal Dyspraxia and Intellectual Disability</td>
<td>Composite 1</td>
<td>2%</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>1%</td>
<td>Very Poor</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>1%</td>
<td>Very Poor</td>
</tr>
<tr>
<td>Auditory Processing Disorder:</td>
<td>Composite 1</td>
<td>21%</td>
<td>Below Average</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>18%</td>
<td>Below Average</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>19%</td>
<td>Below Average</td>
</tr>
<tr>
<td>Autism Spectrum Disorder and Auditory Processing Disorder:</td>
<td>Composite 1</td>
<td>84%</td>
<td>Above Average</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>58%</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>75%</td>
<td>Average</td>
</tr>
</tbody>
</table>

Relationships between the subtests and composites

To investigate this relationship, correlations were conducted using the percentile ranks of the DTVP-3’s subtests against themselves and against the composites. The resulting coefficients are reported in Table 11. All of the coefficients are statistically significant beyond the p=.01 level. The correlation coefficients for the subtests range from r=0.215 to 0.537; the median of the coefficients is r= 0.390. The correlation between the VMI and MRVP Composites was found to be strong r=0.581, p= 0.000 (see Table 11).

All the correlation coefficients for subtest to composite scores are within expected range (moderate to large), however it is interesting to note that the correlation coefficient for subtest 2(Copying) to composite 2(MRVP) is higher than the correlation coefficient for subtest 1 (EHC) to subtest 2(Copying). It is also noteworthy to mention that subtest 3 to 5
had some moderate level correlations with the VMI composite, especially Subtest 4 (Visual Closure; see Table 11).

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Component 2</th>
<th>Significance</th>
<th>Correlation</th>
<th>Strength of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMI Composite</td>
<td>MRVP Composite</td>
<td>p=0.000**</td>
<td>r= 0.581</td>
<td>Moderate</td>
</tr>
<tr>
<td>VMI Composite</td>
<td>GVP Composite</td>
<td>p=0.000**</td>
<td>r= 0.689</td>
<td>Moderate</td>
</tr>
<tr>
<td>MRVP Composite</td>
<td>GVP Composite</td>
<td>p=0.000**</td>
<td>r= 0.786</td>
<td>Strong</td>
</tr>
<tr>
<td>Subtest 1</td>
<td>Subtest 2</td>
<td>p=0.000**</td>
<td>r= <strong>0.453</strong></td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Subtest 3</td>
<td>p=0.011*</td>
<td>r= 0.265</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td>Subtest 4</td>
<td>p=0.022**</td>
<td>r= 0.324</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Subtest 5</td>
<td>p= 0.040*</td>
<td>r= 0.215</td>
<td>Weak</td>
</tr>
<tr>
<td>Subtest 2</td>
<td>Subtest 3</td>
<td>p=0.000**</td>
<td>r= 0.398</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Subtest 4</td>
<td>p=0.000**</td>
<td>r= 0.536</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Subtest 5</td>
<td>p=0.000**</td>
<td>r= 0.359</td>
<td>Moderate</td>
</tr>
<tr>
<td>Subtest 3</td>
<td>Subtest 4</td>
<td>p=0.000**</td>
<td>r= 0.463</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Subtest 5</td>
<td>p=0.000**</td>
<td>r= 0.537</td>
<td>Moderate</td>
</tr>
<tr>
<td>Subtest 4</td>
<td>Subtest 5</td>
<td>p=0.001**</td>
<td>r= 0.353</td>
<td>Moderate</td>
</tr>
<tr>
<td>Subtest 1</td>
<td>Composite 1</td>
<td>p=0.000**</td>
<td>r= 0.818</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>p=0.000**</td>
<td>r= 0.340</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>p=0.000**</td>
<td>r= 0.610</td>
<td>Large</td>
</tr>
<tr>
<td>Subtest 2</td>
<td>Composite 1</td>
<td>p=0.000**</td>
<td>r= 0.850</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>p=0.000**</td>
<td>r= <strong>0.499</strong></td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>p=0.000**</td>
<td>r= 0.750</td>
<td>Large</td>
</tr>
<tr>
<td>Subtest 3</td>
<td>Composite 1</td>
<td>p=0.000**</td>
<td>r= 0.400</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>p=0.000**</td>
<td>r= 0.827</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>p=0.000**</td>
<td>r= 0.723</td>
<td>Large</td>
</tr>
<tr>
<td>Subtest 4</td>
<td>Composite 1</td>
<td>p=0.000**</td>
<td>r= 0.531</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>p=0.000**</td>
<td>r= 0.663</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>p=0.000**</td>
<td>r= 0.705</td>
<td>Large</td>
</tr>
<tr>
<td>Subtest 5</td>
<td>Composite 1</td>
<td>p=0.001**</td>
<td>r= 0.349</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Composite 2</td>
<td>p=0.000**</td>
<td>r= 0.821</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Composite 3</td>
<td>p=0.000**</td>
<td>r= 0.690</td>
<td>Large</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Item validity:

Correlational analysis of the test items showed that EHC Item 1.5, FG 1, 3, 4 and VC 1, 2, 3 did not add variance to the assessment.
Discussion

Evidence based on Internal Structure

Factor Analysis of the DTVP-3

The purpose of this study was to explore the construct validity of the DTVP-3 in a Western Australian cohort. Reviewers have applauded the current edition of the assessment for its enhanced reliability and validity, sound development and clinical value (Alfonso et al., 2015; Lawrence, 2015). Although, Alfonso and colleagues (2015) propose that “factor analyses would be helpful in determining what the DTVP-3 subtests measure or do not measure” (Alfonso et al., 2015, p. 4). Additionally, Brown and colleagues stated that “replications of Hammill et al.’s findings by other researchers add strength to the validity results already published” in the DTVP-3 manual (Brown, Rodger & Davis, 2008, p. 505). This study makes a contribution to the construct validity evidence of the DTVP-3. The DTVP-3 exhibited multidimensionality when evaluated by PCA with Varimax rotation and Kaiser Normalisation. It indicated that the DTVP-3 evaluates two theoretically different but highly interrelated visual perception and visual motor abilities as stated in the assessment manual (Hammill et al., 2014).

The similarly distributed Eye-Hand Coordination (EHC) items (60% of the items loaded onto factor two and 40% loaded onto factor three) from the initial factor analysis (set to three factors) may be due to the manner in which the EHC subtest is scored, e.g. if children lift their pencil they score zero which is more detrimental to their scores than exceeding into the boundaries of the other lines. However, this is not made clear to children from the instructions provided. Further investigation is required.
Guadagnoli & Velicer (1998) state that “a pattern composed of many variables per component (10 to 12) but low loadings (=0.40) should be an accurate solution at all but the lowest sample sizes (N<150)” (Guadagnoli & Velicer, 1998, p.274). Taking into consideration the standards of the previously mentioned authors, the results of this Western Australian study may be considered accurate even with the small sample size. Furthermore, some researchers state that the sample size depends on the nature of the data, where stronger data can be considered accurate even if the sample size is small (Osborne & Costello, 2005, p.4). Thus, OT’s can be confident that the DTVP-3 measures the two constructs it purports within the WA population.

**DTVP-3 Copying Subtest Factor Analysis**

However, the DTVP-3 in this WA study indicated different factor loadings for the copying subtest compared to the manual. The copying subtest unpredictably loaded onto the MRVP construct indicating that the subtest may have a larger visual perceptual influence than anticipated in the population tested. This may be due to age (larger proportion of younger students) skewing the data, a small sample size or the result of scoring all items after the child reached ceiling level as zero. A comparison of the mean subtest raw sores between the American normative population and the current study’s sample, showed that the scores for the copying subtest were similar even slightly above average (copying) whereas MRVP scores were low average to below average (figure-ground and form constancy; see Table 3). However, if MRVP predicts VMI skills (Hammill et al., 2014) then the clinically significantly higher VMI scores in comparison to MRVP scores (22% of students had scores clinically different) are unusual. The DTVP-3 manual states that it is rare to find results such as these as one would expect that developed MRVP is required prior to being able to
duplicate stimuli (Hammill et al., 2014). This may be a result of including children in the sample who are gifted, or children with diagnoses such as intellectual disability. Although only five children were reported to have a diagnosis, the true value is expected to be higher as many more children were identified as having difficulties according to their teachers but often have to wait until year 3 to be formally diagnosed. In addition, there was a high proportion of ESL and non-Australian students within the sample (Table 2). It may be that the DTVP-3’s MRVP Composite displays a different hierarchical ordering of items within this population. Alternatively, the results could be attributed to scant attention to the development of spatial reasoning and visual imagery skills within the new Australian Curriculum (Logan & Lowrie, 2013). This area requires further research.

Other circumstances to consider when analysing the results of the present study are construct under-representation or construct contamination. This occurs when “a sub-test measures less or more than its proposed construct” thus inadequately captures “important aspects of the construct. It implies a narrowed meaning of sub-test scores because the sub-test does not adequately sample some types of content…” (AERA et al., 2014, p. 12). Possible explanations to the DTVP-3’s construct under-representation or contamination may be attributed to construct irrelevancies and scoring bias within the WA sample.

Construct irrelevancies are processes extraneous to the test’s intended purpose that can affect the response processes of participants and hence their performance and test scores. Observations of the responses of the participants “can assist in determining the extent to which capabilities irrelevant or ancillary to the construct may be differentially influencing...test performance” (AERA et al., 2014, p. 15-16). These are also known as test error, situational error or subject error which may have influenced the scores (Lai & Leung,
For example, clinical observations noted during the assessment process may have systematically influenced the test’s scores to some extent by processes that are not part of the construct e.g. familiarity with the subject matter (some children had performed the Beery VMI prior which has almost identical shapes to copy which may have resulted in a practice effect), length or complexity of instructions (DTVP-3 has detailed, complex and time consuming instructions; children had to complete two assessments), lack of attention, engagement, interest or motivation, differential expectations, fatigue (aspects frequently noticed and may be related to the higher proportion of younger participants within the sample), characteristics of measurement such as test administration conditions (instructions given verbatim; room set up not ideal) and scoring criteria (crediting response characteristics that are supplementary to the construct or indirectly scoring the DTVP-3’s copying subtest more leniently as assessors were scoring the Beery VMI concurrently which is less stringent) (AERA et al., 2014, p. 13). Thus, construct irrelevance is closely related to response processes as construct irrelevance may elicit varieties of responses other than those intended hence affecting the way in which children’s performance is scored (AERA et al., 2014).

Scoring bias may occur when “credit is not awarded for responses central to the construct being measured but instead for the responses that are irrelevant or auxiliary to the construct” (AERA et al., 2014, p. 56). In this case, scoring bias may be considered within the scoring procedure of the copying subtest where scoring focuses more on MRVP skills such as spatial and visual closure skills. These skills are related but should be auxiliary to the construct (Brown, 2012). The DTVP-3 Copying subtest scoring guidelines state that items receive fewer points if there are add-on’s, overstrikes, extensions or touching of boundaries, incorrect lengths, angles more than two degrees over or lines failing to come together at an
intersection (Hammill et al., 2014). Additionally, concurrent validity between the VMI-5 and the DTVP-2 (Brown, Unsworth & Lyons, 2009C) indicated that the DTVP-3 Copying subtest is very similar to the Beery VMI-5 VMI subtest with some slight differences. One of these differences are that the DTVP-3 has double the number of items on the page to replicate compared to the Beery VMI therefore children’s drawings on the DTVP-3 need to be smaller which increases the VP complexity and accuracy required. Additional evidence from the current WA study showed that there was a higher correlation between the copying subtest and the MRVP Composite; than between the eye-hand coordination and copying subtests (see Table 11). Further correlations between subtests showed that there were moderate positive correlations between the copying subtests and MRVP subtests (Figure-ground, visual closure and form constancy) especially visual closure (see Table 8). These results concur with other studies which have shown similarly that the VMI composite shares much more of its variance with VP components (sequential memory, figure-ground, spatial relations, discrimination and visual closure) than that of the EHC subtest (Brown, 2012; Idoni, Taub & Harris, 2014). As a result, the EHC and Copying subtests should not be used interchangeably (Idoni et al., 2014). Furthermore, it appears that the Copying subtest is scored in two ways; to one extent items are scored according to motor coordination but then other items are scored more according to the integration of visual perceptual abilities using MRVP and higher level integrative processes (Idoni et al., 2014). One approach to reduce scoring bias from occurring may be to change the way the copying subtest is scored. Scoring this subtest in the same manner as in The Developmental Test of Visual-Motor Integration Fifth Edition (Beery VMI-5) i.e. dichotomously (zero or 1) instead of polytomously (zero, 1, 2 or 3) may reduce the construct complexity within this subtest (AERA et al., 2014).
In summary, the results of the copying subtest presented a conflicting and unusual factor structure where all of the items loaded onto the MRVP construct therefore appeared problematic in relation to its construct validity within this population. Similar findings from a factor analysis of the Beery VMI-5 were found in its VMI subtest which exhibited multidimensionality (Brown, Unsworth & Lyons, 2009B). The multiple factors were defined in terms of structural design or possible developmental sequence with some studies suggesting that the VMI subtest fits well into a visuo-spatial motor factor (Brown et al., 2009B). These results may extend to the DTVP-3 copying subtest as the two are very similar (Brown et al., 2009B), however this requires further investigation. Thus, it is recommended that therapists consider the complexity of the copying subtest when analysing VMI performance for the WA population or similar populations. In contrast, Brown and colleagues (2008) suggested that the subtests are administered separately and individual subtest scores be used to diagnose and identify difficulties in VP skills (Brown et al., 2008). The information provided can then be used to create a profile of the child’s VP skills (Brown et al., 2008). However, therapists may still use the three MRVP subtests combined with the two VMI subtests to calculate a child’s GVP skills (Hammill et al., 2014).

Evidence based on Relations to Other Variables

DTVP-3 Correlations:

Parent Questionnaire to DTVP-3 Composites

The shift toward a client-centred approach to practice has advocated the use of top-down approaches to information gathering by eliciting the perspectives of parents and teachers in order to gain the most comprehensive picture of the child (Kennedy, Brown & Stagnitti, 2013). However, surveys of Australian OT’s indicate that few therapists are in fact
using a top-down approach (Kennedy et al., 2013). Research studies have shown that parent’s perceptions are moderately-to-largely correlated with performance based test scores suggesting that parents are able to predict their children’s assessment scores (Brown & Hockey, 2012; Kennedy, Brown & Chien, 2012; Kennedy et al., 2013). For the most part, the WA study results are in agreement with the findings as shown by the weak to moderate significant correlations (see Table 5).

The eye-hand coordination, copying and form constancy sections of the parent questionnaire (PQ) correlated with composites as expected. It was evident that the DTVP-3 was able to identify more difficulties experienced by children compared to parent’s indications of their child’s performance in both visual motor integration (VMI) and motor-reduced visual perception (MRVP); however, to a larger extent for MRVP. Unexpected results were seen in the figure-ground and visual closure sections of the PQ in which neither section correlated significantly with the MRVP composite. The visual discrimination section of the parent questionnaire resulted in a non-significant correlation. These results may suggest that parents are not able to notice small differences or difficulties in their child’s performance in the home context or how their child’s performance compares with other children of similar ages. Although, the non-significant correlations together with the weak strength of the significant correlations is most likely due to age skewing the results, a small sample size, fewer questions in some sections, (e.g. the visual discrimination section only had four questions) or the way the parent questionnaire was adapted rather than parents being inaccurate predictors of their child’s performance. It was evident that many parents did not understand the questions or were uncertain about the answers as there was a proportion of missing data and inconsistencies within the answers provided; however this may be expected due to the high proportion of ESL homes and because the parent
questionnaire was adapted from a teacher questionnaire. Hence, the questionnaire seemed to lack usability for this population of parents. Further investigation into the adaptation, reorganisation and refinement of the questionnaire may provide greater accuracy in answers with regards to specific categories and to increase its usefulness in this population (Richmond & Holland, 2010, p.14).

Overall, the findings add to the DTVP-3’s construct validity as they show that parent’s assessments of their child’s skills were in agreement with the assessment of skills on the DTVP-3. It also strengthens the importance of stimulating parents’ perspectives (Kennedy et al., 2013) and indicates that parents have different perspectives, levels of awareness and insights into their children’s academic performance (Kennedy, Brown & Chien, 2012) which would be useful for the OT to gain when making decisions about a child’s diagnosis or intervention strategies.

**Teacher Checklist to DTVP-3**

Research has suggested that therapists should involve the perspectives of the child’s teacher together with standardised assessment scores when identifying or monitoring progress of children who have academic performance difficulties (Richmond & Holland, 2011). This is because the teacher is familiar with a child and their work, has many children with which to compare and years of experience (Richmond & Holland, 2010). Furthermore, standardised assessments have been critised for not consistently reflecting the child’s classroom performance (Richmond & Holland, 2011). However, findings from the current WA study showed significant correlations across all academic subjects as rated by teachers in the Teacher Checklist when correlated with DTVP-3 Composite scores (see Table 6). The correlations were weak to moderate indicating that in general teachers were able to observe
similar difficulties in VMI performance in the classroom however; the DTVP-3 was able to identify more MRVP difficulties as opposed to the Teacher Checklist. However, this may be due to the DTVP-3 over identifying MRVP difficulties within this population or the way the Teacher Checklist is designed as it only allows for teachers to rate students according to bottom, middle or top third of the class. For the Teacher Checklist to correlate and be more accurate the categories and the amount of information gathered must be expanded, especially for those children who have more severe academic difficulties.

Results showed that academic subjects correlated more strongly with the VMI composite (see Table 6). This reinforces the statement within the manual which proposes that VMI composite scores are a more accurate predictor for academic abilities than MRVP (Hammill et al., 2014). Reading was expected to have a stronger correlation with MRVP however; it received almost equal correlations in the VMI and MRVP which may be due to age skewing the data. Research does show that poor visual motor skills are related to difficulties progressing in reading (Richmond & Holland, 2010). However, the similar correlation strengths may be a result of young children’s books tending to have larger writing sizes, shorter words and black text on white backgrounds. Younger children who are learning to read may be using more compensatory movements e.g. finger tracing or using their fingers to cover individual letters or syllables in order to sound out or recognise the whole word when reading. The higher VMI correlation in mathematics may have occurred for the same reasons; generally children in the younger years are taught column maths instead of line maths or learn to count using their fingers which reduces the MRVP skill load.

Interestingly, social skills correlated with VMI to a higher degree than MRVP (see Table 6). This, together with moderate correlations found between all academic subjects and social skills suggest that academically higher performing children have higher social skills.
These results are in line with other research that suggests that children with low academic performance are more vulnerable to social, emotional and behavioural difficulties (Berger, Alcalay, Torretti & Milicic, 2011; Epley, 2009; Goldstand et al., 2005; Joffe & Black, 2012; Riitano & Pearson, 2014; Sonja, Jana, Milena & Cirila, 2009).

The current WA study's results add further construct validity evidence as the correlation coefficients (average VMI correlation coefficient: 0.379, MRVP: 0.296, GVP: 0.384) were similar to those reported in the DTVP-3 manual which indicated a small to moderate degree of relationship between school achievement and DTVP-3 scores (Hammill et al., 2014). Therefore, it can be said that the DTVP-3 is able to reflect academic performance as well as observations of the teacher. It also indicates that MRVP and VMI skills are related to academic performance thus interventions focussing on these skills will be beneficial. The results also highlight the need to assess VP in primary school children especially since it is during the primary school developmental phase that VP intervention is most beneficial. Furthermore, by using the DTVP-3 therapists are able to indicate suitable intervention and assist those children who are struggling academically.

Overall, the Teacher Checklist has shown its usefulness as an efficient, accurate and cost saving overall classroom screening tool for identifying children with potential visual perceptual difficulties who may require further assessment on tests such as the DTVP-3, thereby supporting the results of other studies (Richmond & Holland, 2010).
Patterns of VP skills in WA:

Demographics:

There was evidence to support a relationship between visual perceptual skill development and age in this population (see Table 7). The correlations were not as large throughout the subtests as reported in the manual for this population however, this is may be due to a small sample size and that in some age categories subtest scores decreased (Figure 6 & 7; Hammill et al., 2014). The declines in achievements mostly occur at 9-10 years where the sample size became significantly smaller hence a skewing of the results. Overall, the results indicated that the assessment is not biased to gender, ethnicity, nationality, ESL status or handedness in this population. The non-significant correlations found in ethnicity, nationality and ESL correlations are likely to have occurred as many children were born in Australia, spent most if not all of their childhood years in Australia and go to English speaking schools. Results showed that neither school did better or worse on the assessment (likely because both schools are of similar socio-economic status) hence neither school had significantly more children recommended for further OT assessment. There were no significant correlations found between the assessor and DTVP-3 scores, therefore the assessors did not differ significantly in administering or scoring the assessment which adds to the inter-rater reliability of the DTVP-3.

DTVP-3

Correlations between DTVP-3 composites and recommending further OT assessment showed that as scores increased, recommendations decreased. Correlations between time taken to complete the DTVP-3 and recommending further assessment showed that children
who took longer to complete the assessment were less likely to be recommended for further assessment. Results also showed that children who spent longer completing the assessment had generally similar VMI and MRVP scores with less variance (see Table 8).

Results showed that medical conditions, hearing and vision testing or concerns did not significantly impact DTVP-3 Composite results. They also showed that children who scored higher on the DTVP-3 were less likely to be seeing a Health Professional. The weak correlation between seeing a Health professional and VP difficulties may be due to lower socio-economic status, the parent’s definition of what constitutes learning difficulties and/or knowledge of their child’s performance in relation to other children. Furthermore, of children who have seen or currently see a Health Professional almost 50% (n= 11/23) were seeing a Speech Pathologist or Psychologist instead of an OT who would most likely assist with VP skill difficulties. Other correlations indicate that length of pregnancy did not affect DTVP-3 scores; however children who reached their developmental milestones before or at the same time as other children were likely to score better on the DTVP-3 (see Table 9).

The moderate positive correlation coefficient between diagnosis and IEP indicates that children who have a diagnosis were likely to have an IEP in place at school. The small number of children who had a diagnosis meant that statistics involving this variable was not reliable (Hammill, Pearson & Voress, 2014). Visual inspection of the results of the children who had diagnoses, suggest that they respond in similar ways on the DTVP-3 as children with similar diagnoses in other studies (Bamiou, Campbell & Sirimanna, 2006; Ferguson, Hall, Riley & Moore, 2011; Hammill et al., 2014, see Table 10). The findings were consistent with what is stated in the manual thus adding additional construct validity evidence for the DTVP-3 (see Table 10).
**Relationships between the subtests and composites**

The correlations between the DTVP-3 subtests were low enough to indicate that all subtests were relevant (Hammill et al., 2014). Correlation coefficients between the subtests were within the range of $r=0.30$ and $0.70$, which indicates that each subtest is contributing unique variance to the assessment’s total score (Hammill et al., 2014). The strong correlation between the VMI and MRVP Composites is consistent with findings in the assessment manual (Hammill et al., 2014). Correlation coefficients for subtest to composites are large enough to show that they are measuring aspects of visual perception and small enough to show that they are each providing unique contributions to the assessment (Hammill et al., 2014). Confirmatory factor analysis showed that VMI factor loadings and MRVP factor loadings are high. These results are similar to those reported in the manual thus adding further evidence to the DTVP-3’s construct validity (see Table 11).

**Item validity:**

All participants in the sample scored perfectly on EHC item 1.5, figure-ground (FG) items 1, 3, 4 and visual closure (VC) items 1, 2, 3 therefore it may be useful to remove these items from the test or use them as entry level items instead within this population.
Study Limitations

This study was limited due to the constraints of time for an honours project. This meant that the desired sample size of over 100 children could not be achieved. Thus, this study has restricted generalisability due: the small sample size and exclusion of participants who did not provide consent, did not have functional English language skills, had a hearing impairment or a corrected visual acuity of less than 20/60. Also, participants were recruited from one city in Western Australia which indicates a geographical bias (Portney & Watkins, 2009). In addition, data were collected at one point in time thus; the child’s performance on that day may not have been representative of their actual everyday performance. Other limitations include the non-randomized nature of convenience sampling, high proportions of ESL students, higher proportions of younger students and similar low to middle socio-economic status schools. Despite these limitations the study is useful as it adds to the construct validity evidence of the DTVP-3 and highlights the potential link of cultural influence on standardised assessments.

Recommendations for Future Study

It is suggested that the measurement properties of the DTVP-3, especially the copying subtest continue to be evaluated to increase the body of evidence about the assessment’s usefulness. Further construct validity of the DTVP-3 using the Rasch Measurement Model should be conducted with a larger and more varied sample in order to examine the scalability, dimensionality, differential item functioning across matched samples and testing occasions, hierarchical ordering and wording of items. Non-correlating items should be studied further as they did not add variance to the assessment when administered to this population. It would also be worthwhile to evaluate the criterion related validity of
the DTVP-3 and another VP assessment such as the updated Developmental Test of Visual Motor Integration 6th Edition.

**Conclusion**

This is the first study to report psychometric property analysis results from a group of typically developing children in WA that empirically examines the constructs of VMI and MRVP as defined by the DTVP-3. Preliminary results from this study indicate that the DTVP-3 has construct validity for the WA population as it measures the constructs reported in the manual. Occupational therapists working in this country can have greater confidence that the test appropriately identifies children with visual perceptual (VP) difficulties. Thus, administration of the DTVP-3 can lead to informed and targeted assistance through standard occupational therapy evidence based intervention. Targeted early intervention has the potential to improve academic performance and decrease adverse secondary effects, though further research into this area will be required. However, therapists should be aware that the Copying subtest displayed factor complexity within the population tested. Construct validity of this subtest should be investigated further with a more diverse and random sample. Finally, the preliminary correlation coefficients obtained from this study indicate that VP develops with age and that the DTVP-3 is unbiased to gender, ethnicity, nationality, ESL status or handedness in this population. The correlations also suggest that the parent questionnaire and teacher checklist have potential to be used as information gathering/screening tools as they identified similar abilities as the DTVP-3.


Department of Local Government and Communities. (2013). *Cultural Diversity in Western Australia: A Demographic Profile.* Perth, WA: DLGC.


Lategan, I. (2002). *The teaching of reading within the context of inclusion.* Paper presented at The First International Conference in South Africa on reading difficulties and dyslexia at the turn of the century - biological and environmental influences., Cape Town, South Africa.


Appendices

Appendix A: Definitions

- **ICSEA**: Created by the ACARA to enable meaningful comparisons of the National Assessment Program- Literacy and Numeracy (NAPLAN) test achievement by students in schools across Australia taking into account key factors in students’ family backgrounds:
  - Example: parents’ occupations, school education and non-school education which have an influence on students’ outcomes at school.

- Therefore, the ICSEA is a numerical representative of the relative magnitude of this influence, and is constructed taking into account both the student-and the school-level factors (ACARA, 2013B, p.1). According to ACARA, the lower the ICSEA value, the lower the level of educational advantage of students who go to the (this) school (ACARA, 2015, p.1).

- **SEA Quarters**: “These quarters are calculated using only the student level factors of educational advantage. SEA quarters give contextual information about the socio-economic composition of the students in the school” (ACARA, 2013B, p.1).

- **Domains of Practice**: “All aspects of the domain, including occupations, client factors, performance skills, performance patterns, and context and environment, are of equal value, and together they interact to affect the client’s occupational identity, health, well-being, and participation in life” (American Occupational Therapy Association, 2014, p. S4). Visual perception specifically in relation to the present study, falls under the ‘performance skills’ domain (American Occupational...
Performance skills are “the client’s demonstrated abilities” (American Occupational Therapy Association, 2014, p. S7).

- **Occupation/s**: “The things that people do that occupy their time and attention; meaningful, purposeful activity; the personal activities that individuals choose or need to engage in and the ways in which each individual actually experiences them” (American Occupational Therapy Association, 2014, p. 55).


- **Measurement Properties**: “Two measurement properties that standardised tests need to possess are reliability and validity, which clinicians rely on for meaningful indicators of test accuracy, consistency, and rigor” (Brown & Hockey, 2013, p. 429).

- **General Visual Perception**: “Visual perception refers to the process which involves receiving visual information through sensory impulses and then translating those impulses into meaning, based on a previously developed view of the environment. It is a composite skill that embodies a number of sub-skills and related abilities that interface with one another to analyse, integrate and synthesise visual information efficiently” (Brown & Hockey, 2013, p. 426).

“Visual perception and visual motor are two separate systems that develop in parallel and are closely related” (Brown & Hockey, 2013, p. 427).
- **Visual Motor Integration:** “The degree to which visual perception (information) and limb movement (finger-hand movements) are well coordinated thus the ability to use vision to correctly perform motor tasks” (Brown & Hockey, 2013, p. 426).
  
  o Eye-Hand Coordination: “Children are required to draw precise straight or curved lines in accordance with visual boundaries” (Hammill, Pearson & Voress, 2013, p.6).
  
  o Copying: “Children are shown a simple figure and asked to draw it on a piece of paper. The figure serves as a model for the drawing” (Hammill, Pearson & Voress, 2013, p.6).

- **Non-Motor Visual Perception:** “A purely receptive ability that does not require any manual-motor ability more complex than pointing (Hammill, Pearson & Voress, 2013, p.4).
  
  o Figure-Ground: “Children are shown stimulus figures and asked to find as many of the figures as they can on a page where the figures are hidden in a complex, confusing background (Hammill, Pearson & Voress, 2013, p.6).
  
  o Visual Closure: “Children are shown a stimulus figure and asked to select the exact figure from a series of figures that have been incompletely drawn. In order to complete the match, children have to mentally supply the missing parts of the figures in the series (Hammill, Pearson & Voress, 2013, p.6).
  
  o Form Constancy: “Children are shown a stimulus figure and asked to find it in a series of figures. The targeted figure will have different size, position,
and/or shade, and it may be hidden in a distracting background (Hammill, Pearson & Voress, 2013, p.6).

- **Reliability:** “Degree of consistency with which an instrument measures an attribute. Reliability is an indicator of the ability of an instrument to produce similar scores on repeated testing occasions that occur under similar conditions. The reliability of an instrument is important to consider ensuring that changes in the variable under study represent observable variations and not those resulting from the measurement process itself. If an instrument yields different scores each time the same person is tested, the scale will not be able to detect the ‘objective’ value or truth of the phenomenon being examined” (DePoy & Gitlin, 2011, p. 201). There are three elements in tests of reliability: stability, tests of internal consistency and equivalence (DePoy & Gitlin, 2011).

- **Construct Validity:** “Represents the most complex and comprehensive form of validation. It is used when an investigator has developed a theoretical rationale underlying the test instrument. The researcher moves through different steps to evolve supporting evidence of the relationship of the test instrument to related and distinct variables. Construct validity is based on not only the direct and full measurement of a concept, but also the theoretical principles related to the concept. Therefore, the investigator who attempts construct validity must consider how the measurement of the selected concept relates to other indicators of the same phenomenon (DePoy & Gitlin, 2011, p.205).

  - Validating a Scale: “There are many complex approaches to construct validity, including various types of factor analysis and confirmatory structural equation modelling. The validation of a scale is ongoing;
each form (content, criterion and construct) builds on the other and occurs progressively or sequentially (DePoy & Gitlin, 2011, p.206).

- **Factor Analysis:** “Is a mathematical process that determines linear combinations of the variables to explain the maximum amount of variance in the data” (Brown, Rodger & Davis, 2008, p.505).
Invitation Letter

Visual Perception Test in Western Australian Schools
Research Project for children ages 6-10 years

Dear Parents,

My name is Kirsten Clarke and I am collecting information on the usefulness of an updated visual perception test for primary school children. The information received from the test will assist health professionals such as occupational therapists in determining whether the test is able to correctly and accurately identify visual perceptual difficulties in primary school children in Western Australia. This will ensure that children receive the assistance they need in their areas of difficulty. In order to do this we need to assess a wide diversity of children, whether they appear to have visual perceptual difficulties or not. The more children we collect information from, the better our understanding of the usefulness of the assessment will be. Please assist us by allowing your child to participate in this research.

Please read the information sheet enclosed and complete the forms attached in order to allow your child to participate in this study. Please return this form to your child’s teacher.

Should you have any further questions, please contact us on the below:

Thank you.
Information Sheet

This information sheet is for you to keep.

Visual Perception Test in Western Australian Schools
Research Project for children ages 6-10 years

Dear Parents,

My name is Kirsten Clarke and I am conducting a research project with Dr Janet Richmond (Research Coordinator of Occupational Therapy, Faculty of Health, Engineering and Science) towards the requirements for a Bachelor of Science (Occupational Therapy) (Honours) at Edith Cowan University. I am looking at the way Western Australian primary school children perform on an updated visual perceptual test. For this I need to collect information about how children between the ages of 6 and 10 years perform on the test. This involves pencil-and-paper tasks and looking at a picture-book to point out the correct answers after listening to instructions. The purpose of this research is to determine if a test developed in the United States is applicable to a Western Australian population. There are no pass or fail points on the test, just observation of how the children perceive and copy shapes.

I have approval from the Association of Independent Schools Western Australia (AISWA) and the Edith Cowan University Human Research Ethics Committee to approach schools and request access to some of the pupils in order to carry out this research. The principal at your child’s school has agreed to allow me to collect this information provided that you agree.

Your child should not feel anxious during the activity as a number of children from each class will be participating. If your child no longer wants to participate, then they are free to say so. The activity will be stopped and no further information will be gathered from your child. You do not have to agree to your child taking part in this study – it is completely voluntary. You may also withdraw your consent at any time prior to final completion of all activities. Once the activities are complete and submitted to the computer programme, there will be no way of identifying a single child’s information to withdraw it from the group results. All information will be kept confidential. We will not identify your child’s name on any work once they have completed the test. No payment will be offered for their involvement in the study.
You will be asked to complete the ‘Parent Questionnaire’ which may take around 5-10 minutes. This will provide further information regarding your observations of your child. The forms will all be stored on Edith Cowan University premises in a locked cupboard/filing cabinet in a locked office for 7 years as prescribed by the Edith Cowan University regulations. No individual child or school will be identified in any computer analysis, publication or report of this study.

In thanks and appreciation for participating in the research, an information session relating to the influence of visual perception on learning and what can be done to assist children with visual perceptual difficulties will be presented at your child’s school in term four.

If you have a complaint concerning the manner in which this research is being conducted, please contact:

Research Ethics Officer  
Edith Cowan University  
Joondalup Campus  
270 Joondalup Drive  
Joondalup WA 6027  
Tel: 6304 2170  
Email: research.ethics@ecu.edu.au

Should you have any further questions, please contact us on the below:

Thank you for your consideration to this request.
Consent Form

Visual Perception Test in Western Australian Schools
Research Project for children ages 6-10 years

Name of Researcher/s: Kirsten Clarke and Dr Janet Richmond

Please return this form with your questionnaire if you have read and understand the information sheet and are happy to participate in the research.

Name of Parent/Guardian: ________________ Mother □ Father □ Guardian/Other □

Name of Child: __________________________ Due Date: ________________________

If we do not receive this consent form we will not include your data or your child’s data in the study.
1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my child’s care or legal rights being affected.
3. I understand that the test and questionnaire data collected during the study may be looked at by the project researchers at Edith Cowan University.
4. I agree that the test and questionnaire data can be used in the study.
5. I agree that the test and questionnaire data can be used within work contributing to the fulfilment of a Bachelor of Science (Occupational Therapy) (Honours) at Edith Cowan University and any future projects.
6. I understand that participation in this research is voluntary and will not be paid for.
7. I agree to my child participating in this research project for a maximum of 40 minutes during the school day at a time agreed to by the class teacher.
8. I understand that the researchers will explain the project in plain English to my child and will obtain verbal and/or written consent from them.

Name    Date    Signature
_____________________ __________________ ___________________

Would you like feedback of your child’s performance on this test? If so, please provide your email address: ______________________________________________________

Thank you.
Hello,

My name is Kirsten. I have a project that you might like to help me with.

The project is about helping me to learn how children see shapes and copy them.

Would you like to help me for about 40 minutes or less?

If you want to stop at any time, that’s OK, you can.

Your parents, or the person who looks after you, has talked with you about helping with the project.

If you would like to help with the project, please write your name and draw a circle around the word YES, on the next page.

If you don’t want to help with the project – that’s OK too.

Kirsten Clarke

*Occupational Therapy Honours Student*
Child Consent Form

- I know I have a choice whether or not I want to do this project.
- I know that I can stop whenever I want.
- I know that I will be seeing shapes and copying them as part of the project.
- I know that I need to write my name and draw a circle around the word YES on this page before I can help with the project.

YES  NO

I would like to help with the project  I do not want to help with the project

Name: _______________________________  Date: ______________
## Appendix D: Materials and Reliability and Validity of the DTVP-3

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Year published</td>
<td>2014</td>
<td>2010</td>
<td>2010</td>
</tr>
<tr>
<td>Age Range</td>
<td>4 years through to 12 years 11 months</td>
<td>6 years through to 11 years 11 months. Chosen according to the visual perceptual developmental phases</td>
<td>6 years to 11 years 11 months.</td>
</tr>
<tr>
<td>Sample Size (Norming Group)</td>
<td>1035 children from the U.S.A.</td>
<td>206 children from South Africa.</td>
<td>206 children from South Africa.</td>
</tr>
<tr>
<td>Administration Time</td>
<td>Approx. 30 minutes</td>
<td>Approx. 10-15 minutes</td>
<td>Approx. 5 minutes</td>
</tr>
<tr>
<td>Subtests</td>
<td>Eye-Hand Coordination Copying Figure-Ground Visual Closure Form Constancy</td>
<td>Eye-Hand Coordination Copying Figure-Ground Visual Closure Form Constancy Visual Discrimination - Bias is limited by not separating the questions into headings.</td>
<td>Reading Writing Spelling Maths Social Skills</td>
</tr>
<tr>
<td>Scoring</td>
<td>The Examiner administers the test in the test order (as above) and records the raw scores on an</td>
<td>Parents asked to indicate the frequency of the observation;</td>
<td>Teachers rate the child according to their level of performance in</td>
</tr>
<tr>
<td>Characteristics</td>
<td>‘Examiner Record Booklet’. The raw scores are converted to scaled scores with corresponding percentile ranks using age-based norm tables. Scaled scores have a mean of 10 and a standard deviation of 3. Descriptive performance terms are also provided for subtest scaled scores. Various subtest combinations form three different composites: Visual Motor Integration (VMI), Motor Reduced Visual Perception (MRVP) and General Visual Perception (GVP).</td>
<td>1. Mostly/Daily&lt;br&gt;2. Often/1x a week&lt;br&gt;3. Seldom&lt;br&gt;4. Never&lt;br&gt;Compiled by Richmond and Holland from various unreferenced sources covering the visual perceptual skills of a child.</td>
<td>comparison to the rest of their class peers: bottom, middle or top third of the class. These ratings will be used as classroom measures of academic performance.</td>
</tr>
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<td>---</td>
</tr>
<tr>
<td>Battery of five subtests involving the participant/s to copy figures and trace within boundaries in a ‘Response Booklet’ and look at series of stimulus figures and select the correct answer from the ‘Picture Book’ according to the instructions provided.</td>
<td>Can be used in the assessment or screening of visual perceptual difficulties related to occupational performance in school related tasks as observed by their parents.</td>
<td>Incorporates the observations of the teacher when determining children in need of assistance and as a precursor to formal tests of visual perception.</td>
<td></td>
</tr>
</tbody>
</table>
## Reliability and Validity of the DTVP-3 Assessment (Manual)

### Reliability:

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal Consistency (IC)</strong></td>
<td>IC: 0.92 for the VMI and MRVP composites across all ages (Indicative of near perfect reliability). The averaged correlation coefficient for the VMI and MRVP composites across all subgroups was .96 and .95 respectively with 81% of the entire standardisation sample receiving .90 or above. This proposes that the assessment contains little to no bias relative to those subgroups.</td>
</tr>
<tr>
<td><strong>Confidence Interval (CI)</strong></td>
<td>CI: 4 for the VMI and MRVP composites across all ages. (SEM = 1 for all subtests, 4 for the two composites and 3 for the overall composite.)</td>
</tr>
<tr>
<td><strong>Test-Retest (TR)</strong></td>
<td>TR: 0.88 for the VMI, 0.87 for the MRVP and 0.90 for the GVP composite, all corrected to account for range effects. (Acceptable test-retest)</td>
</tr>
<tr>
<td><strong>Interscorer (I)</strong></td>
<td>I: 0.97 for both VMI and MRVP composites and 0.98 for the GVP composite. (Strong evidence to support test’s scorer difference reliability)</td>
</tr>
</tbody>
</table>

"The DTVP-3 scores satisfy the most demanding standards for reliability, including those recommended by Nunnally & Bernstein (1994); Reynolds et al., (2008) & Salvia et al., (2010), which is that when important decisions are to be made for individuals, the minimum standard for a reliability coefficient should be 0.90. For the most part, coefficients for the
composites meet this rigorous standard in that they all round to or exceed the 0.90 criterion. These results strongly suggest that the test possesses little test error and that its users can have confidence in its results” (Hammill, Pearson & Voress, 2014, p.35).

<table>
<thead>
<tr>
<th>Validity:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content description validity</strong> (CD)</td>
<td>CD: 12 other tests of visual perception with similar formats were shown to have a relationship with one or more of the DTVP-3 test formats. (Especially the DTVP, then the MVPT-3 and TVPS-3)</td>
</tr>
<tr>
<td>Conventional item analysis (Item Description [IT] and Item Difficulties [ID])</td>
<td>IT: 0.27 – 0.47 across ages and subtests (0.20-0.30 was considered satisfactory)</td>
</tr>
<tr>
<td>Item Difficulties [ID])</td>
<td>ID: 0.21 – 0.95 across ages and subtests (0.15-0.85 are generally considered acceptable)</td>
</tr>
<tr>
<td>Differential item functioning analysis (DIF)</td>
<td>DIF: All statistically significant (0.001 was chosen as the significance level) comparisons had negligible effect sizes and as such, according to the authors, the test is non-biased in regard to gender, race, ethnicity, and handedness.</td>
</tr>
<tr>
<td><strong>Criterion-prediction validity</strong> (CP)</td>
<td>CM: Correlation Coefficients showing the relationships between DTVP-3 and VMI-5 and TVPS-3. [0.74 average for VMI composite, 0.69 for MRVP composite and 0.76 for the GVP composite which are large to very large</td>
</tr>
<tr>
<td>Table: Construct Validity</td>
<td>Analysis</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Comparison of the means</strong> and standard deviations of the DTVP-3 and criterion tests (CMS)</td>
<td><strong>CMS</strong>: DTVP-3 and Criterion averages were: 106 mean (125.0) and 105 mean (145.0) respectively, both receiving the ‘average’ descriptive term. DTVP-3 t-test (2.27), significance (&lt;.05), effect size correlation (0.20), magnitude (small).</td>
</tr>
<tr>
<td><strong>Binary classification (BC)</strong> and ROC/AUC Analyses</td>
<td><strong>BC (Sensitivity and Specificity)</strong>: 0.70 (acceptable) and 0.94 (high) respectively. <strong>ROC/AUC</strong>: 0.92 (Representative of near perfect/excellent predictive ability).</td>
</tr>
<tr>
<td><strong>Construct-Identification validity (CIV)</strong></td>
<td>RA: Eye-Hand Coordination (0.65), Figure Ground (0.53), Visual Closure (0.67), Form Constancy (0.51) all of large magnitude and Copying (0.76) which was of very large magnitude. This demonstrates a strong VP relationship to age.</td>
</tr>
<tr>
<td><strong>Relationships among the subtests and the composites (RSC)</strong></td>
<td><strong>RSC</strong>: Ranged from 0.33 – 0.52 across subtests; with median coefficient of 0.43 (moderate). Correlation between VMI and MRVP composites = 0.53 (large). (Correlations between 0.30 and 0.70 mean that the two subtests are each contributing unique variance to the battery’s total score)</td>
</tr>
<tr>
<td><strong>Differences among groups (DG)</strong></td>
<td><strong>DG</strong>: All ‘typical subgroups’ scored in the average range. (Mean Standard Scores of 90-110 are considered average) Of the nine ‘atypical subgroups’; five subgroups had average scores and four had below average magnitudes of correlation]</td>
</tr>
</tbody>
</table>
Relationship to school achievement (RSA)

These findings are consistent with what is known about the VP abilities of those subgroups.

**RSA:** Correlation of the DTVP-3 with the school achievement tests (0.30 – 0.49 are indicative of a small to moderate degree of relationship) resulted in MRVP (0.42) – which was expected, VMI (0.52) – which was not expected [Perhaps indicating that there is something inherent in this composite that is not present in the MRVP composite making it a better predictor of academic abilities] and GVP (0.48).

Confirmatory factor analysis (CFA)

**CFA:** Correlation between VMI and MRVP is 0.74 (strong). High VMI factor loadings [Eye-Hand Coordination (0.62) and Copying (0.80)] and MRVP factor loadings [Figure-Ground (0.72), Form Constancy (0.65) and Visual Closure (0.69)] indicate that the subtests variances are in common with the other variables on the same factor. Unique variances of the subtests: EHC (0.61), Copying (0.37), FG (0.48), FC (0.58) and VC (0.53). “This unique variance consists of unreliable variance and systematic variance that is unrelated to the variance of the other subtests.”

Comparative Fit Index (CFI)

**CFI:** ≥ 0.997

Tucker-Lewis Index (TLI)

**TLI:** ≥ 0.989

Root Mean Square Error of Approximation (RMSEA)

**RMSEA:** ≤ 0.029 with a probability of close fit as high as possible.
**Chi-square Value (CSV)**

**Item validity (IV)**

**CSV:** 7.42 with 4 degrees of freedom.

**IV:** Correlating item scores with total test scores. “This procedure was used in the early stages of test construction to select good items for the DTVP-3, based upon item discriminating power. Strong evidence of the test’s validity is found in the discriminating powers” (Hammill, Pearson & Voress, 2014, p.52).

**Keywords:** VMI (Visual-Motor Integration); MRVP (Motor Reduced Visual Perception); GVP (General Visual Perception); VMI-5 (Test of Visual Motor Integration 5th Edition); TVPS-3 (Test of Visual Perceptual Skills 3rd Edition); ROC/AUC (Receiver Operating Characteristic/Area Under the Curve) (Hammill, Pearson & Voress, 2014, p.32-52).
### Reviews on the DTVP-3: Mental Measurements Yearbook 2015

<table>
<thead>
<tr>
<th>Area</th>
<th>(Alfonso, Wissel &amp; Lorimer, 2015). Comments</th>
<th>(Lawrence, 2015). Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standardisation sample characteristics</strong></td>
<td>- Adequate to Good</td>
<td>Reliability and validity is firmly established and enhanced.</td>
</tr>
<tr>
<td><strong>Internal consistency reliability</strong></td>
<td>- Adequate</td>
<td>The DTVP-3 is well developed and likely to be a valuable resource.</td>
</tr>
<tr>
<td><strong>Test retest reliability sample and reliability coefficients</strong></td>
<td>- Adequate</td>
<td>“Especially in educational settings, the DTVP-3 will continue the sound practice of discerning visual perceptual status, an essential function for learning and adaptation, via simple perceptual and motor tasks” (Lawrence, 2015, p.3).</td>
</tr>
<tr>
<td><strong>Test retest age range of samples</strong></td>
<td>- Inadequate</td>
<td>Overall comments: Significant improvements have been made which make the DTVP-3 a valuable tool for various clinicians and practitioners provided that they use it for specified purposes” (Alfonso, Wissel &amp; Lorimer, 2015, p.5).</td>
</tr>
<tr>
<td><strong>Length of test retest interval</strong></td>
<td>- Good</td>
<td></td>
</tr>
<tr>
<td><strong>Subtest and composite floors and ceilings across age spans</strong></td>
<td>- Adequate</td>
<td></td>
</tr>
<tr>
<td><strong>General validity</strong></td>
<td>- Adequate</td>
<td></td>
</tr>
</tbody>
</table>

However lack of breadth and depth and as such “additional validity evidence is strongly suggested for the DTVP-3” (Alfonso, Wissel & Lorimer, 2015, p.5).

“... factor analyses would be helpful in determining what the DTVP-3 subtests measure or do not measure” (Alfonso, Wissel & Lorimer, 2015, p.4).
Appendix E: Samples of DTVP-3 Assessment (Manual)

Characteristics of the DTVP-3

The reviews, comments, and queries from individuals who used the test and our own ideas for improving the test were all considered in the development of the DTVP-3. This third edition has improved the test in many ways. Listed are some of the most important changes:

1. All-new normative data were collected in 2010 and 2011. The demographic characteristics of the sample conform to those of the 2010 population reported by the U.S. Census Bureau (www.census.gov) and are thereby representative of the U.S. population. The normative data have now been stratified by age.

2. The floor and ceiling effects present in the second edition have been eliminated in the DTVP-3’s composite scores.

3. The study of the item bias has been expanded.

4. Three subtests were dropped from the test: Position in Space (PS), Spatial Relations (SR), and Visual-Motor Speed (VMS). The first two subtests (PS and SR) were dropped because the authors had recognized shortcomings with them (e.g., too few difficult items for children who were 8 through 10 years old, which created ceiling effects for these ages). Also, the authors recognized that the formats of these subtests were not appropriate for use with the 11- and 12-year-old children who had been added to the DTVP-3.

A revised-version VMS subtest was originally included in the collection of the DTVP-3 normative data. After the data were collected and analyzed, this subtest was found to correlate poorly with the other visual-motor integration subtests. Also, a confirmatory factor analysis of the DTVP-3 subtests showed that VMS did not fit in the theoretical model upon which the test was based. For these reasons, it was dropped from the DTVP-3.

5. The age range for which the test is appropriate has been extended to include children who are 12 years of age.

6. A major effort has been made to show conclusively that the DTVP-3 is both reliable and valid. This effort included more studies with larger numbers of subjects than were used in the second edition, a confirmatory factor analysis, and binary classification analyses relating to sensitivity, specificity, false positives, and receiver operating characteristic/area under the curve (ROC/AUC).

(Hammill, Pearson & Voress, 2014, p. x)
Subtest 3: Figure-Ground

Example A
Sample from Examiner Record Sheet

Appendix F: Teacher Information Letter

Edith Cowan University

For all queries, please contact:
Kirsten Clarke
Edith Cowan University
Faculty of Health, Engineering and Science
270 Joondalup Drive
Joondalup WA 6027

Information Sheet

This information sheet is for you to keep.

Visual Perception Test in Western Australian Schools
Research Project for children ages 6-10 years

Dear Teachers,

My name is Kirsten Clarke and I am conducting a research project with Dr Janet Richmond (Research Coordinator of Occupational Therapy, Faculty of Health, Engineering and Science) towards the requirements for a Bachelor of Science (Occupational Therapy) (Honours) at Edith Cowan University. I am looking at the way Western Australian primary school children perform on an updated visual perceptual test. For this I need to collect information about how children between the ages of 6 and 10 years perform on the test. This involves pencil-and-paper tasks and looking at a picture-book to point out the correct answers after listening to instructions. The purpose of this research is to determine if a test developed in the United States is applicable to a Western Australian population. There are no pass or fail points on the test, just observation of how the children perceive and copy shapes.

I have approval from the Association of Independent Schools Western Australia (AISWA) and the Edith Cowan University Human Research Ethics Committee to approach schools and request access to some of the pupils in order to carry out this research. The principal of your school has agreed to allow us to collect this information.

I will consult you with regards to an appropriate time to withdraw children from class to complete the tests. You will be asked to complete the ‘Teacher Checklist’. This contains five multiple choice items which should take less than 5 minutes per child. This will provide further information regarding your observations of each child.

The forms will all be stored on Edith Cowan University premises in a locked cupboard/filing cabinet in a locked office for 7 years as prescribed by the Edith Cowan University
regulations. No individual child or school will be identified in any computer analysis, publication or report of this study.

In thanks and appreciation for participating in the research, an in-service training session may be provided to staff if requested. The in-service training session will relate to the influence of visual perception on learning and what can be done to assist children with visual perceptual difficulties. In addition, an information session for the parents can also be organised.

If you have a complaint concerning the manner in which this research is being conducted, please contact:

Research Ethics Officer
Edith Cowan University
Joondalup Campus
270 Joondalup Drive
Joondalup WA 6027
Tel: 6304 2170
Email: research.ethics@ecu.edu.au

Should you have any further questions, please contact us on the below:

We look forward to working in your school. Thank you for your consideration to this request.
Appendix G: Teacher’s Checklist

For all queries, please contact:
Kirsten Clarke
Edith Cowan University
Faculty of Health, Engineering and Science
270 Joondalup Drive
Joondalup WA 6027

Due Date: ________________

**Teacher Checklist**

<table>
<thead>
<tr>
<th>Teacher Name:</th>
<th>Grade Level:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Name:</td>
<td></td>
</tr>
</tbody>
</table>

Please rate each student with regards to the following aspects of academic performance:

<table>
<thead>
<tr>
<th></th>
<th>Bottom Third of the Class (v)</th>
<th>Middle Third of the Class (v)</th>
<th>Top Third of the Class (v)</th>
<th>Comments (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spelling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Should you have any further questions, please contact us on the below:

Thank you for your time.
# Parent Questionnaire

**Visual Perception Test in Western Australian Schools**  
*Research Project for children aged 6-10 years*

<table>
<thead>
<tr>
<th>Demographic Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child’s Name:</td>
</tr>
<tr>
<td>Date of Birth:</td>
</tr>
<tr>
<td>Name of School:</td>
</tr>
<tr>
<td>Dominant Hand</td>
</tr>
</tbody>
</table>

Does the child have any brothers or sisters (siblings)? [ ] Yes ☐ No ☐  
If yes, please describe how many siblings and the sibling/s ages:

<table>
<thead>
<tr>
<th>Does the sibling/s attend the same school?</th>
<th>What grade level in school are the sibling/s?</th>
<th>Does the sibling/s have a diagnosis or learning difficulty?</th>
<th>Is the sibling/s receiving assistance for their diagnosis/learning difficulty?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Is English the language your family speaks at home? [ ] Yes ☐ No ☐  
If no, please provide details:  
______________________________

Has your child ever repeated a year of school? [ ] Yes ☐ No ☐  
If yes, which grade? ______

Has your child ever received special education or extra help at school? [ ] Yes ☐ No ☐  
Date: ______________________
<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has your child ever received any extra tutoring to help with school work?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date: __________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Has your child ever been seen by a professional (e.g. speech/language pathologist, occupational therapist, physiotherapist, social worker, psychologist) for any learning difficulties or to assist with educational problems?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Does your child have any medical conditions/take medications?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Has your child had their eyes tested?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have concerns about your child’s eyesight?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Has your child had their hearing tested?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have concerns about your child’s hearing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Has your child ever been diagnosed/labelled as having any type of learning disability?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Has your child ever had an Individual Education Plan (IEP) at school?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, how long have they had the IEP in place?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When was your child born? Full-term (38-40 weeks) Premature/Early Late</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where there any complications?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Do you worry about your child’s development?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please provide details: _____________________________________________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did your child do the same things as other children their age did?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before At the same time or after other children?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(The demographic data will be kept in a separate file to ensure confidentiality.)
Please tick the box that matches what you have noticed about the way your child does things most of the time. Please fill in as much as you can. If you are not sure, ask your child’s teacher.

<table>
<thead>
<tr>
<th></th>
<th>Mostly/daily</th>
<th>Often/1x/week</th>
<th>Seldom</th>
<th>Never</th>
</tr>
</thead>
</table>

**SECTION 1**

a. Holds pencil in an awkward way or differently to other children

b. Presses very hard on the pencil

c. Holds the pencil lightly

d. Shakes when writing or drawing

e. Will be shaky or jerky when writing or drawing

f. Difficulty staying on the line

g. Neatness and size of writing or drawing changes over time.

h. Slouches, can’t sit straight in chair or moves constantly in chair

**SECTION 2**

a. Difficulty copying something that is close by (for example: from a page next to him/her)

b. Difficulty copying something that is far away (for example: from a picture on the wall)

c. Is able to see when they have made a mistake and will try to correct it

d. Finds it difficult to draw diagonal lines, for example: /, \, x, A

**SECTION 3**

a. Skips words or letters
b. Skips lines or gets confused when moving on to the next line when writing or reading

c. Uses his/her finger or something else to help keep their place on the line when reading

d. Loses place on a page when reading or when copying

e. Easily distracted by things they see around the room

f. Reads slowly or is unsure when reading

g. Is not able to see small details when looking at a picture or in a story

h. Difficulty understanding important information when reading

### SECTION 4

a. Does not write the whole word, for example: crac = crack, th = the

b. Has trouble working out difficult problems

c. Difficulty reading a word that has part of it on one line and the other part of the word on another line, for example: mis- on one line and -take on next line = mistake

d. Sounds out words correctly but is not able to put the letters together to make the word

e. Has trouble working out problems that
are more difficult, for example:

\[ 3 + \_ \_ = 11 \]

### SECTION 5

a. Confuses letters that look very much like each other, for example: r/n, n/m

b. Does not always recognise or know a word after they have read it out?

c. Writes some letters or numbers back-to-front or upside-down, for example: n/u, b/d, 2/S

### SECTION 6

a. Does not see small differences in letters, for example: h/n

b. Does not see small differences in words, for example: e.g. car / cat

c. Has trouble sorting things or matching things

d. Forgets small details when writing or reading

### SECTION 7

a. Guesses word from looking at the beginning, middle or end letters of the word

b. Does not make his/her letters in the right way. Which letters: ________________

c. Does not always read or write all the letters in the word

d. Reads very slowly

Thank you for your time. (Adapted from Richmond & Holland, 2010)
### Visual Perceptual Subtests of the DTVP-3

<table>
<thead>
<tr>
<th>Visual Motor Integration (VMI)</th>
<th>Parent Questionnaire Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Eye-Hand Coordination</td>
<td>- Total of Section 1</td>
</tr>
<tr>
<td>- Copying</td>
<td>- Total of Section 2, and question (b) of Section 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor-Reduced Visual Perception (MRVP)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Figure Ground</td>
<td>- Total of Section 3, and questions (a) and (b) of Section 2 and question (c) of Section 7</td>
</tr>
<tr>
<td>- Visual Closure</td>
<td>- Total of Section 4, and questions (a), (b), and (d) of Section 7</td>
</tr>
<tr>
<td>- Form Constancy</td>
<td>- Total of Section 5, and questions (a), (b), (c) of Section 7</td>
</tr>
<tr>
<td>- Visual Discrimination</td>
<td>- Total of Section 6, and questions (a) and (d) of Section 7</td>
</tr>
</tbody>
</table>

| General Visual Perception           | - Total of the VMI and MRVP Subtests |

(Adapted from Richmond & Holland, 2010).
Dear Sir/Madam,

RE: Conducting a non-intrusive research project at ____________________________ School

Visual Perception Test in Western Australian Schools
Research Project for children ages 6-10 years

My name is Kirsten Clarke and I am conducting a research project with Dr Janet Richmond (Research Coordinator of Occupational Therapy, Faculty of Health, Engineering and Science) towards the requirements for a Bachelor of Science (Occupational Therapy) (Honours) at Edith Cowan University. I am looking at the way Western Australian primary school children perform on an updated visual perceptual test. For this I need to collect information about how children between the ages of 6 and 10 years perform on the test. This involves pencil-and-paper tasks and looking at a picture-book to point out the correct answers after listening to instructions. The purpose of this research is to determine if a test developed in the United States is applicable to a Western Australian population. There are no pass or fail points on the test, just observation of how the children perceive and copy shapes.

I have approval from the Association of Independent Schools Western Australia (AISWA) and the Edith Cowan University Human Research Ethics Committee to approach schools and request access to some of the pupils in order to carry out this research. In return for the privilege of access to your school and the pupils to conduct this research, we would like to offer an in-service training session to your staff and/or the parents of your school relating to the influence of visual perception on learning and what we can do to assist children with visual perceptual difficulties. Participation in the research is completely voluntary. The commitment from each child will be approximately 40 minutes.

The possible benefit of this research is that it will establish accurate and early identification of visual perceptual difficulties; therefore children will receive timely assistance. This will have a positive impact on their academic performance. Participation in this study will contribute to the existing bank of knowledge.
Parents will be asked to complete a consent form for their child and a Parent Questionnaire which includes demographic information about the child. Teachers will be asked to complete a short Teacher Checklist for each child, which will take less than 5 minutes per child.

If you are in agreement with the research being conducted at your school, I will negotiate with you regarding appropriate times to attend the school for the research. It may be Monday to Friday for one week or spread across two weeks, depending on what suits your school and the number of children who agree to participate in the project. It would be beneficial to the project if there was a room or space separate from the classroom in which we could work, however this may be a storeroom at the back of the classroom or an office or a corner of the school hall. All resources other than a space to work and a desk and chair will be supplied by the researchers. Other than collecting the forms, being disturbed when children are collected from the class and completing a short checklist, the teachers will not be involved unless they have any specific queries.

No payment will be offered to children or children’s parents for their involvement in the research. The child should not feel uncomfortable at any time during the activity, but should they for some reason no longer want to participate, then they are free to say so. At that point the activity will be stopped and no further information will be gathered from the child. As a number of children from each class will be participating, the child will not feel singled out.

All information will be kept confidential. No names will appear on the test forms; only the child’s assigned code will be recorded. Thus, there will be no way of identifying who completed each test form. Your school will not be identified in any computer analysis, publication or report of this study.

Storage of the data collected will adhere to Edith Cowan University regulations and will be kept on University premises in a locked cupboard/filing cabinet in a locked office for 7 years. The information entered onto the computer will be de-identified and will be password protected. A report of the study will be submitted for publication, but individual participants will not be identifiable in such a report.

If you have a complaint concerning the manner in which this research is being conducted, please contact:

Research Ethics Officer
Edith Cowan University
Joondalup Campus
270 Joondalup Drive
Joondalup WA 6027
Tel: 6304 2170
Email: research.ethics@ecu.edu.au

We look forward to working in your school. Should you have any further questions, please contact us on the below:
Thank you for your consideration to this request.

Consent for Research Project

I understand that participation in this research is voluntary and will not be paid for. I agree
to ___________________ (name of school) participating in this research project with
involvement of any one child limited to approximately 40 minutes during the school day at a
time agreed to by the school and the researchers.

Name of Principal ________________________________

Signature__________________________ Date_________________

Contact person and number to arrange a meeting time:
_______________________________

Our school would like:

☐ An in-service training session to the staff of your school relating to the
  influence of visual perception on learning and what we can do to assist
  children with visual perceptual difficulties

☐ An information session to the parents of your school relating to the influence
  of visual perception on learning and what we can do to assist children with
  visual perceptual difficulties

☐ To receive a copy of the study results once they are published. It is
  anticipated that the study results will be available in 2015/6.
### Clinical Observations Record

<table>
<thead>
<tr>
<th></th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Incorrect pencil grip</td>
</tr>
<tr>
<td>2.</td>
<td>Presses very hard, holds pencil lightly, tremor</td>
</tr>
<tr>
<td>3.</td>
<td>Inconsistent rhythm; jerky, shaky letters</td>
</tr>
<tr>
<td>4.</td>
<td>Difficulty staying within the line</td>
</tr>
<tr>
<td>5.</td>
<td>Stabilises paper with one hand while drawing with the other</td>
</tr>
<tr>
<td>6.</td>
<td>Quality/size varies with sustained written output</td>
</tr>
<tr>
<td>7.</td>
<td>Climbs into and sits in chair without help</td>
</tr>
<tr>
<td>8.</td>
<td>Poor desk posture or shifts around in chair</td>
</tr>
<tr>
<td>9.</td>
<td>Difficulty copying from book</td>
</tr>
<tr>
<td>10.</td>
<td>Sees image is incorrect and keeps trying to correct it</td>
</tr>
<tr>
<td>11.</td>
<td>Difficulty with diagonal lines e.g. /, ×, A</td>
</tr>
<tr>
<td>12.</td>
<td>Loses place on page or when copying</td>
</tr>
<tr>
<td>13.</td>
<td>Easily distracted by visual stimuli</td>
</tr>
<tr>
<td>14.</td>
<td>Unable to find individual detail in a picture</td>
</tr>
<tr>
<td>15.</td>
<td>Difficulty choosing relevant /important information</td>
</tr>
<tr>
<td>16.</td>
<td>Confuses similar shapes</td>
</tr>
<tr>
<td>17.</td>
<td>Reverses or inverts shapes</td>
</tr>
<tr>
<td>18.</td>
<td>Does not notice small differences in shapes or pictures</td>
</tr>
<tr>
<td>19.</td>
<td>Difficulty with sorting and/or comparing information</td>
</tr>
<tr>
<td>20.</td>
<td>Does not pay attention to detail</td>
</tr>
<tr>
<td>21.</td>
<td>Incorrect shape formation</td>
</tr>
</tbody>
</table>
Appendix L: Child Summary of Results

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270 Joondalup Drive
Joondalup WA 6027

**Summary of Test Results**

<table>
<thead>
<tr>
<th>Student Name:</th>
<th>Below Average (V)</th>
<th>Average (V)</th>
<th>Above Average (V)</th>
</tr>
</thead>
</table>

**Visual-Motor Integration [VMI]**
- **Composite** (copying and tracing)

**Motor-Reduced Visual Perception [MRVP] Composite** (identifying shapes in different forms or backgrounds)

**General Visual Perception Composite** (VMI and MRVP scores)

It is recommended that the child receive further assessment

Private Occupational Therapy Practitioner List Attached:

Invitation to an information session regarding visual perception presented by Kirsten Clarke and Christine van Vreeswijk (Occupational Therapy Honours Students) attached:

Should you have any further questions, please contact us on the below:

Thank you for your time.

(Hammill, Pearson & Voress, 2014).
Appendix M: Occupational Therapy Theory, Frame of Reference and Framework


**Visual skills**
- Visual acuity
- Visual field
- Oculomotor function
- Visual scanning and attention

**Sensory**
- Tactile
- Proprioceptive/Vestibular
- Oral
- Olfactory
- Vision
- Auditory

**Enabled by the processes of:**
- Visual discrimination
- Visual memory
- Visual attention

**Non-Motor Visual Perception:**
- Constancy (form/shape/colour/size)
- Direction (left/right/top/bottom/diagonal)
- Spatial concepts (orientation to another object)
- Sequencing (including visual sequential memory)
- Visual closure (or analysis/synthesis)
- Figure-ground (background)

**Reflected in recognition of:**
- Letters/Words/Sentences/Numbers/Calculations

Further processing, storage and retrieval of information

**Understanding**

**Occupational Performance**
- Leisure/Play – sport, toys, finding, manipulation
- ADL – Dressing, eating, drinking, personal hygiene, toileting, bathing
- Productivity/Educational – visual motor integration, visual perception, writing words/maths, drawing, reading
- Oral/Verbal – read, speak
The Model of Visual Skills, Visual Perceptual Skills and Visual Motor Skills (Richmond, 2010) was developed from various existing models of visual perception. The input (blue) is “an external stimulus (vision, visual skills or other sensory stimulus) or an internal stimulus (thought), with the prerequisite enabling processes of visual attention, visual discrimination and visual memory. Throughput/ integration (orange) consist of non-motor visual perception that enables the person to understand letters, words and numbers in the school environment. Once understanding of the perceived stimulus occurs, the resultant output (purple) occurs in the form of an action, thought or verbal response. Throughout this process, a feedback loop is active allowing adjustment of the visual or thought input and perception to match requirements of the occupational performance (output such as verbalising the image seen, or understanding the written text)” (Richmond, 2010, p.59).


- “The *Occupational Therapy Practice Framework: Domain and Process* describes the central concepts that ground occupational therapy practice and builds a common understanding of the basic tenets and vision of the profession. By design, the *Framework* must be used to guide occupational therapy practice in conjunction with the knowledge and evidence relevant to occupation and occupational therapy within the identified areas of practice and with the appropriate clients. Embedded in this document is the profession’s core belief in the positive relationship between occupation and health and its view of people as occupational beings” (AOTA, 2014, p.S3).
**Research Framework:** (DePoy & Gitlin, 2011; Liamputtong, 2013, p.10)

<table>
<thead>
<tr>
<th>Ontology:</th>
<th>Six Characteristics of Use of Theory in Experimental-Type Research: (taken from DePoy &amp; Gitlin, 2011, p.66)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Objectivism</td>
<td>1. Logical deductive process</td>
</tr>
<tr>
<td>philosophy/paradigm</td>
<td>2. Primarily uses theory testing</td>
</tr>
<tr>
<td>/Epistemology:</td>
<td>3. Movement from theory to lesser levels of abstraction</td>
</tr>
<tr>
<td>- Positivism</td>
<td>4. Assumes unitary reality that can be measured</td>
</tr>
<tr>
<td>Approach/reasoning:</td>
<td>5. Assumes knowledge through existing conceptions</td>
</tr>
<tr>
<td>- Deductive</td>
<td>6. Focus on measureable parts of phenomena</td>
</tr>
</tbody>
</table>

End.