

A Validation of the Visual Perceptual Aspects Test Using a Bifactor Exploratory
Structural Equation Modelling Approach

by

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DECLARATION

I, Jonathan Menno Klapwijk, student number 57277699, declare that *A Validation of the Visual Perceptual Aspects Test using a Bifactor Exploratory Structural Equation Modelling Approach*, submitted for the degree of Master of Arts, is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another university or for another qualification. I declare that it is all my own work and all the sources I have referenced have been acknowledged by means of completed references.

JONATHAN MENNO KLAPWIJK

_____/_____/_____

DATE

This work is dedicated to my Father, Menno Klapwijk

&

Is in loving memory of my Mother, Valerie Klapwijk

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LIST OF ABBREVIATIONS:

VPAT - Visual Perceptual Aspects Test

VD - Visual discrimination

VFC - Visual form constancy

VM - Visual memory

VSM - Visual sequential memory

VS-R - Visual spatial-relationships

P-S - Position-in-space

VC - Visual closure

VF-G - Visual figure-ground

VA/S - Visual analysis and synthesis

CFA – Confirmatory factor analysis

ESEM – Exploratory structural equation model

ABSTRACT

Visual perception is a psychological construct that describes the awareness of visual sensations and arise from the interactions of the individual or observer in the external environment together with the physiology of the observer's visual system. A variety of theories of the development of visual perception have led to the development of different psychometric measures aimed at quantifying the cognitive construct. The Visual Perceptual Aspects Test was developed by Clutten (2009) to measure nine different constructs of visual perception. The original VPAT was validated using content and construct validity based on a Western Cape sample. However, to the researcher's knowledge, a factor analysis had not yet been conducted on the VPAT to determine the factor validity of the test. Furthermore, no measures of validity or reliability had been conducted on the VPAT using a sample outside of the Western Cape. The aim of this research is to validate the hypothesised nine factor structure of the Visual Perceptual Aspects Test, using a confirmatory factor analysis, exploratory structural equation model, a bifactor confirmatory factor analysis and a bifactor exploratory structural equation model. The results of the analysis showed marginal model fit of the VPAT with the sample data, with sufficient levels of reliability for certain sub-tests. However, the VPAT did not meet significant levels of validity or reliability of the proposed model structure of the VPAT for the sample group of learners based in the Eastern Cape.

Keywords: Bifactor exploratory structural equation modelling; Cognition; Early childhood development; Factor analysis; Intelligence; Psychometric measuring instrument; Scale validation; Validation methodology; Visual perception; Visual Perceptual Aspects Test.

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CHAPTER ONE: INTRODUCTION

1.1 Introduction and Overview

A Foundation Phase learner is typically sent to an occupational therapist when empirical evidence has emerged that suggests a deficit in perception or a perceptual difficulty. The primary problem with this type of visual intervention is the timing (Vlok, Smit, & Bester, 2011). If the child's perceptual development has already reached an advanced phase, the intervention will be less effective at such a late stage. In this regard it should be noted that a stage in the development of visual information processing comprises of the individual acquiring the relevant executive cognitive processes to analyse information with regard to tasks such as problem-solving, creative thinking, and reasoning (Piaget, 1952).

Despite the importance of attending to perceptual deficits timeously, the development of psychological instruments that can be used by multidisciplinary teams, including clinical, counselling, educational and research psychologists, as well as speech and occupational therapists, attempting to enhance the capabilities of cognitive functions, has received little attention in psychological research. However, for professionals to develop intervention focused on these specific cognitive functions, it is important to have a valid psychometric measurement test to accurately measure visual perceptual constructs (Green & Thompson, 2003). Building on The World Health Organisation's definition of health as, "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 2004), it is important to promote the 'prophylaxis' and improvement of visual perception during the vital periods of visual development. Vlok, Smit and Bester (2011) conducted research on school children with neurological and cognitive dysfunctions, using an intervention of daily eye exercises to enhance visual perception. Their findings suggest that an improvement of visual attention occurred due to the intervention of daily eye exercise. Later in their research,

cognitive strategies and intervention were included in the therapy given by multidisciplinary teams involving medical, occupational and psychological practitioners. A major improvement from a short intervention period was observed in executive functions as well as in academic performance. These results led to a recommendation to incorporate perceptual development activities to improve visual perceptual and other cognitive skills, to increase the effectiveness of visual perception in Foundation Phase learners (Vlok et al., 2011). Based on this research, it is clear that it is important to develop and validate appropriate psychometric scales that can be used to accurately determine an individual's level of visual perception, so that the necessary therapeutic interventions can be organised in cases where there are developmental lags in this cognitive ability.

Such interventions are crucial because perception is a cognitive process that is essential for the daily functioning and existence of all individuals in every context and culture around the world. It is an umbrella construct that underlies various abilities required to navigate through the world. This cognitive process allows us to participate in social behaviour, move around and understand the landscape we are in, as well as engage in social dialogue with others (Chinchester & Wiley, 1990). Visual spatial perception is at the core of all perceptual abilities because it enables us to identify and analyse empirical sensory information within the world and to assign meaning to our visual experiences (Yu, 2012). The constructs underlying visual perception form the basis of our cognitive capability to select and interpret environmental stimuli and to encode meanings assigned to them. As infants develop, the experiences they have help to shape and evolve their visual spatial cognitive abilities. The more experience the child has in the empirical world, the faster the child will learn to analyse the world, thus enabling them to understand and analyse concepts such as symbols, mathematics, linguistics and aesthetics in the external world (Wade & Swanston, 2001; Yu, 2012). Deficits in proper perceptual development and irregularities of visual perceptual abilities may negatively impact

on visual cognition which is the process that guides a child to interpret their lived experiences in the world when they are exposed to a multitude of empirical stimuli. Therefore, a deficit or lack of visual perception may lead to impairment in a variety of psychological and social behaviours, disadvantaging a child to live at maximum potential (Kirk, Gallagher, Coleman, & Anastasiow, 2008).

Clutten (2009) understood the importance of visual perception in foundation phase learners living in South Africa. After extensive research on visual perception and test development, she developed the Visual Perceptual Aspects Test (VPAT), a psychometric test specifically designed for the South African context to measure Foundation Phase learners' visual perception (Clutten, 2009). To the researcher's knowledge, this is still the only test of visual perception that has been specifically designed for South African children and it has only been used in research by Brey (2016) to measure Foundation Phase learner's visual perceptual ability.

Since its development, to the researcher's knowledge, the VPAT has not undergone any form of experimental factor analysis to determine whether the underlying hypothesised factor structure has significant factorial validity. Furthermore, the VPAT has only undergone entry level measures of reliability and validity from one sample group in the Western Cape. The following questions, therefore, arose: Is the proposed underlying factor structures within the Visual Perceptual Aspects Test statistically significant when analysed using a sample from a different region in South Africa? Furthermore, can the reliability of the measure be properly evaluated using a sample from a different region in South Africa, that is a sample different from the one used during the initial development of the test? To answer these questions, an evaluation of the model fit would have to be conducted, analysing whether the model has significant levels of validity and reliability when using a sample group based in a different

region of the country, such as the Eastern Cape. The analysis could also include relatively advanced statistical techniques such as a bifactor structural equation modelling approach. The aim of this study is to do such an analysis, and the sample group that has been selected for use in this research dissertation was the second sample group to be introduced to the VPAT.

1.2 Exploring the Problem

This research dissertation study is aimed at evaluating the hypothesised unidimensional nine factor structure of the Visual Perception Aspects Test (VPAT). As already stated, the VPAT was originally developed by Clutten (2009) with the aim of evaluating visual perception of Foundation Phase learners in South Africa. The test was developed using a framework for understanding visual perception, based on a broad perspective from a cognitive, neurobiological, and developmental approaches of visual perceptual abilities (Clutten, 2009). Furthermore, it was also based on definitions of visual perception from previously developed measures of visual perception such as the *Test of Visual-Perceptual Skills-Revised* (Gardner, 1996).

Generally, a major problem that researchers and practitioners face concerns the usability of cognitive tests applied to determine possible causes and types of dysfunctions during psychometric testing. In several cases, these tests have never undergone adequate testing of psychometric properties relating to the reliability, validity, and clinical usability of the psychometric test (Brown & Elliott, 2011). Therefore, it is important to conduct an in-depth evaluation of the psychometric properties of instruments administered to measure psychological characteristics such as the constructs of visual perception, and to achieve an understanding of the validity of the psychological theories underlying these instruments. Addressing such issues will assist researchers and practitioners in understanding how constructs of cognitive ability, with specific reference to visual perception, have been measured

and quantified. If a measure claims to measure specific abilities of visual perception, it is important for the administrator to have full confidence that the specific items on the test are measuring the proposed cognitive ability.

The VPAT was developed in the Western Cape with the aim of measuring Foundation Phase learner's visual perception. During the development of the VPAT, the test underwent one measure of reliability using *Cronbach's alpha* reliability coefficient scores. The reliability was determined from a single administration of the VPAT, using a sample of 118 participants from an English-medium government school within the Western Cape. The initial results indicated good internal consistency with alpha values ranging from 0.72 to 0.84. However, two sub-tests have never undergone any measure of reliability and one sub-test was omitted during the development of the VPAT for having insignificant values for Cronbach's alpha but it was still included in the final version of the test. A description of these sub-tests and scores are provided later in the second chapter. Furthermore, during the initial validation of the VPAT, content and construct validity were only determined by using *Pearson Product-Moment* correlations, the definition of the items of each test, and by referring to experts in the field. Recent research has indicated that a more thorough measure of validity should be conducted on psychometric measures, involving techniques such as experimental factor analysis (Brown, 2006).

Therefore, this research dissertation is aimed at exploring the reliability and validity of the VPAT and determining whether the hypothesised factor structure of the measure is statistically significant when analysed using factor analysis. The research will make use of secondary data from a different region of South Africa than the region where the VPAT was originally developed and will therefore also evaluate the more general applicability of this psychological test to different areas and cultures in South Africa. However, before describing

the research aims in more detail, it is first important to provide some general background about visual perception and to explain how the VPAT was designed to test the perceptual abilities of children.

1.2.1 Visual Perception

Visual perception is a psychological construct that describes the awareness of visual sensations and arises from the interactions of the individual or observer in the external environment in combination with the physiology of the observer's visual system (APA, 2015). Vision, according to the neurophysiological approach to visual perception, is a complex set of processes that manifests through neural mechanisms, which allow an individual to identify and make informed decisions in the world around them (Gordon, 2004). These processes are responsible for preparing us to interpret external stimuli in the world and granting us the ability to respond to the stimuli (Kranowitz, 2003). As the sensory modality, vision is not just restricted to the ability of eyesight. Eyesight is only one aspect of vision and is something we are born with. Humans are either capable of seeing or are unable to see (Gordon, 2004). Vision on the other hand, is an ability we develop over time (Kranowitz, 2003). A child is born with specific physiological and reflexive aspects that form the foundation for the development of vision. An example of these aspects is the pupillary reflex. This is the eye's ability to constrict their pupil to bright light if shined into their eye (Harris, 2016). As children grow older, experiences they have encountered in their young life will influence their visual perception, developing their cognitive ability to analyse the world around them (Harris, 2016). The process of visual perception allows us to understand what we see in the world. Visual perception works in collaboration with our other senses (the olfactory, somatic, gustation and audition systems), to make sense of the information we receive in the world. An individual with underdeveloped visual perception will have difficulty with orientation and mobility, as well as in their

interaction with the environment and with the experiences they have of the empirical world (Tilstone et al., 2004).

Visual perception is 'perceived' to be a conscious, subjective and internal psychological cognitive perceptual process. According to the structural information theory, the visual cognitive process works in a systematic flow, involving first the active and cognisant identification, then interpretation and categorisation, and finally the assignment of meaning to specific environmental stimuli (Leeuwenberg & Helm, 2013). Individuals make sense of the world around them by consciously assigning meaning to selective visual stimuli within the focus of the retina. Once the information has been gathered by the retina, the information is then analysed by the visual cortex within the brain. This process allows for the development of visual perceptual abilities (Clutten, 2009). Vision is therefore understood as a continuous source of information and humans are dependent on visual perception to orient themselves within the world, to identify the world around them together with the people and objects residing within it, and, finally, to regulate their social interactions in the world (Wade & Swanston, 2001). An individual with a significant visual defect would likely suffer from a primary impairment that influences and hampers her cognitive development. This would result in a possible misunderstanding of experiences this individual have within the world that require the visual perceptual system to analyse and decipher (Kirk et al., 2008).

There are a wide variety of definitions and conceptualisations of visual perception which will be discussed in greater detail in chapter 2. However, there seems to be a general consensus among theorists that visual perception plays a vital role in the development of a child's cognition and the effects it has on the functioning of the child within the external world (Dowling & Dowling, 2016). Therefore, understanding and measuring the constructs underlying the visual perceptual abilities of children in the early phase of development is

important for understanding how psychologists and educators could enhance children's perceptual abilities and improve their quality of life as they interact within the world. Furthermore, this type of information could assist psychologists in measuring perceptual skills and validating interventions aimed at improving a specific perceptual ability. For this to happen, it is important to validate the underlying structure of psychometric measures that are used to quantify cognitive constructs within visual perception.

1.2.2 Visual Perceptual Aspects Test

The Visual Perceptual Aspects Test (VPAT) was developed by an educational psychologist from South Africa, who recognised the need to develop a psychometric measure of visual perception, designed specifically for the South African context. Clutten (2009) became cognisant of the crucial effect visual perception has on the capabilities of Foundation Phase learner's ability and could not find any psychometric test to quantify visual perceptual abilities in the South African setting. For this reason, she developed the VPAT, a context specific psychometric test aimed at measuring a range of visual aspects, using nine unidimensional factors, with the goal of measuring the visual perceptual abilities of Foundation Phase learners.

The VPAT consists of nine unique sub-tests that, when combined, are intended to measure a series of underlying constructs of visual perception holistically. The nine sub-tests include visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S). The individual tests are comprised of a variety of shapes, forms and designs that are arranged in a specific manner to create a pool of varied forms ranging from easy to more complex in terms of perceptual ability. The original VPAT is a paper-based test where the individual forms are

housed in a stand-alone box with a distinctive border (refer to Figure 2). The participant or Foundation Phase learner is then given the instruction to meticulously observe the container and the form found within the housing. Once the participant has accurately observed the form, they are instructed to select an answer from a list of multiple-choice options of forms and designs. This step of the assessment varies depending on the specific visual perception sub-test or aspect being tested. A time limit of nine seconds is allocated to the participant to select an answer from the multiple-choice options on seven of the sub-tests. Visual Memory (VM) and Visual Sequential Memory (VSM) differ in the time allocated for the participant to successfully complete the test. The VM and VSM tests' time range between five and fourteen seconds, depending on the form, to complete. A threshold for all the individual sub-tests is reached when the participants completes three consecutive tests with unsuccessful results.

The forms in each sub-test are presented to the participant in a 'left-to-right' or a 'top-to-bottom' manner of choice. Each sub-test has a series of items, ranging in difficulty as they progress. The first four items in each sub-test are presented in a top-to-bottom design (refer to Appendix E). These items are specifically designed for Grade R learners (i.e. learners aged between four and five) as Foundation Phase learners tend to visually perceive and attend to items in a top down approach (Clutten, 2009). The remaining twelve items in each sub-test are presented in a left-to-right approach. These items have been specifically designed for learners in grade one to three (i.e. learners aged between five to eight) as these Foundation Phase learners have started to learn to read from left to right and this requires visual perception and the ability to concentrate.

For the sake of assessment and to make the evaluation process simpler, Clutten (2009) divided the nine sub-tests of the VPAT into four major categories. These include, (i) visual discriminatory aspects, (ii) visual memory aspects, (iii) visual spatial processing aspects, and

(iv) visual perceptual analytical aspects. These categories have been developed systematically to band together the evaluation of identified aspects of visual perception. This ranges from the meekest level of visual discriminatory aspects, through to higher function levels of visual processing and perception as well as analytical abilities (Clutten, 2009). A more detailed description of each category and sub-test will be presented in chapter two.

For scientific research purposes, all psychometric measures undergo a series of tests to measure the validity and reliability of the tests. A psychological measurement can be understood as the assigning of numbers in a systematic manner as a form of representing or quantifying a specific property or ability of an individual (Allen & Yen, 1979). Brown (2008) noted that psychologists and practitioners are in need of visual perceptual measurement scales that are well-constructed and are used with confidence regarding the perceptual ability that is being tested (Brown, 2008). The VPAT's content analysis was based on various sections of similar available tests and was developed in accordance to each underlying construct's definition. Thus, it is important for the VPAT to undergo a series of factor analysis methods to determine whether the proposed nine factor model is valid and reliable according to the goodness-of-fit and item estimates of the test. This should preferably be done using a different South African sample than the one that was used in the original development of the test.

1.2.3 Standardised Test

A standardised test is a form of measuring a specific phenomenon or context that has been structured in a predetermined, and uniform manner (Popham, 1999). The aim of the development of a standardised test is to construct a tool designed to measure an individual's knowledge, skill or ability in a specific content area or construct. The results allow the administrator to make inferences about particular abilities within individuals in relation to their peers on a cultural, context specific or national scale. A standardised test assists in developing

a norm for a specific construct within a context. These norms can be used to assess an individual's developmental or cognitive functioning in relation to their peers. The VPAT was designed to be a standardised test for visual perception that could be used within the South Africa context to measure Foundation Phase learner's visual perception.

An important aspect of the development of a standardised test is to ensure that the measurement instrument will produce precise, valid, norm-referenced interpretations or quantifications of a specific construct. These tests are usually developed using a specific sample, where the test was designed to be used. When a standardised test is taken from one setting and used in another, the validity and reliability of that scale could potentially become compromised because the individuals are being rated against a sample group that they are not part of. It is therefore important to develop a standardised scale for a specific culture or context. This can be done using two methods, by either altering an already existing measure that becomes specific to a culture or context, or by developing an original measurement scale for the specific context. The VPAT was designed using the second method, where a novel scale was developed in order to measure visual perceptual abilities, but only using a small sample from the Western Cape to determine its validity and reliability. Thus, it is imperative to test the hypothesised nine factor structure of the scale to determine whether the pre-existing model suggesting the latent variable that the test claims to measure, are in fact being measured. Furthermore, it is important to obtain significant levels of reliability and validity using a sample group that is different from those who were used during the development of the test.

1.2.4 Scale Validation

The validation of a psychometric test indicates that the proposed test yields specific measurements that are deemed to be appropriate in terms of the theory. A psychometric test is built from a theory on a psychological construct or phenomenon, and the testing of the theory

can determine, for example, whether the test is testing the relevant constructs (Salkind, 2010). The primary aim of a psychometric scale is to measure, evaluate and quantify a specific psychological construct or phenomenon. Psychometric scales have been developed in the global context, measuring a wide variety of psychological phenomena, including cognitive abilities. It is important for psychometric scales to be validated to determine the underlying constructs that they are testing, as well as their usability in a specific context (Dimitrov, 2012). Only when a psychometric scale has been validated for a specific context, may the information that was gathered via the scale be used to evaluate, improve or intervene with regard to the cognitive or behavioural constructs it was designed to measure.

A factor analysis is a method for the evaluation of factorial validity of psychometric test instruments. There are several methods of factor analysis, and the primary consideration relating to each type of analysis is to examine the underlying constructs and latent structure of the psychological testing instrument. The analysis is used to validate the proposed number of underlying structures and dimensions of the psychological instruments, which are known as factors, as well as the relationships that items from each sub-test share with specific factors. It is used to determine whether each item is specifically measuring the proposed factor or structure based on theory (Brown, 2006).

This type of validation allows for the scientific community to understand how a specific psychometric scale or test may function in different cultures or contexts. Furthermore, the validated measure ensures the researcher or practitioner that the phenomenon or constructs that they aimed to study are successfully captured through the specific scale. The data may then be used to develop theories and to make inferences in respect of that specific context, thus assisting in managing behavioural and cognitive change, or the implementation of intervention. The validation of a scale is divided into two major themes, reliability and validity. The validation

of a scale is determined by analysing the statistical outputs by a variety of methods to authorise statistically significant aspects of a test for the validity and reliability of the measure.

1.2.4.1 Reliability

Reliability is typically defined as the trustworthiness, dependability or consistency of a psychological measure, considering the degree to which a psychometric test or measure is free from confounding variables that result in random error (Field, 2009). The same basic point is stressed in various other definitions, as the following examples show. A reliable measure requires a yielding of the same result across applications when analysed using the same sample group (APA, 2015; Creswell, 2009). When a phenomenon or construct is deemed reliable, it refers to the uniformity and consistency of a measure as it has the same output in the same conditions (Foxcroft & Roodt, 2013). Before a measure may obtain validity, it should first meet standards of significant reliability. If the psychometric measure computes varying results using the same stimuli or data in the same context, there is a lack of value in the results obtained through the specific psychometric measure. Therefore, the reliability of a measure can primarily be referred to as the consistency with which the psychometric test measures what it is designed to measure (Foxcroft & Roodt, 2013; Stangor, 2011).

Reliability can be measured in terms of a series of forms or 'types' of reliability. Each type has been developed and designed to be used in different settings, for different types of scales. The types of reliability measures include: test-retest reliability, interrater reliability, alternate forms reliability and internal consistency reliability. By measuring the hypothesised nine factor structure of the VPAT, the foundation of the validation is established through the internal consistency reliability based on Cronbach's alpha, and this then allows for the testing of the validity of the proposed nine factor structure of the measure.

1.2.4.2 Validity

The validity of a measure is usually defined as the process of analysing what a specific test is trying to measure. Furthermore, it is not a specific property within a psychological measure but rather, a criterion that a psychological measure be valid for a specific purpose or context (Foxcroft & Roodt, 2013). When a psychological measure has been shown to be valid in a specific context, it is possible to quantify the extent to which that measure is measuring a specific phenomenon or construct. Validity of a measure also refers to the degree that the specific measure is uncorrelated with other psychological measures measuring a different construct (Gravetter & Wallnau, 2009).

A series of techniques have been developed to measure the validity of a scale. Each technique has been designed to measure different levels and types of validity in psychometric scales. There are two broad procedures of determining validity, each comprising of different aims and techniques. The first procedure is the content description procedure which includes the techniques of face validity and content validity. The second procedure is the construct identification process, which includes the techniques of construct validity, a measure of correlation with other tests as well as factorial validity among others.

Face validity is determined through the judgement and intuition of the researcher. It does not measure what the test is measuring but rather what it appears to measure. If the measure at first review relates more to the construct it tends to measure, than it does to other constructs, it has face validity. An analysis is concentrated on just the look and feel of a measure to determine the face validity. Face validity is not regarded as a sufficient technique when establishing the validity of a measure as it does not use empirical testing to establish the validity (Dimitrov, 2012).

A second technique at measuring validity is content validity. Content validity is concerned with determining whether the specific content within the psychological measure has the means to represent the holistic sample of the psychological construct it aims to measure (Foxcroft & Roodt, 2013). Content validity is determined by measuring whether a test or scale is capable of measuring the phenomenon in its entirety. The full range of a specific phenomenon is defined as a construct. This construct cannot always be declared objective and is sometimes under the influence of what the professional, who developed the construct, believes that the phenomenon includes. Thus, content validity is also not a sufficient measure of validity as the confounding variable of opinion taints the results (Creswell, 2009).

The first validation technique that uses a statistical analytical procedure to determine validity is construct validity. A measure is deemed to have construct validity when the measure's outputs are consistent with what is hypothesised in theoretical understanding of the phenomenon and measure. Construct validity can also be seen as the first technique in the umbrella term 'construct identification process' which is divided into several techniques, each designed to measure different aspects of the validity within a measurement (Cromhout, 2015; Foxcroft & Roodt, 2013). The sub-categories of this process include: content validity, discriminant validity, convergent validity and finally factorial validity. Discriminant validity, also known as a hetero-trait mono method, is determined when the output of a measure does not significantly correlate to other measures that it is associated with it. Convergent validity, also known as the mono-trait hetero method, is determined as sound when the results are in line and correlate with other measures that are aimed at measuring the same phenomenon or are in tandem on a theoretical basis (Foxcroft & Roodt, 2013).

Factorial validity is determined by analysing the underlying factor structure within a measure through methods of factor analysis. Generally, the broad purpose of a factor analysis

is to summarise data, to easily interpret and understand relationships and patterns within the data (Yong & Pearce, 2013). Factor analysis is a statistical procedure for determining and analysing the interrelationships between constructs or factors within a psychological measure. The primary goal is to uncover the relationships of the set of proposed or hypothesised variables within the measure by analysing the variance between each factor (Stangor, 2011) The use of this technique can allow for the reduction of items within a measure if they are all testing for the same construct. This form of statistical analysis is primarily used with a psychological measure that has been newly developed, or when an existing measure is applied to a different context than the context it was primarily developed for (Green & Thompson, 2003). Methods of factorial analysis have been used for a variety of measures. Starting in the early 1900, factor analysis methods were conceptualised and used to understand how intelligence, or the ‘G’ factor of intelligence could be measured. The method of factor analysis has become an important tool in addressing questions regarding construct validity of a psychometric measure. It has been claimed that the methods of factor analysis are at the core of how a psychological measure, and the psychological constructs within the specific measure, are uncovered and measured (Thompson, 2004). In this dissertation, the use of a factor analysis method was deemed appropriate for evaluating the validity of the VPAT.

1.3 Problem Statement

A variety of studies dating back to the early 1990s have delivered empirical evidence that teachers in the South African context do not possess the ability to instil specific executive skills required for the development of higher-order cognition (Brey, 2016; Kirk et al., 2008). Visual perception has been identified as playing a primary role in the development of academic ability (entry level literacy and numeracy skills) for Foundation Phase learners (Brey, 2016). In turn, the underdevelopment of visual perception is associated with difficulties in daily

functioning and ability in a variety of skills, including learning processes and academic performance (Clutten, 2009; Kranowitz, 2003). It has been claimed that South African Foundation Phase learners have specifically fallen victim to visual perception problems that have led to a wide spread of below standard performance in academia (Brown, Rodger, & Davis, 2003; DoE, 2008; Vlok et al., 2011).

In an attempt to address visual perceptual difficulties faced by South African Foundation Phase Learners, Brey (2016) conducted a literature review on interventions for development of children's visual perception. Her findings suggest that specific constructive play using tactile stimuli create concrete opportunity for the development of specific cognitive ability, explicitly in children, in tasks that relate to visual perception. Based on these findings she subsequently developed the VPAT as an instrument to test visual perceptual abilities in children.

The VPAT was the first psychometric test developed specifically in the South African context that is aimed at measuring Foundation Phase learner's visual perception. Prior to the development of the VPAT psychometric scale, Clutten (2009) claimed that other tests of visual perception were not adequately equipped to measure the multidimensional construct of visual perception for the South African context. Preceding the development of the VPAT, there had been no empirical method for acquiring a quantification on the visual perception constructs such as visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S) in one measure for the South African Foundation Phase population.

Since its development, the VPAT has only been subjected to entry level validation and reliability measurement, specifically only using content and construct validation techniques,

and Cronbach's alpha scores from one sample group in the Western Cape. The measure has never undergone or been analysed using factor validation based on a different sample group from South Africa. Furthermore, certain sub-tests within the measure have never been measured for reliability or validity in any South African context.

When originally testing for reliability and validity of the measure, Clutten (2009) used a sample of 118 Foundation Phase learners (41 from grade one, 34 from grade two and 43 from grade three) from one government school within the Western Cape province, South Africa. The school was required to be representative of an urban population within the Western Cape context, where the language medium of the school was English. Clutten conducted a single administration of the VPAT to this sample in order to determine the reliability of the scale. Using Cronbach's alpha reliability coefficients for each sub-test, her results indicated that the VPAT had reliable to highly reliable Cronbach's Alpha reliability coefficient with scores between sub-tests ranging from 0.72 – 0.84. Clutten (2009), through her results, concluded that the sub-tests within the VPAT and the test itself can be deemed reliable.

The validity of the test was based on content and construct validity. According to the developer, significant content validity of the measure was obtained by basing the construction of the content and items on various related sections of similar international and commercially available tests. However, it is not clear which international or commercial tests were used as a basis for the VPAT. Furthermore, according to Clutten (2009), she referred the items of the test to recognised experts within the field of visual perception test development, and adapted the test according to their recommendations. However, it is not documented which experts were contacted for this purpose or how the measure was altered according to their recommendation. It also appears that construct validity was obtained using Pearson Product-Moment

correlations, that there were significant positive correlations between the sub-tests, and therefore, that the test was considered to have construct validity due to these correlations.

To the researcher's knowledge, there has only been one instance where the VPAT has been used in practice. Brey (2016) analysed the visual perception of 443 grade two Foundation Phase learners from five schools within the Port Elizabeth district in the Eastern Cape using the VPAT. She based her validity and reliability of the measure on the results that Clutten (2002) obtained with her sample in the Western Cape. Therefore, no levels of validity or reliability, in any form, have been conducted on the VPAT using the 443 Foundation Phase learners from the Eastern Cape.

As noted previously, a method of factor analysis is the primary method for understanding the validity of a psychological measure, to rightfully claim that what the test claims to measure, is in fact being measured. A variety of factor analysis methods have been used in this dissertation, each aimed at examining strengths and weaknesses of the analysis method as well as of any psychometric model. The guiding principle was that by using a bifactor exploratory structural equation model, together with three other methods of factor analysis, the problem of using a psychological measure that has not undergone extensive measures of validity will be addressed. The use of all four methods was intended to account for possible misrepresentation of the results due to one specific experimental factor analysis. The researcher hoped that the results yielded by such a reasonably thorough analysis would allow psychologists and practitioners to use the VPAT with more confidence regarding the reliability and validity of the measure, when they apply it to evaluate the visual perception abilities of children in other areas of South Africa.

1.4 Research Objective

The objective of this research dissertation was to examine the underlying factor structure and unidimensionality of the Visual Perceptual Aspects Test (VPAT) and its hypothesised nine sub-scales using a confirmatory factor analysis, an exploratory structural equation model, a bifactor confirmatory factor analysis as well as a bifactor exploratory structural equation model. The unidimensional factor which the VPAT attempts to evaluate is the cognitive ability of visual perception. The research aim of the study was to validate the proposed nine factor structure of the VPAT within the sub-scales of visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S) using a South African sample of Foundation Phase learners from Port Elizabeth.

The primary objective of this research dissertation was thus to conduct a scale validation on the VPAT using a sample from a different region in South Africa, compared to the sample from the Western Cape that was used during the development of the scale. The research questions for this dissertation include:

1. Does the Visual Perceptual Aspects Test hold significant reliability according to Cronbach's Alpha scores using a South African sample of Foundation Phase learners from Port Elizabeth?
2. Does the Visual Perceptual Aspects Test hold statistical significance in terms of the proposed nine factor structure using a South African sample of Foundation Phase learners from Port Elizabeth?

By answering these questions, this research dissertation will hopefully make a valuable contribution in clarifying the conceptual consistency and unidimensionality of the nine VPAT

sub-scales. The research is specifically intended to evaluate the latent factorial structure together with the internal consistency of the hypothesised nine sub-scales of the VPAT. Furthermore, it will evaluate the VPAT's ability to quantify the overall construct of visual perception. To analyse the validity of the VPAT, it is important to look at the goodness-of-fit models of each statistical analysis methods. A variety of different analyses will be used, including the confirmatory factor analysis, exploratory structural equation model, bifactor confirmatory factor analysis as well as a bifactor exploratory structural equation modelling models. The justification for using such a variety of analyses, is that the combination of the different techniques will yield a more trustworthy scientific analysis and evaluation of the hypothesised model structure of the VPAT than would have been the case if only one specific type of analysis was used.

1.5 Motivation to Conduct Study

The cognitive process of visual perception plays an important role in the development of a wide variety of skills in Foundation Phase learners (Palmer, 2002). When an individual's visual perception abilities are inefficient, it could possibly correlate negatively with other developmental markers of learning performance or academic capability and aptitude (Clutten, 2009). In South Africa, the Western Cape Education Department reported that visual perception difficulties and deficiencies are the fundamental factors that predicts an individual's efficacy for educational markers (literacy and numeracy) of development (Vlok et al., 2011). There has been an abundance of research from a variety of contexts that highlight the correlation between an individual's visual perceptual ability and developmental markers, including academic ability (Ayhan, Aki, Mutlu, & Aral, 2015; Braisby & Gellatly, 2012; Robinson-Riegler & Robinson-Riegler, 2004; Warren, 1993).

Since Clutten (2009) became cognisant of the importance of visual perception in Foundation Phase learner's development and its correlation with academic performance, she saw the need to develop a psychometric test specifically designed for the South African context. The VPAT was therefore intentionally developed to easily measure large samples of South African Foundation Phase learners, and to screen them for the efficacy of their visual perception. As the original scale was only subject to a basic validation screening of content and construct validity, and reliability using Cronbach's alpha scores, the researcher realised that it was important to validate the VPAT using an in-depth analysis method to assist psychologists, researchers and practitioners on the use of the VPAT. An in-depth validation study focusing on the VPAT's use in a different region of South Africa will potentially further validate the scale in the South African context, which could theoretically be used to motivate the Department of Education to implement a policy of making visual perceptual testing compulsory in Foundation Phase learners.

Researchers in psychology and other social and behaviour sciences are constantly confronted with the question of whether the measurement scales they are using are valid in terms of the factors underlying the test. Recently, researchers have reintroduced bifactor models as a statistical analysis method to examine the construct relevant dimensionality of a psychometric measure (Gu, Wen, & Fan, 2016). A combination of structural equation modelling and bifactor models has led to an analytic method that specifies a set of covariances among a set of items. The analysis has set parameters within a measurement that is accounted for by a single general factor, as proposed by the psychometric measurement, which in this case is visual perception (Reise, 2012). Using newly developed statistical methods of analysis to determine the factor validity of a psychometric scale is of the utmost importance to measure the value, usability and suitability of the scale in a variety of contexts (Tóth-Király, Bőthe, Rigó, & Orosz, 2017). Therefore, it was deemed necessary to use such methods to analyse the

VPAT for validity and reliability in terms of its hypothesised factor structure and the unidimensionality of constructs related to visual perception.

1.6 Outline of Chapters

This research dissertation is reported in five distinct chapters. Each chapter serves a specific purpose in describing and analysing the research topic. Below is a brief explanation of each chapter.

In chapter one, an introduction and overview of the research is provided. The research problem is addressed, indicating the gap in research and aim of this dissertation. The introduction to the problem is then explained, and the core concepts are explored within the context of the proposed research study, including the definition of visual perception, the description of a standardised test, scale validation and the VPAT.

Chapter two provides a systematic review of the literature relating to all the concepts and constructs used within this dissertation. The chapter begins with a detailed literature review of visual perception. This review includes research about the definition, development, demographics, and theories of various aspects of visual perception. This chapter also includes a theoretical framework in terms of which visual perception can be described. As there has only been one case of validation for the measure, a review on this analysis is then given, followed by a detailed description of the subskills that are being evaluated by the Visual Perception Aspects Test.

Chapter three details the methodological paradigm and framework which the researcher adopted for the analysis of the data. This includes a description of the groundwork for the research, detailing the secondary data from the Visual Perceptual Aspects Test that were gathered by Brey (2016) on 443 grade two Foundation Phase learners from schools stationed

in the Eastern Cape. The chapter further describes the sample group, research setting, data acquisition and data analysis. Finally, the research validity, reliability and ethical considerations are presented.

Chapter four concentrates on the results presented in this research. An in-depth description of the results is provided with regard to both reliability and validity. The results were generated from the variety of statistical tests and analyses that evaluated the internal consistency of each sub-test, together with the model fit and factor structure estimates of the VPAT.

Chapter five focuses on the presentation and interpretation of empirical results gathered in chapter four as well as a discussion thereof. The discussion is reported in terms of psychological theory, and relates the results to the aim and research questions of this research study. The limitations, contributions and recommendations are all presented within this chapter, ending with a suggestion for future research.

1.7 Chapter Summary

This chapter provided an introductory background to the research and an outline of the relative definitions for the main concepts within the research. An exploration of the research problem was given with descriptions of each major construct presented in this research. The research aim of this study is presented as a validation of the Visual Perceptual Aspects Test using a sample of Foundation Phase learners from Port Elizabeth. It is aimed at evaluating and analysing the proposed factor structure, reliability and validity of the newly developed scale using a variety of statistical analysis methods. Reasons for the motivation of the study are described, as well as a summary of the chapters to follow.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Cognitive psychology is a subdiscipline within psychology that can be defined as the psychology of mental processes. Specifically, it is understood as the subject area concerned with research aimed at achieving an understanding of the way in which the brain processes information (Groome et al., 2014). When visual or auditory information is received by the sensory receptors, it is transduced and interpreted in a cognitive process that is known as perception. More generally, perception is the process of interpreting stimuli through the visual, auditory, tactile, olfactory and gustation senses (Ward, 2015). Visual perception is the part of perception specifically concerned with visual stimuli, and may be defined as the cognitive ability to process visual stimuli to understand the things we see, and consequently to identify and distinguish between objects in the world.

The cognitive process of perception enables all humans the ability to learn how to mentally decipher and manipulate visual information, leading to problem-solving and decision making on how to interact and respond to environmental action (Kurtz, 2006). The development of visual perception within paediatric development is an imperative process for children's learning. A child that has underdeveloped visual perception abilities according to their chronological benchmark, may experience adverse difficulties in recognising, memorising and/or organising visual imagery that is required to grasp concepts such as pictorial symbols which are a vital element for learning (Kurtz, 2006).

The measuring and validation of a psychological measure is important for all researchers and practitioners in the field of social science, to ensure that the data they retrieve from testing are accurate and useful. The term validation is actually an umbrella term in social

science and behavioural research. Primarily, it is used to express the obvious, namely that it is necessary to evaluate whether a specific psychological scale or measure is functioning as expected according to the theories the development of the measure were based on. The principal goal for the development of an instrument is to describe, provide, and explain a pattern of cognitive processes, behaviours or phenomena within a specific domain. To reach a sound theory or conclusion, a reliable and valid testing of hypotheses should be conducted to collect accurate data of the constructs or variables being tested. Therefore, it is essential that researchers and clinicians know that the instrument they are using for testing, produces accurate and valid results of the phenomenon under examination (Dimitrov, 2012).

Understanding perceptual development, visual perception and the measurement of visual perception are all aspects that will be considered in this literature review. It is important to bring a holistic viewpoint of what visual perception is, and why it is a difficult construct to measure. As psychometric tests have developed over time, so have the methods for critically analysing the validity of a psychological scale, which is a crucial step in reviewing specific psychological measures in different contexts. A detailed review of perception, visual perception, and scale validation will follow now.

2.2 Perceptual Development

The process of perceptual development is agreed by many theorists to begin at birth (Louw & Louw, 2007). Perception can be defined as an individual's sensory experience of the world, which also involves the analysis of this sensory information (Braisby & Gellatly, 2012). It is a complex set of processes that are responsible for the organisation and processing of sensory experiences to yield an understanding of the external world (Gilhooly, Lyddy, & Pollick, 2014). The processes underlying perception develop in a relatively sequential manner over time (Groome et al., 2014). In cognitive psychology, perception is further defined as the

processors that are responsible for analysing sensory information of the world through our senses (Braisby & Gellatly, 2012). The concept of perception is actually at the core of cognitive psychology. It has a direct bearing on questions of what the nature of the basic psychological abilities are that are vital for healthy functioning in understanding, and also by implication on what it means to be human (Neisser, 2014). Furthermore, research regarding perception is directly related to the science of understanding the fundamental foundation of how the mind makes sense of the sensory experience within the world we live in. Furthermore, research on perception is not just relevant to cognitive psychology, but to all the other disciplines within psychology, including:

- *Social psychology*, which is the investigation of mental processors involved in analysing people around us;
- *Developmental psychology*, which is the understanding how cognition changes over a period of time;
- *Neuropsychology*, which is the understanding the correlations between the cognitive processes and brain activity; and even
- *Industrial Psychology*, which is the understanding how the cognitive processors influence our capabilities and efficacy in a work place (Robinson-Riegler & Robinson-Riegler, 2004).

Perception, recognition and attention can be understood as a tripartite model that is centred around the relationship between the external world and internal mind (Braisby & Gellatly, 2012).

2.3 Visual Perception

When addressing a research problem relating to perception, it is important to understand the construct of 'visual perception'. Our understanding of visual perception has been developed in great detail from a variety of theories over a significant period of time. The next section will focus on defining visual perception, understanding the development of visual perception from a leading theory, including a neurophysiological theory of visual perception within the information processing paradigm, as well as describing types of measures that have attempted to quantify a variety of constructs within this theory.

2.3.1 Defining Visual Perception

Perception allows all animals and humans to adapt to their environment. In order for us to adapt, we are required to be able to detect how the environment around us is in flux. The external world emits a variety of information which are analysed and deciphered by our sensory receptors, and this include an important type of information in the form of energy, known as *light*. The definition of light is complex because it exhibits characteristics of both waves and particles (Serway & Jewett, 2004). However, in the psychology of perception, light is usually conceptualised as a form of electromagnetic radiation, and a mode of propagation of energy that moves through space. The way in which we understand the nature of this electromagnetic radiation is through a pattern of waves, also known as light waves (Bruce, Green, & Georgeson, 2010) When light is made of a single wavelength, we define it as monochromatic. If this monochromatic wavelength of light is detected by our eye, we can decipher the colour that is correlated to that specific wavelength, allowing us to interpret our environment at a singular level (Snowden, Thompson, & Troscianko, 2012).

The psychological study of visual perception has its roots embedded in the philosophical study of the mind. The foundations of theories of visual perception were

developed when René Descartes (1596 – 1650) presented the theory and principle of optics, allowing for the duality between the empirical properties of light and wavelengths, with the psychological properties of vision, the visual experience and visual perception (Bruce et al., 2010). The distinction between these two properties of images and vision, allowed for the modern theoretical conception that visual perception involves more than light entering the eye, but that information must be added to bring meaning to our perception. Therefore, visual perception is now understood as more than just the ability of seeing an image in the world, but as a cognitive process that allows us to make sense of the stimuli we are experiencing, to interact with them and to search for and manipulate objects in the world (Gregory, 1980; Snowden et al., 2012).

2.3.2 The Neuroscience of Vision

Visual information and the coding of visual information begins in the two retinas of the human eyes and the information is then transmitted from the retinas to the primary visual cortex of the brain (Gilhooly et al., 2014). After visual stimuli has entered the retina, the process is continued using a cluster of specialised receptors that transform light waves or energy into a neural transmitter or signal that is then transferred to specific regions within the brain that have unique functions (Gilhooly et al., 2014). Our visual sense, or vision is regarded as one of the dominant senses, as well as one of the most complex as it is able to adapt to the environment at a remarkable rate (Dowling & Dowling, 2016). This is highlighted to us when we find ourselves in a dark space for a short period of time and our eyes adapt to the environment granting us the ability of slowly ‘seeing in the dark’. Our fast adaption to our environment occurs because our retinal rod photoreceptors become intricately sensitive, capable of reacting to as little as a single photon. When our eyes are exposed to light, we capture the light using

cone photoreceptors, allowing us to make sense of details around the world, including colour (Dowling & Dowling, 2016).

The fovea, a region that is found in the centre of each of the two retinas contains a wealth of receptors known as *cones*. Cones are tasked with encoding colour light waves as well as high resolution spatial information. Surrounding the cones is a different type of receptor known as *rods*. The rods specifically encode information regarding motion as well as low resolution form information (Gilhooly et al., 2014). The mapping of visual information that travels from the retina to the cortex follows a systematic retinotopic organisation from the optic nerve, to the thalamus and finally the visual cortex. The regions in the retina and cortex share spatial organisation, that is, regions in the retina and regions in the cortex share neighbouring structures.

The occipital cortex plays a major role in visual processing. In addition to the occipital lobe, the temporal and parietal lobes are also key players in the processing of vision (Zillmer, Spiers, & Culbertson, 2008). These areas are not the only areas that play a role in visual processing. Several other areas within the frontal lobe are responsible for the movement of the eyes as well as the higher processing of visuospatial working memory (Zillmer et al., 2008). The fact that such a large portion of the brain is devoted to the analysis of vision and visual perception indicates the importance of human reliance on the visual sense and thus on perception.

An understanding of the optics of the visual system are required to understand how the process of visual perception is organised. Images are projected onto the retina of each eye by the lens within the eyes. The visual pathways of the optic nerve organise the transmissions of each eye. The right-hand side of the visual world is projected in the left-hand side of the primary visual cortex of the brain. In turn, the left-hand side of the visual world is projected in the right-

hand side of the primary visual cortex of the brain (Wade & Swanston, 2001). As noted earlier, visual perception should not be confused with eyesight. Several children who experienced developmental delays or difficulties may have high functioning eyesight, however, they could nevertheless still have visual perception problems due to a learning dysfunction or a neurodevelopmental impairment.

2.3.3 Visual Information Processing and the Visual System

The eye could be understood as a type of camera that maps visual images on the retina of the eye and transmits these inverted 'pictures' into a form of retinotopic map that is sent to the primary visual processing parts of the brain or cortex (Zillmer et al., 2008). The average adult human is capable of perceiving only a small range of wavelengths that have been measured in existence. The portion of the electromagnetic spectrum that is visible to the human eyes without any form of assistance varies from 380 to 750 nanometres (Sternberg & Sternberg, 2012). The process of vision begins when incoming light passes through the outer protective clear dome of the eye, known as the *cornea*, into the anterior chamber that contains *aqueous humour*, which is a transparent watery fluid (Braisby & Gellatly, 2012). The light is then passed through the *pupil*, an opening in the centre of the iris. As the light travels further through the eye, it passes through the eye's crystalline lens and into the body of the eye known as the *vitreous humour*. At the back of the vitreous humour lies the retina, where the electromagnetic light is converted into neural electromagnetic impulses of energy that are transmitted by neurons to the brain (Sternberg & Sternberg, 2012). These, electromagnetic pulses of energy travel via bipolar cells of the eyes to the ganglion cells, whose axons collectively form the optic nerve of each eye. Each eye's optic nerve are connected at the base of the brain and form the *optic chiasma*, which carry the ganglion cells towards the thalamus, where neurotransmitters

carry the information to the occipital lobe, the centre of the primary visual cortex in the brain (Sternberg & Sternberg, 2012).

As vision can be broken down into components of a physical and mental process, the neurocognitive process of vision is understood to involve the ability of acquiring, creating and understanding meaning of vision from eyesight (Clutten, 2009). When analysing an individual's level of visual perceptual cognitive ability, the concern does not sit with measuring the visual acuity, or how well the person can see, but rather the focus is concentrated on the perceptual understanding that results from what is being seen, or on how the individual interprets the information that is being presented to her. Therefore, the study of visual perception is focused on the processes that develop the abilities to identify, recognise, and interpret aspects related to spaces, distances, sizes, features, attributes and spatial relations of visual information, as opposed to the study of visual acuity alone. When understanding the visual processing system, Warren (1993) presented a hierarchical framework (see Figure 1 below) for visual perceptual skill development within the central nervous system according to the visual information processing theory.

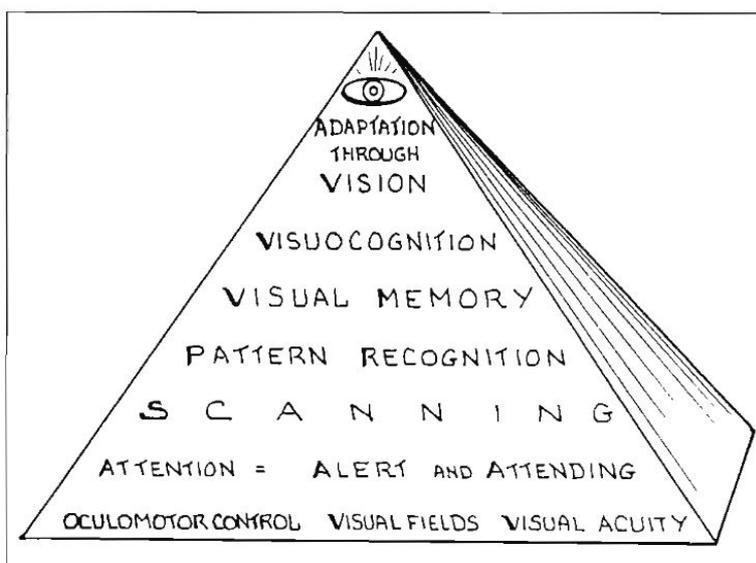


Figure 1: Hierarchy of visual perceptual aspects development in the CNS. Source: from Warren 1993.

According to this hierarchical framework, visual perception can be conceptualised as a hierarchy of skills or levels. Skills at the bottom of the hierarchy form the foundation for each set of skills that sit successive to the foundational skills. According to this model, visual cognition is the highest level of perceptual ability and is dependent on all the supporting levels below it. Here, visual cognition is defined as the ability to cognitively manipulate visual information and integrate it with other sensory information to understand and respond to the external environment (Warren, 1993). Because of this, Warren (1993) stated that visual cognition and perception is the foundation for all academic endeavours.

Research has indicated a significant correlation between the perceptual modality of vision or sight (the reflection of light from a stimulus in the form of electromagnetic waves) and the progression of visual perception (the cognitive process of understanding what an individual is seeing) in academic achievement for early childhood development learners (Clutten, 2009). Thus, research has focused on attempting to understand the processes that lie between visual acuity and visual perception (McBride-Chang et al., 2011).

2.3.4 Theories of Visual Perception

One major theory of visual perception will now be discussed, namely the neuropsychological approach to visual perception in accordance with Marr's (1982) information processing systems (Marr, 1982; 2010). From this perspective, the visual perceptual aspects within the Visual Perceptual Aspects Test are presumed to be logical and coherent, where each sub-test is an ability that can be empirically tested. As the focus of this dissertation is on the validation of the VPAT and not on the theory of visual perception, the theory of information processing from a neurophysiological and neuropsychological approach will be described to give the reader an overview of the development of visual perception, together with the cognitive constructs the VPAT is attempting to measure.

2.3.4.1 Neuropsychological Approach

The link between the psychological theory of visual perception and neural mechanisms is the foundation of neuropsychological theories of visual perception (Gordon, 2004). The premise of neuropsychological theories of perception is on the assumption that perceptual processes and the interpretation of visual phenomena can be explained through neural mechanisms and interactions. Gordon (2004) has suggested that neural mechanisms underlie all behaviour and that a significant number of researchers doing research regarding perception have started to focus on neural mechanisms to explain it. To understand this shift, it is important to first understand the neurophysiology of the neural mechanisms featuring in explanations of perceptual phenomena.

The neuron is a specialised type of cell in its function as it is uniquely used for information processing. Every neuron is anatomically independent from other neurons. Neurons pass information between themselves, however, the neurons in sequence are not physically connected (Wade & Swanston, 2001). The activity in a single neuron leads to a temporary change in a tiny gap known as the synaptic gap between each neuron. Whether the information from the first neuron is passed to the next is dependent on the strength and timing of the changes made in the synaptic gap (Gordon, 2004). It is important to understand that a neural network is a combination of separate neurons, that when combined are understood as a structure, and is not a whole structure in itself (Ward, 2015).

Similar to the structure of other cells, the neuron shares characteristics with several other bodily cells in that the major part of the neuron is the cell body. Within the cell body, structures such as the nucleus, genes, cytoplasm and mitochondria play an essential role in protein synthesis (Zillmer et al., 2008). Every neuron is unique in its shape and size but share four common features including the cell body with a nucleus, dendrites, an axon as well as

terminal synaptic buttons (Gibb, Gray, & Scharff, 2010). The structure and process of the neuron allows for communication with other neurons using axonal firing which emits electrochemical transmission across the neuron synapse, a small gap separating every neuron (Zillmer et al., 2008). During this process, chemical neurotransmitters are produced and released that lead to psychological and behavioural outputs.

Each neuron receives the chemical transmission, or neurotransmitter from other neurons by means of dendrites. The physical appearance of dendrites resembles the look of tree branches, connecting one neuron's dendrites to the neighbouring neuron's cell body (Zillmer et al., 2008). Each neuron often houses thousands of dendrites, differing in amount depending on the function of the specific neuron. It has been estimated that the total connectivity among all the neurons a human has is approximately equal to 10^{15} or 10,000,000,000,000,000 (Posner, DiGirolamo, & Fernandez-Duque, 1997; Zillmer et al., 2008). This neural substructure forms the basis of visual information processing in the brain, which is described below.

Visual information travels along the visual pathway of each eye, along the visual pathways to the occipital lobe. As the visual information leaves the eye, the electrochemical energy travels along the optic nerve to the optic chiasm, a structure in the shape of an X where the two optic nerves cross one another (Snowden et al., 2012). It is here where visual information from both eyes partially joins and decussates, crossing over to the contralateral side of each eye (Wright, 1998). As the visual information flows down the nerves, each hemisphere takes control of different visual fields. The left hemisphere of the brain processes information entered from the right visual field, and vice versa for the right hemisphere (Zangemeister, Stiehl, & Freksa, 1996). It is important to note that the visual fields not only process on contralateral sides, the information is also reversed from top and bottom. Although it is understood that the occipital lobe is the primary cortex for processing vision, it is important

to state that majority of visual perception processors are not completely understood and that more research is required to fully understand the phenomenon from a neuropsychological perspective (Zillmer et al., 2008).

2.3.5 Visual Perception and Brain Development

A significant portion of the cerebral cortex is dedicated primarily to the processing of visual perceptual information. Different types of visual functions rely on different areas of the cortex, as well as a variety of different processes devoted to perception, including visual perception. Recent research on visual perception, early brain development and neurology has highlighted that visual perception relies on a complex network of cortex structures, including, but not limited to, the optic radiations and the primary visual cortex, the frontal and temporal lobe, as well as the basal ganglia. Each of these cortical and subcortical areas play a role in visual functions and consequently in visual-spatial abilities (Farroni & Menon, 2008; Gibb et al., 2010; Snowden et al., 2012).

During the first few months of a new-born's life, the visual system is developing at an exceptional rate. The human eye grows to three times the size it was at birth within the first three years of the child's development. At birth, the pupils are unable to dilate fully, and the curvature of the eye ball is almost spherical. By three months of age, an infant starts to gain cortical control of their eye and head, starting to make movements to allow for attentional switching (Farroni & Menon, 2008). At this age, visual attention and visual search abilities begin to develop. By the age of six months, infants are able to visually analyse objects that they are holding. This is due to a more coordinated ocular movement that allows them to become aware of their visual environment. By nine months of age, visual acuity has developed, and infants are able to visually identify and explore items in their tactile proximity and environment. At the first year of age, the infant's visual perception has developed to a level

allowing them to imitate expressions by others, as well as recognise object permanence, understanding that when an item has left the visual field, it still exists within the world (Kurtz, 2006). When the infant is about two years-of-age, the myelination of the optic nerve has been completed or is nearing full development. Optic abilities as well as acuity have developed fully, allowing for smooth coordination. By the third year of age, retinal tissue has developed fully, and the infant's brain functions seem to have reached adult development in terms of basic sensory cognitive abilities. Between the ages of five and seven, most of the known basic functions of early visual perception and sensory function as well as the areas within the cortex have completed development. However, a variety of functional developments and complex visual perceptual abilities are still in their infancy and will only develop during the post-puberty stage (Farroni & Menon, 2008).

According to Gardner (1996), the construct of visual perception is a complex combination of several relatable abilities that are assumed to be interdependent upon each construct. Marr's (1982) computational approach to visual perception examines how the processes in the visual system extract information from proximal stimuli. Here, visual information is organised and analysed as a system of different processes that relay feedback from systems within the receptive fields in the visual cortex.

2.3.6 Aspects of Visual Perception

As previously discussed, visual perception can be understood as a complex process that is a result of the interaction and response to visual stimuli found in our environment (Zimbardo & Gerrig, 1996). The reason for the development of visual perception skills is to allow individuals to make sense of what is happening in their environment and to associate these experiences with their own mind and body within the external world (Ayhan et al., 2015). Visual perception is thus the capacity to interpret or give meaning to what is seen by an

individual, and it includes the abilities of recognition, insight, as well as the interpretation of this incoming information at the higher levels of the central nervous system (Gardner, 1996). Furthermore, visual perception is an important aspect of an infant's understanding of their environment as approximately 70% of all sensory receptors are located within the human eye (Ayhan et al., 2015).

Focussing on the measurement of perceptual abilities in young children, Clutten (2009) developed the VPAT to test nine visual-perceptual subskills. Each sub-test is made up by 16 items which are strategically arranged to be progressively more challenging. The abilities of visual perception that are evaluated by the VPAT have been separated in a collection of visuo-perceptual constructs, which include visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S) (Clutten, 2009).

The Test of Visual Perceptual Skills – Revised (TVPS-R), a commonly used instrument designed to evaluate visual perceptual aspects of vision, that was developed by Gardner (1996), evaluates seven visual perceptual subskills which have been included in the VPAT, namely, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), visual closure (VC) and visual figure-ground (VF-G) (Brown & Gaboury, 2006). An introductory definition for each of the nine visuo-perceptual constructs included in the VPAT is detailed below.

2.3.6.1 Visual Discrimination

The definition of visual discrimination is stated differently across literature depending on what approach a researcher or author used as the starting point. The American Psychological Association (2015) defines visual discrimination as the ability to distinguish or discriminate

forms, shapes, patterns, figures, or object from any similar object or form that is different in a refined way. This definition is logical if defined in accordance with information processing of visual perception because the visual cortex contains a variety of cells that respond differently to lines, edges, and forms, depending on the orientation of the stimuli (Gordon, 2004). Generally, the consensus is that visual discrimination is a visual observation and awareness of several distinct characteristics of an object or form that are understood as having similarities or differences (Norman, Todd, Norman, Clayton, & McBride, 2006; Paukner, Huntsberry, & Suomi, 2009). It is the ability to discriminate between the domineering and presiding features within a specific shape, object or form (Brown et al., 2010; Nilsson & Warrant, 1999). Previous research has hypothesised that an individual should be cognisant of specific features of an item or object in order to achieve visual discrimination between other similar items or objects, and should also have acquired the concept of 'numerousness' (Horner & Comstock, 2005).

Numerousness can be characterised from two perspectives, either comparative or absolute, depending on the size of the judgements required on a shape or form (Kaufman, Lord, Reese, & Volkman, 1949). The concept of numerousness was developed to describe the property of a collection of forms or objects that an individual may not distinctly judge, but where they can nevertheless distinguish between clusters or groups of forms (Kaufman et al., 1949). Judging a series of objects from the point of numerousness, where different shapes are perceived by different receptor cells and neural networks within the visual cortex and system, allows the individual to discriminate between the number of object types within a scene. For this reason, Horner and Comstock (2005) suggest that visual discrimination is not only due to the process of identifying distinct features within an object or form, but also to the ability to distinguish between objects because specific features may be more salient within one object or form than others. Here, the visual information is analysed by discriminating between different forms that are perceived by different receptor cells within the visual system.

2.3.6.2 Visual Form Constancy

Visual form constancy is a construct used in the explanation of visuo-spatial processing that relates to an individual's ability to find a form (shape or object), or to match a form, whether it has been transformed by size as either bigger, or smaller. Furthermore, it is the ability that allows participants in an experiment to examine a form to determine whether the shade has been transformed lighter or darker, or has been turned in any direction (Allison, 2000). In simpler terms, visual form constancy is the ability to recognise a form or object, even though the object looks slightly different to the viewer compared to the original form (Kurtz, 2006). Within visual form constancy, a construct known as brightness constancy describes the ability to perceive an object as having the same contrast of brightness under different conditions. An example of this construct can be easily explained when one thinks of a piece of blank white paper as having a similar brightness between midday and dusk, even though the energy or light that is being reflected from the paper could possibly be very different at these two different times of day (APA, 2015).

When an individual suffers from deficits in visual form constancy, as is the case with individuals who have been diagnosed with *visual form agnosia*, they have a difficulty in perceiving the shape, size or orientation of an object (Bruce et al., 2010). An individual with a deficit relating to visual form constancy may possibly struggle with daily functions such as recognising letter structures when they are presented in other forms. For example, when a letter is presented in a different form, or written or upper case, lower case, bold or italics, the individual will have difficulty in recognising what that letter is (Clutten, 2009).

2.3.6.3 Position-in-Space

The construct of position-in-space can be understood as directly correlated to the definition of spatial ability. Spatial ability is defined as the skill and process that allows an

individual to comprehend relationships between objects in space, including the ability to orient or perceive one's own body in space. It is also the ability to detect or to reason about the relationships and correlations within or between the self and objects in space (APA, 2015). Psychometric tests of position-in-space are aimed at measuring an individual's ability to combine or to match two similar figures in terms of the common features they share (Clutten, 2009). An individual who struggles with position-in-space may find it difficult to determine the difference of spatial orientation of numbers or letters, such as b and d, or p and q. This difficulty may relate to the distinction of position between where the circle lies on the line between b or d (Brey, 2016).

2.3.6.4 Visual Memory

Visual processing and visual memory form part of the most important components of visual processing within the brain. Visual memory can be understood as a form of declarative memory, involving the skill of an individual being able to judge whether they have encountered a visual stimulus before (Khan, Martin-Montanez, & Baxter, 2011). Gardner (1996) defines visual memory as the ability to remember, for the purpose of immediate recall, the characteristics of a specific form, together with the ability to identify that form from an array of similar forms. Visual memory is defined by the APA (2015) as the capacity to remember what has previously been seen in the form of visual images. It is then understandable to view visual memory as any type of memory where the stimuli or stored information was initially acquired through the visual system or visual perception. A second understanding of visual memory is that all visual memories or perceptual representations of a previously viewed piece of information that has been retained by means of topographic and metric properties of the originally viewed perceptual state (Hollingworth & Luck, 2008). In retrospect, the first definition is not clear enough and the second is too narrow in terms of encompassing all aspects

of visual memory. Thus, visual memory could be understood to encompass all representations of memory that maintain and recall information about the visual and perceptual properties of a previously viewed stimulus (Hollingworth & Luck, 2008). Visual memory is the cognitive ability to assist us in remembering what we have previously encounter visually, allowing us to read, spell, write and a variety of other skills required to excel in an educational setting (Eberman & McKelvie, 2002).

2.3.6.5 Visual Sequential Memory

Visual sequential memory can be broadly defined as an individual's competency or ability to recall a variety of numbers, letters, shapes, forms or objects in the correct sequential order (Mohammed, Rashed, & Shirmohammadi, 2017). This cognitive ability is crucial for functioning within society as it allows us the skill to remember names, places, phone numbers, directions and all activities that require a formal sequence to complete. In school, learning is required to recognise a variety of letters in a sequence, as well as to recall the specific word that is represented by such a sequence (Brey, 2016).

The ability to encode a letter order in an effective manner could possibly play a major role in forming precise orthographic units, where the letter sequence are directly correlated to the word's corresponding phonemic structure (Holmes, 2012). As such, a child or learner who has a substantial amount of difficulty in visual sequential memory will often exhibit this deficit when attempting to remember numbers or letters in sequence, such as the words as was/saw or reserve/reverse. When attempting to copy from a textbook, board or even recalling an event, VSM is required and a lack of this skill will result in a decline in correct output. Pathologies associated to an absence of VSM could include dyslexia or dyscalculia (APA, 2015; Giles & Terrell, 1997).

2.3.6.6 Visual Closure

Gardner (1996) defined visual closure as the ability to identify and determine that a form that is partially incomplete is identical to an original or stimulus form that was previously observed. Visual closure is conceptualised as the ability to identify a familiar object or form from an incomplete or defragmented visual presentation of information (APA, 2015). It can be understood as the cognitive ability that enables us to recognise a variety of forms and objects that have missing parts or are not completely visually presented. This ability allows for us to recognise an object faster by mentally completing the missing parts of the visual stimuli by recalling the completed visual stimuli from a previous experience (Kurtz, 2006).

2.3.6.7 Visual Figure-Ground Discrimination

There are a variety of theories that try to explain the attentional and organisational process that divide regions of our visual field by distinguishing between a figure and the ground that it supposedly falls onto (Snowden et al., 2012). A figure is understood to be the stimulus or object that is processed as standing in the forefront of the attentional visual space. The ground is understood as the backdrop where the figure is situated within the visual space (Zimbardo & Gerrig, 1996). Kurtz (2006) state that visual figure-ground discrimination is the ability to separate the foreground from the background, allowing us to attend to relevant details within the presentation of visual information. In simpler terms, it is described as the skill to distinguish a shape or object from the background (Cortiella & Horowitz, 2014).

2.3.6.8 Visual Spatial-Relationships

The APA (2015) defines a visual-spatial ability as the skill to comprehend and conceptualise objects in terms of their spatial relationships when performing tasks such as reading a map or navigating a maze. It is the cognitive ability to conceptualise objects in space

from different perspectives as well as executing a variety of various visual spatial processes (McBride-Chang et al., 2011). It is understood to be the skills an individual develops in order to be aware of or recognise and identify an object in two- and three-dimensional orientations (Brown & Gaboury, 2006). Here, an individual's ability to position the orientation of the object, as well as the orientation of the self is understood as the visual spatial relationship. It is the skill that allows the individual to be able to distinguish between the orientation, and space, of left from right, up from down, top from bottom. This ability is learnt together with the psycholinguistics of using the specific language to describe each relationship (Kurtz, 2006).

2.3.6.9 Visual Analysis and Synthesis

Visual analysis is understood as the ability to perceive, break apart, and understand objects, forms, shapes as well as words. A difficulty in visual analysis results in deficits related to written words, which could be characterised as visual word form dyslexia (APA, 2015). On the other hand, visual synthesis is the cognitive ability to assemble parts of an object, form, or word. The parts of a word that are assembled by the skill of visual synthesis include letter combination, syllable use as well as the syntactic aspects of word development (Clutten, 2009). Visual synthesis is an imperative perceptual construct as it allows for the building up of all visual information that was analysed and compounded into each specific visual perceptual component. Without the ability of visual synthesis, the constructs of visual perception would not end in the result of allowing us to understand our visual environment (Wade & Swanston, 2001).

2.3.7 The Visual Perceptual Aspect Test

The Visual Perceptual Aspects Test was developed after Clutten (2009) recognised the need for a context specific test of visual perception that is aimed at evaluating a collection of visual perceptual constructs or abilities. She developed the test to measure four umbrella

aspects of visual perception based on a variety of measurement scales that have been developed in North America. These aspects include a collection of constructs of visual perception, namely, visual perception discriminatory aspects, visual memory aspects, visual spatial processing aspects and visual analytical aspects. The four combined aspects all measure constructs of visual perception individually under what is defined as a sub-test. The sub-tests include measuring visual discrimination, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S). Together these tests quantify the ability visual perception in the South African context. As previously mentioned, Clutten (2009) categorised all the sub-tests into four aspects of visual perception for assessment and evaluation purposes to understand each construct of visual perception easier. The description of each aspect, together with the sub-test that fall in each aspect shall be explored in detail with examples from the VPAT.

2.3.7.1 Aspect 1: Visual Perception Discriminatory Aspects

All types of shapes, designs and forms may share or be completely unique in terms of distinctive features. These distinctive features include size, colour, proportion, positional orientation and directional rotation of the shape or design (Brey, 2016). An individual's awareness or cognitive perception of each distinctive feature in any type of form, shape or design reflects an ability regarding the discriminatory aspects of visual perception (Clutten, 2009).

Three sub-tests are clustered together under the discriminatory aspects relating to visual perception. These include visual discrimination, visual form constancy as well as visual spatial relationships, where each is used to assess and evaluate an individual's level of visual discrimination of visual perception. The visual spatial relationship sub-test is categorised under

the visual perception discriminatory aspects, however, the sub-test also shares similarities to visual spatial processing aspects and shall be described later in this section.

The first sub-test, visual discrimination is designed to measure, assess and evaluate an individual's ability to merely be conscious of and empirically note the similarities and/or differences regarding the distinctive features of the form, shape or design.

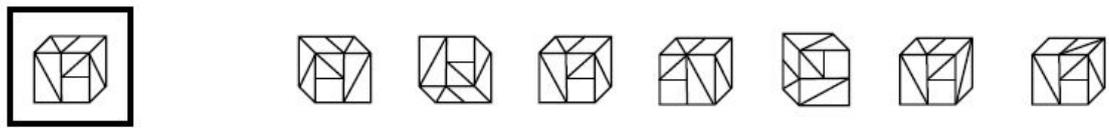


Figure 2: An example of an item from the Visual Discrimination sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

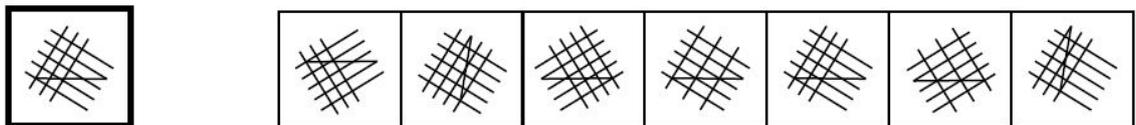


Figure 3: A second example of an item from the Visual Discrimination sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The second sub-test, visual form constancy is designed to measure, assess and evaluate an individual's ability to discern and/or identify a form, shape or design irrespective of its size, colour, proportion, positional orientation and directional rotation of the shape, design or form.

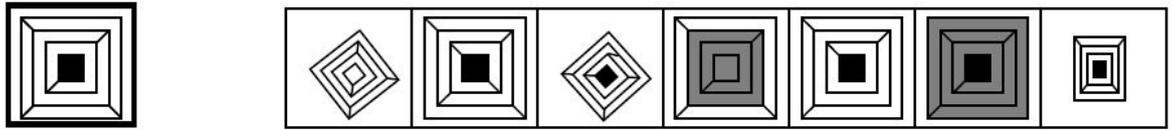


Figure 4: An example of an item from the Visual Form Constancy sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

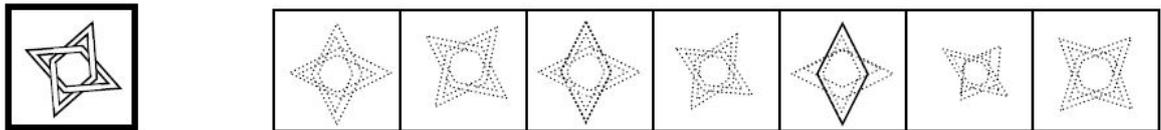


Figure 5: A second example of an item from the Visual Form Constancy sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

Both the visual discriminatory and visual form constancy sub-tests are identical in their construction, presentation, administration and scoring in the Visual Perceptual Aspects Test. All of the items are represented in a multiple-choice format, gradually increasing in choices, chunks or ‘bits’ of information and complexity as the individual progresses through the sub-test (refer to Appendix E for the full Visual Perceptual Aspects Test and scoring sheet). The individual being assessed is first given a concrete example of the sub-test to explain and facilitate a clear understanding of what is required of them. This is to minimise possible confounding variables, which could include test anxiety or a misunderstanding on how to complete the test. An example of how to engage with the measurement is given to the individual to show a concrete sample of what the visual discrimination sub-test will offer. This is to make the participant carefully aware of differences and similarities within a shape, form or design using various plastic shapes and multi-sensory inputs that require visual, somatic and auditory response.

The researcher conducting the measurement also carefully demonstrates to the participant, by use of an existing example, the difference between a two-dimensional and a three-dimensional form, shape or design. Each sub-test is arranged from easy to more complex forms through 16 distinct and discrete plates that are arranged to this difficulty. The instructions direct the participant to meticulously observe the form, shape or design that is housed in a clearly marked square with a distinctive boarder. The aim of the sub-test is for the individual to identify and highlight the identical form, shape or design in a multiple-choice selection of forms, shapes and designs.

The forms, shapes or designs are presented to the participant in either a top-to-bottom presentation of multiple-choice type answers or in a left-to-right presentation of multiple choice answers. The first four items in both the visual discriminatory and visual form constancy sub-tests (as they are identical in presentation) are presented in a top-to-bottom format and have been designed with the premise of accommodating for Grade R learners. This format is similar to the Beery VMI Developmental Test of Visual-Motor Integration (Harris, 2017). The last twelve items within the two sub-tests are presented in a left-to-right format, which is similar to the structure that was used in the test of Visual-perceptual Skills developed by Gardner (1996). The principle concept behind this type of structure when developing the format of the sub-test is that children developmentally perceive, and visually interpret forms, objects or shapes in a top-to-bottom approach. While children are learning to read, they are required to track their visual field from left to right, taking on a left-to-right format, as the remaining twelve items are presented in the sub-tests (Holšánová, 2008).

The selection of items for the participant or learner to choose from will progressively increase from two to seven multiple choice answers. The progression will be standardised as follows for the different educational groups: Grade R = two items, Grade one = three items,

Grade two = four items and Grade three = seven items. As the progression increases, the items within the sub-test are subject to diminution and become increasingly complex in nature, that is, the form shape or design become more detailed in observation and more difficult to discriminate between.

In the administration of the computerised version of the Visual Perceptual Aspects Test, the participants select their perceived choice or answer by pointing at their selection among a multiple-choice display of response on a touch display screen. The participants are allocated a total of nine seconds during which they have to select an answer from the selection of possible answers on the multiple-choice answer display. The developer noted that this reduces the motor component required for testing. The test is also capable of accommodating for participants who are physically disadvantaged to point (i.e. a participant with a spinal injury, cerebral palsy or neurological disorder affecting their motor cortex) who would blink or nod in validating their answer when an administrator points to a specific selection or response. Each time a participant selects the correct response, they positively gain one mark which are all added together to provide a raw score for each specific subtext.

2.3.7.2 Aspect 2: Evaluation of Visual Memory Aspects

A variety of cognitive aspects influence and facilitate the development of visual memory. These include identification, attention, visualisation, recognition and recall (Clutten, 2009). There are two sub-tests in Section 2. The two sub-tests include visual memory and visual sequential memory. Both sub-test measure, assess and evaluate an individual's level of visual memory aspects that facilitate visual perception.

The third sub-test within the Visual Perceptual Aspects Test is visual memory. Visual memory is designed to measure, assess and evaluate the participants ability to visualise, recognise and recall a stimulus that was visually presented to them. In this task, visual spatial

memory is also being evaluated as the participant is required not only recognise and recall the stimulus, but also to visualise whether the presented stimuli have been transposed in any form, measuring mental rotation by rotating the object to a certain degree.

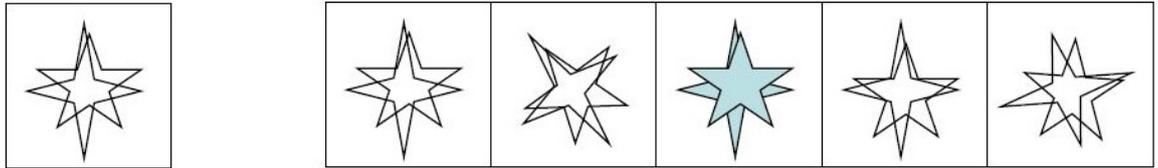


Figure 6: An example of an item from the Visual Memory sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

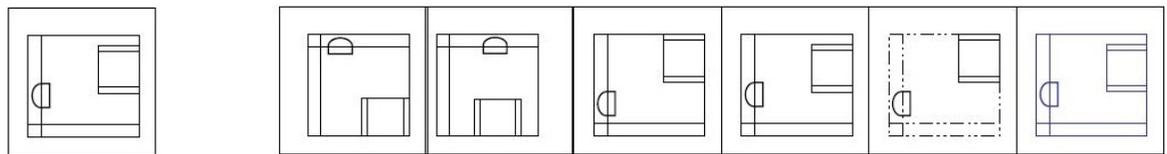


Figure 7: A second example of an item from the Visual Memory sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The fourth sub-test, visual sequential memory is designed to measure, assess and evaluate an individual's ability to distinguish and recall information that is presented in a sequential nature. To identify and hold a 2- or 3-D represented sequential pattern of forms in the working memory and then to be able to accurately recall it. The subtest is designed to evaluate the learner's ability to remember an ambiguous sequential pattern of a visual stimulus previously seen. Visual sequential memory requires over and above visual perception, the specific constructs of visual attention, visual scanning, reasoning, comprehending and planning.

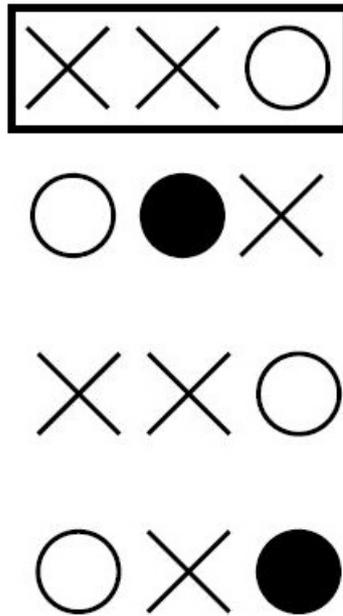


Figure 8: An example of an item from the Visual Sequential Memory sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

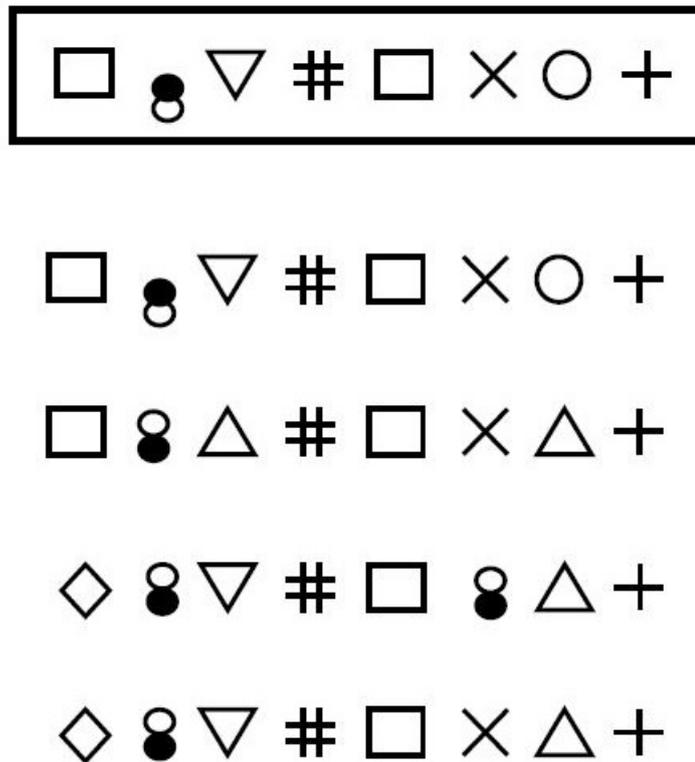


Figure 9: A Second example of an item from the Visual Sequential Memory sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The visual memory aspects and visual sequential memory aspects sub-tests are identical in their construction, administration and scoring in the VPAT. Both the sub-tests consist of 16 discrete individual plates or bars containing a single form that is presented in a multiple-choice format arranged in ascending order from the easiest level, moving to a more complicated advanced, progressively refined level. The participants are instructed to visually concentrate at the initial plate that contains a single form and that they may view for a specific amount of time. In the visual memory sub-test, an 8 second timeframe is given to participants who are younger than a certain age, and 4 to 5 seconds for older participants. In the visual sequential memory sub-test, different time allocations are granted for different items. 5 seconds for 2 to 3 sequential forms (items 1 - 5); 9 seconds for 4 to 5 sequential forms (items 6 - 9); 12 seconds for 6 to 7 sequential forms (items 10 – 13); 14 seconds for 8 to 9 sequential forms (items 14 - 16). For both sub-tests, they are completed once all items have been answered or if three consecutive unsuccessful responses are given.

2.3.7.3 Aspect 3: Visual Spatial Processing Aspects

An individual's cognitive and perceptual ability to comprehend the orientation of visual information in two-and three- dimensional space is known as the construct of visual spatial processing (Clutten, 2009). The visual spatial process is vastly complex and involves multiple, distinct, yet interrelated components (i.e. the fundamental ability and process to discriminate between a variety of forms, to rotate forms in spatial mental space, to scan, to analyse and to compare forms in space) (Braisby & Gellatly, 2012; Brey, 2016). Section three comprises of two sub-tests, namely, visual spatial-relationships and position-in-space. Both sub-tests are designed to measure, assess and evaluate an individual's visual spatial processing aspect of visual perception. The fifth sub-test, visual spatial-relationships (VSR), specifically measures, assesses and evaluates the individual's ability to be conscious of a design that has been

transposed in some form, yet retaining its identity (i.e. to become inverted, to be rotated or to be mirrored). It evaluates the individual's ability to consciously determine the one form, from amongst a variety of forms, that is facing a different direction (Gardner, 1996). The sub-test also requires skill in visual attention, visual scanning, directionality, reasoning and comprehension over and above the Visual Spatial process (Clutten, 2009).

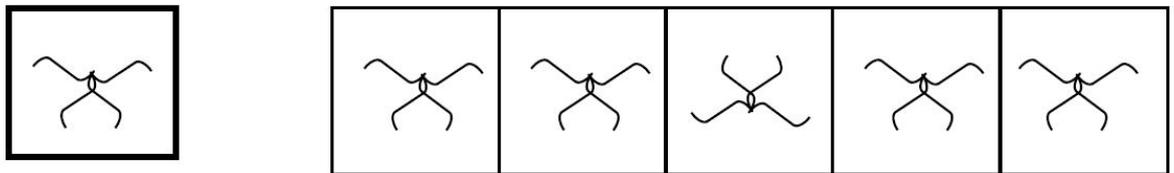


Figure 10: An example of an item from the Visual Spatial-Relationship sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

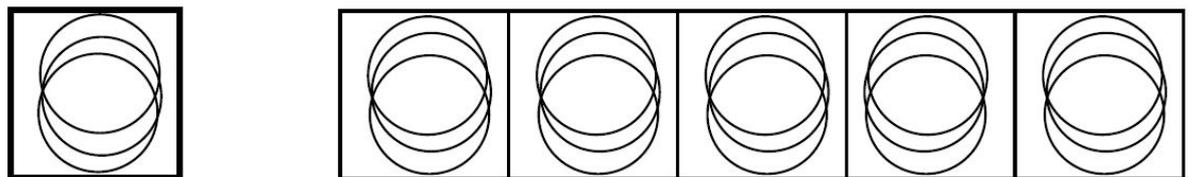


Figure 11: A second example of an item from the Visual Spatial-Relationship sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

Sub-test six, position-in-space (P-S) is aimed at measuring, assessing and evaluating the individual's or participants ability to become aware of the spatial orientation of objects, first to the self and then to other objects (Clutten, 2009). Over and above to the ability of position-in-space, the individual requires ability in visual attention, visual scanning, laterality, reasoning and comprehension.

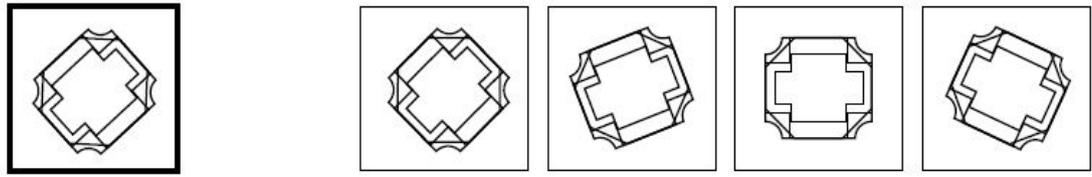


Figure 12: An example of an item from the Position-in-Space sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

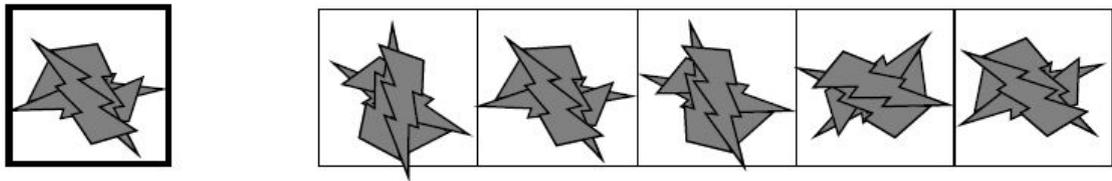


Figure 13: An example of an item from the Position-in-Space sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The task of this sub-test is to locate a 2- or 3D view of a specific form which is presented in the same directional position as the target form. The time allocation varies between two to nine seconds depending on the individual's age as well as the item's level of difficulty. The sub-test is completed after all 16 items have been answered without three consecutive unsuccessful responses, or three consecutive unsuccessful responses were given. For both the visual spatial-relationships and position-in-space sub-tests, the construction, item development of the sixteen discrete items per sub-test, administration and scoring are identical to the sub-tests within the visual perception discriminatory aspects in Aspect 1.

2.3.7.4 Aspect 4: Visual Analytical Aspects

The final three sub-tests within the VPAT which collectively are categorised under Aspect 4: visual analytical aspects. The visual analytical aspects require a higher level of processing of visual perception. The sub-tests include visual closure, visual figure-ground and

visual analysis and synthesis. Each sub-test specifically measures, assesses and evaluates the individual's ability regarding the visual perceptual analytical aspects of visual perception (Clutten, 2009). Each sub-test will be described below with figures to illustrate examples from within each test.

Sub-test 7, visual closure (VC), measures, assesses and evaluates the individual's ability to recognise specific clues in the visual array and determine the final percept, without all the details being present or visible.

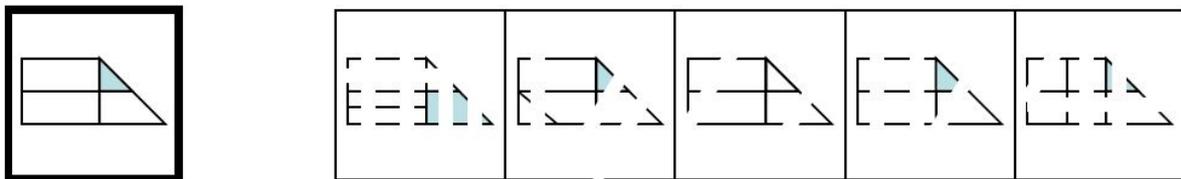


Figure 14: An example of an item from the Visual Closure sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

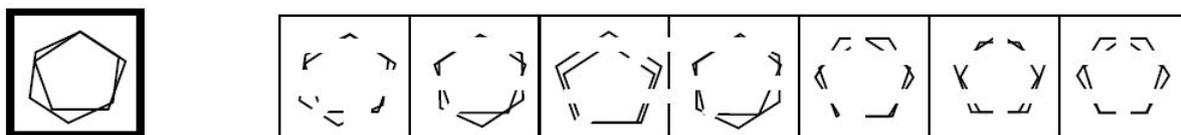


Figure 15: A second example of an item from the Visual Closure sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The task of the sub-test is to locate the identified form, even though it is incomplete in presentation in the array of possible correct forms. Its purpose is to evaluate the individual's ability to identify and become aware of the target form's clues to a complete form from an incomplete visual representation of the target form. An above average score in visual closure (VC) requires ability over and above VC in visual attention, visual memory, reasoning and comprehending the task. The time allocation varies between two to nine seconds depending on the individual's age as well as the item's level of difficulty. The sub-test is completed after all

16 items have been answered without three consecutive unsuccessful responses, or three consecutive unsuccessful responses were given.

Sub-test 8, visual figure-ground (VF-G) measures, assesses and evaluates the individual's ability to attend to as well as identify specific forms while remaining conscious of a relationship between the specific form and the information presented within the background. The individual is required to locate the same 2- or 3D form view even though it has been placed within a background of other stimuli.

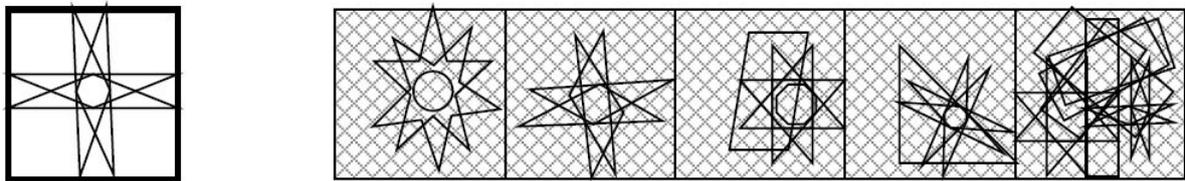


Figure 16: An example of an item from the Visual Figure-Ground sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

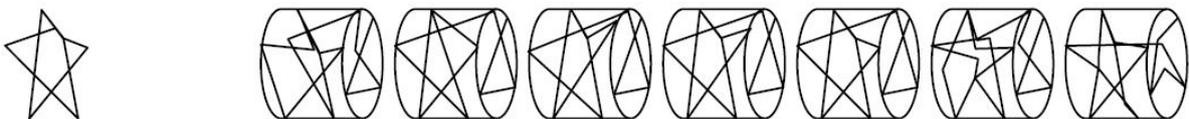


Figure 17: A second example of an item from the Visual Figure-Ground sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The primary purpose is for the individual to attend to the target form whilst sustaining an awareness of the relationship this form or feature has to the background information the form/feature is found within. Together with visual closure (VC), visual figure-ground (VF-G) requires over and above the abilities of visual attention, reasoning, comprehending as well as visual scanning. The time allocation varies between two to nine seconds depending on the individual's age as well as the item's level of difficulty. The sub-test is completed after all 16

items have been answered without three consecutive unsuccessful responses, or three consecutive unsuccessful responses were given.

Sub-test 9, the final sub-test within the section of evaluation of visual analytical aspects as well as the Visual Perceptual Aspects Test is visual analysis (VA) and visual synthesis (VS), in tandem as visual analysis and synthesis (VA/S). The sub-test measures, assesses and evaluates the individual's ability to analyse (specifically break-up) a represented form of visual information, or to synthesise (specifically re-assemble) a form of visual representation. The sub-test's purpose is to evaluate the capacity to analyse, assemble and disassemble 2- or 3D forms presented to them. The individual tests within the sub-test alternate between VA and VS in chronological order.

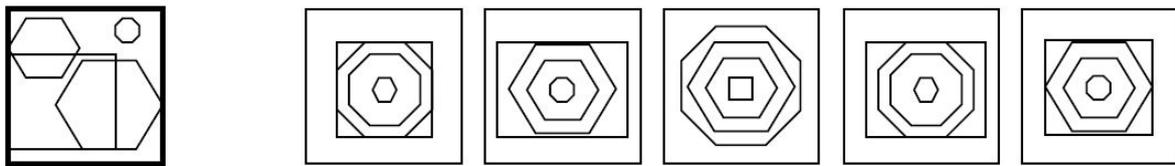


Figure 18: An example of an item from the Visual Analysis and Synthesis sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

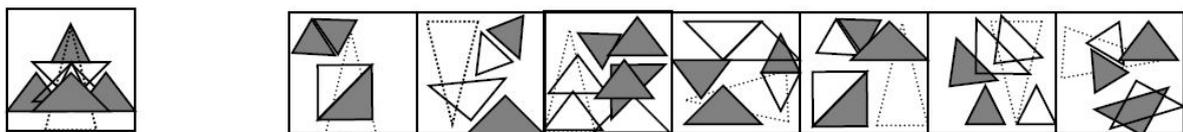


Figure 19: An example of an item from the Visual Analysis and Synthesis sub-test of the Visual Perceptual Aspects Test (Clutten, 2009).

The participant is tasked with analysing/breaking-up/assembling a represented form that is presented to them. The time allocation varies between two to nine seconds depending on the individual's age as well as the item's level of difficulty. The sub-test is completed after all 16 items have been answered without three consecutive unsuccessful responses being given.

For all three sub-tests, visual closure, visual figure-ground and visual analysis and synthesis, the construction, item development of the sixteen discrete items per sub-test, administration and scoring are identical to the sub-tests in the visual perception discriminatory aspects of Aspect 1.

2.4 Reliability of the VPAT

To the researcher's knowledge, the VPAT has been administered in two settings. The first was during the development of the psychometric scale when Clutten (2009) administered the VPAT to 118 Foundation Phase learners who were enrolled at a government school within the Western Cape Province, South Africa. The second was by Brey (2016) whose pre-test data on 443 Foundation Phase learners, which is used as secondary data in this research dissertation.

According to Clutten (2009) her sample was representative of an urban population within South Africa. According to Clutten (2009) the VPAT has good internal consistency, with Cronbach's alpha coefficient values reported at ranging from 0.72 to 0.84. A Cronbach's alpha value for Visual Discrimination (VD) was reported at 0.72. The analysis for VD was conducted using 13 items within the sub-test as she excluded items that correlated low or contributed negatively to the total of the sub-test. However, in the final test, these items were included in the sub-tests. The Visual Spatial Relationships (VSR) sub-test had a Cronbach's alpha value of 0.81 using 14 items in the analysis. Position-in-Space (P-S) had a Cronbach's alpha value of 0.84 using 15 items in the analysis. Visual Closure (VC) had a Cronbach's alpha score of 0.74 when using all 16 items within the sub-test. Visual Figure-Ground (VF-G) had a Cronbach's alpha score of 0.80 using 15 items within the sub-test. Lastly, Visual Analysis and Synthesis (VA/S) had a Cronbach's alpha value of 0.72 using 15 items within the sub-test.

Clutten (2009) omitted the sub-tests of Visual Memory (VM), Visual Sequential Memory (VSM) as well as Visual Form Constancy (VFC). VM as well as VSM were omitted

from her analysis due to administration difficulties that she experienced during her testing of the measure. Furthermore, the Visual Form Constancy sub-test was omitted from her results due to the fact that the Cronbach's alpha coefficient values were reported at 0.48 even after identified items that correlated low or contributed negatively to the total of the sub-test were omitted. She defended this result with a variety of reasons. Firstly, she argued that it could be that the learners interpreted the instructions inaccurately due to the instruction not being clear enough or the participants not attending to the instruction. Secondly, she contended that the test items may have been at a much higher difficulty than what the learner could manage at their stage of cognitive development in visual perception. Thirdly, she hypothesised that her sample group's visual perceptual discriminatory aspects of visual form constancy were not sufficiently developed and as such could not be measured. Due to these reasons, the sub-test of VFC was included in the final version of the VPAT. However, it is important to note that all of the sub-tests that were initially developed by Clutten (2009) to be included in the VPAT were included in the measure that was used by Brey (2016). This was done irrespective of the results found by Clutten (2009) with recommendations to remove certain aspects of the VPAT due to insufficient reliability levels.

2.5 Psychological Assessment

Many children and adults who present with cognitive dysfunction, including visual perception, are referred to psychologists and occupational therapists to assist in the diagnosis and prognosis of neurological disabilities, learning difficulties or neurocognitive developmental delays (Brown, Unsworth, & Lyons, 2009). Research into visual perception as well as other cognitive abilities has been conducted extensively in a variety of contexts, however, the instrumentation or scales that are used to measure the specific cognitive constructs have not received as much detail in the world of research (Brown & Elliott, 2011).

The importance of a valid assessment measure is vital for the treatment of visual perceptual deficits as the constructs related to visual perception have a direct correlation to occupational performance (Brown & Elliott, 2011; Brown et al., 2009; Brown & Gaboury, 2006; Chan & Chow, 2005). Prior research on the topic has concluded that cultural experiences and context influences the development and ability of visual perception, and a small portion of research has concentrated on examining whether measures of visual perception that have been defined for a specific context, are valid in terms of the structure and measurement of the cognitive ability (Brown & Gaboury, 2006; Chan & Chow, 2005).

2.5.1 Measurement of Visual Perception

The use of a standardised test for visual perception is imperative in understanding whether the psychometric measure is suitable for a specific population, which in this case is children and adults living in South Africa. According to literature, visual perceptual standardised tests have not been extensively researched using a South African population, and therefore it is not known whether measures of visual perception are valid or reliable in terms of the quantifiable scores collected by the specific measure (Brey, 2016; Clutten, 2009; M. Harris, 2017). As the Test of Visual Perceptual Skills is often used in Western society as a measure to assess and treat individuals with visual problems, it has started being used in South Africa as the standardised test for visual perception (Gardner, 1996; M. Harris, 2017). The Visual Perceptual Aspects Test (VPAT) attempts to measure and evaluate all of the subskills of visual perception that are evaluated by the Test of Visual Perceptual Skills (Non-Motor)-Revised. However, the VPAT has not undergone the vigorous assessments of validity and reliability that have been conducted on the Test of Visual Perceptual Skills (Non-Motor)-Revised, irrespective of the context where the test is being used (Brown & Gaboury, 2006).

2.5.2 Statistical Scaling and Testing

In social and behaviour sciences, especially in psychology, the use of measurement scales, procedures and testing is ubiquitous across the discipline. To uncover the workings of the mind and behaviour, a variety of tests are used to answer questions related to observable behaviour, intelligence, personality, cognitive and neuropsychological functioning (Gruijter & Kamp, 2008). By using a scale or test within behaviour science, the researcher is required to involve a type of measurement and statistical theory for analysing the results produced by the measurement scale. According to traditional statistical test theory, the test's score is always interpreted within the context where the test was developed, and is to be used for persons or groups within the designated age range and are able to fully understand the instructions of the specific measure (Gruijter & Kamp, 2008).

A test or measurement is broadly defined as a method for measuring and sampling behaviour and cognition, as well as describing the constructs with categorisation or contextual score (GL-Assessment, 2013). In certain instances, psychometric measurements become standardised for a specific population or context. Very few methods of assessment have been standardised for the South African context and therefore, more research should be aimed at standardising measures for developmental, educational and clinical settings (Harris, 2017). This definition is specific to the measurement of psychological constructs and abilities, but includes the systematic measurement in all disciplines related to the behavioural and social sciences (Gruijter & Kamp, 2008).

2.5.3 Scale Validation

Social, behavioural and cognitive science phenomena are complex and understood to be multi-factorial (Groome et al., 2014). To understand these phenomena, a systematic examination of each of the multiple intricately correlated dimensions is needed. Therefore,

research psychologists and cognitive psychologists are required to measure and evaluate a number of interrelated variables that will in turn capture the essence of the phenomenon under examination (Raykov & Marcoulides, 2008). The research is often focused on the measurement and analysis of theoretical constructs, such as anxiety, intelligence, as well as cognitive ability. These constructs are defined and identified through empirical observation of variables within a phenomenon (Welch, 2010). In many instances, multivariate statistics is used to determine the relationships between observable variables and scores, with the goal of making inferences about the set of latent variables (the hypothetical conceptualised constructs within the measure) with observed theorised psychological constructs (Yates, 1987).

Multivariate statistics is defined as a combination of methods that simultaneously analyse multiple outcomes of response variables, otherwise known as dependent variables (Raykov & Marcoulides, 2008). Multivariate statistics is commonly viewed as a multitude of statistical methods, related to mathematics, that is used to solve the complex issues of inter-related variables within a phenomenon or psychometric measure (Dunn, 2001). Multivariate statistics represented several methods that are used to analyse the potentially frequent correlated and interrelated measurements that are considered to be together rather than separate or analysed in isolation (Raykov & Marcoulides, 2008). A factor analysis is a method used to explore the relationships between the variables that are measured within a test and are analysed to determine whether the relationships between variables can be reduced to a small number of variables or factors (Thompson, 2004). A factor analysis can be conceptualised as a multivariate multiple regression technique when the researcher is trying to predict psychological constructs from scores of observable behaviour (Yates, 1987).

The method of factor analysis was originally developed as a technique for disclosing the unobserved variables or latent variables, known as factors, which are assumed to be part of

the foundation of an individuals' performance on a set of observer variables and to explain the correlation or interrelationships (Raykov & Marcoulides, 2008).

In the early 1900, psychologists were debating on different ways of measuring intellectual performance. The arguments concerned two major standpoints. Some psychologists believe that intelligence was a single ability that was under an umbrella term, whereas, other psychologists argued that expertise or intelligence has little or no predictability in terms of correlation to other cognitive abilities. The latter arguments led to the idea that intelligence involved multiple factors that are interrelated with one another. Spearman (1904) sought to solve the issue by trying to find divergent and analytic tools to measure each factor (Raykov & Marcoulides, 2008). This development subsequently led to the theory and statistical analysis that today we term factor analysis (Spearman, 1904).

Typically, in psychology, the factors associated with a given phenomenon are not directly measurable and are instead known as constructs where the observed measures are the construct indicators or manifestations in the observable behaviours. The method of factor analysis is applied in the study of the structure of multivariate data (Tucker & MacCallum, 1997). Factor analysis is also used to assist in answering questions on validity. The primary aim of a factor analysis is to measure whether the measurement tool is producing scores that measure the intended construct or phenomenon. It is also concerned with the issue of whether the score is measuring the construct in isolation and not of the phenomenon as a whole. A factor analysis is primarily used to determine the number of factors that are at the foundation of a set of variables within a phenomenon.

The technique is applied to understand which variables are correlated with a specific factor, as well as to determine the correlations between the different variables and factors. Lastly, it is used to describe the correlations, if any, between the factors, together with the size

of the proportions and variance between the variables and factors within the scale (Dimitrov, 2012). It has been suggested that factor analysis is part of the validation process and is at the foundation of measurement in regards to psychological constructs and testing (Thompson, 2004).

A factor analytic methodology may be understood to sit on a continuum ranging from techniques aimed at confirmatory analysis, to procedures concerned with the exploration of data. The two major methodologies within factor analysis are the exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The original analysis proposed by Spearman (1904) would today be regarded as an exploratory factor analysis (Thompson, 2004). Factor analysis is a primary tool used for validation of assessment scale data in psychology and social science (Dimitrov, 2012). The exploratory and confirmatory factor analyses are widely used across the discipline of psychology to validate the process and development of testing and scale data within the field. Both type of analyses (EFA & CFA) have factors that represent all unobservable variables which are termed, latent variables, factors or constructs. This is different to the observed variables which are defined as indicators. Each phenomenon has a set of factors and indicators that define the factorial structures that is underlying the set of indicators within the psychological construct (Dimitrov, 2012).

2.5.4 Factor Analysis

As already mentioned, the methodology of factor analysis may be understood to lie on a continuum that ranges from a purely exploratory procedure, to a more confirmatory technique. The methodology was developed when Charles Spearman (1904) aimed at confirming the construct or factor of general intelligence (Tucker & MacCallum, 1997). Through the method of factor analysis, Spearman's theory of a single unique factor of intelligences was declared to be inadequate to holistically explain intelligence. Louis

Thurstone's contribution to the discipline of psychology was to better understand the tools we use to quantify or measure psychological constructs (Guttman & Lawley, 1947). His powerful analytical methodology of factor analysis allowed for psychology as a whole to better understand the workings of the mind (Wolfe, 1956). The developments of factor analysis have led to a variety of methods within factor analysis, including exploratory factor analysis, confirmatory factor analysis, structural equation modelling, as well as the newly developed bifactor models within each methodology. The bifactor model was first introduced by Holzinger and Swineford (1937) to measure a psychological structure with a general factor, group factor as well as a pattern matrix within the psychological model (Holzinger & Swineford, 1937). However, the model was overshadowed by Spearman (1904) and Thurstone's (1947) factor analysis method. Each of these methodologies will be explained below. It is important to note that the exploratory factor analysis methodology will not be used in this research dissertation but it was nevertheless deemed important to explain here so as to give a more complete overview of factor analysis.

2.5.4.1 Exploratory Factor Analysis

An exploratory factor analysis (EFA) is a method used to explore which model would have the best fit for the interrelationships, covariances and correlations in terms of factors within a phenomenon (Gruijter & Kamp, 2008). Researchers in social and behavioural sciences try to make sense of the world by understanding, describing and explaining complex variables and correlations between them by defining a set of factors that underpin these relationships (Dimitrov, 2012). Factors here are understood to be a set of variables that have been statistically deriving into sets or new variables (Gruijter & Kamp, 2008).

In an EFA, the researcher generally holds no expectations regarding the output of underlying constructs or the number of factors within a measurement or phenomenon. The

researcher may have assumptions about what they believe to be the underlying factors within the psychological test, however, they are not required to input these into the EFA when conducting the analysis (Thompson, 2004; Tucker & MacCallum, 1997). EFA is typically used when the psychological researcher does not have a concrete theoretical background or empirical stance on the information or data to hypothesise how many factors are at the foundation of the set of variables they are working with. Furthermore, it applies to cases where researchers have no hypothesis about which variables are correlated with which factors (Dimitrov, 2012). If a psychometric measure is built on a specific theoretical foundation but does not have a concrete factorial structure to analyse for factorial validity, the researcher would then conduct an EFA. This method of analysis is used to evaluate the psychological constructs that make up the phenomenon and determine what observable behaviour can be measured to accurately quantify the psychological construct in question. The goal of EFA is to define the set of factors through a statistical and mathematical process that maximises the total variance within each individual variable and how they are accounted for by each factor (Dimitrov, 2012).

In terms of the general principle factor method within an exploratory factor analysis, the first factor is extracted from the correlation matrix of variables that have been observed and are then weighted against in linear combination to all of the variables that are observed in the phenomenon and rated against those that produce the highest squared correlation between variable and factor. From there, the second factor is extracted by maximising the variance from the residual correlation matrix that was obtained after the removing of the original first factor. The development means that the second factor would be orthogonal to the first factor, that is, they are uncorrelated to each other. The third factor would maximise the variances that have been extracted from the residual correlation matrix after it has been removed from the previous two factors. This process will continue until all factors have met the specified statistical

criterion set by the researcher (Dimitrov, 2012). This process leads to the discovery of the number of factors that could describe and explain the relationships among a set of observed variables that have been measured, as well as which variables significantly correlate with, or load on each factor (Raykov & Marcoulides, 2008).

Therefore, an EFA is used in circumstances when there are no pre-existing hypothesis or model for the latent factors that are underlying the defined factors within a phenomenon. Here, an EFA offers a framework or guidelines on the factor structure of a psychological construct (McGrath, 2011). This research dissertation does not make use of the EFA as there is already a pre-existing hypothesis to the VPAT's latent factor structure.

2.5.4.2 Confirmatory Factor Analysis

The confirmatory factors analysis (CFA) was developed after the exploratory factor analysis as a tool to validate theory and factor structure within a measure. To conduct a CFA, the researcher is required to have expectations regarding the number of factors within the psychological test; an estimate on which variables influence or reflect the different factors; and to understand whether these factors are interrelated or correlated in any form. The primary difference is that a CFA is a theory-driven approach to analysis that has the primary goal of confirming hypothesised factor structures by the researcher (Dimitrov, 2012). This is opposed to an EFA which is used as a data-driven approach aimed at exploring the factor structure of a phenomenon that has not been hypothesised by the researcher.

As discussed in the previous section, an exploratory factor analysis (EFA) is used when the researcher does not have a theoretical or empirical foundation to hypothesise what and how many factors underlie the variables within a phenomenon (Dimitrov, 2012). Confirmatory factor analysis (CFA) has been regarded as more useful than its predecessor the EFA. It is not possible to conduct a CFA without a psychological theory to understand the data by. The

confirmatory factor analysis proves its' usefulness with a psychological theory because the theory is directly tested by the CFA and the model fit of the measure is quantifiable, allowing for more precise measurements (Thompson, 2004). A CFA is used when the goal of the researcher is to test the validity of a psychological model's number of factors and whether those specific correlational factors are sound to the empirical variables (Dimitrov, 2012). The primary goal of a CFA is not to explore, discover or disclose the factors within a phenomenon or testing scale, but rather to quantify, test, analyse and confirm the a priori, or hypothesised and presented structure of factors within a phenomenon or set of observations (Raykov & Marcoulides, 2008). It is therefore imperative for the researcher to have a clear, initial hypothesis about the composition and structure of the factors and variables within a set of data or psychological phenomenon. A confirmatory factor analysis is defined as a method of testing using *a priori* hypotheses to understand the effect that the relationships or correlations among a set of observable variables are owing to unobservable variables within a phenomenon (APA, 2014). In review, a CFA is understood as being the mode of analysis when a theory under examination is complete, taking all of the unobservable aspects within the model that are derived from the theory and quantifying each result, therefore, testing if the model is consistent with the literature and observable data (Raykov & Marcoulides, 2008).

The process of the CFA starts with the researcher specifying a hypothesised model based on a specific theoretical or empirical platform that details the latent factors and interrelationships among the variables. This phase of the analysis requires the specification of how many factors are expected within the scale; which factors are related to the specific empirical variables; to define where and if factors are correlated to one another and where the loadings of each factors should be equal (Dimitrov, 2012).

A confirmatory factor analysis is then understood to be an analytical method of analysis that is based on a modelling approach that is designed to test the prescribed hypothesis about the factor structure that was inputted into the model in advance defining the number of factors involved in the analysis of the model (Raykov & Marcoulides, 2008). CFA is concerned with examining the correlations, interrelationships and patterns of relations among the confirmed factors as well as the variables observed within the phenomenon (Raykov & Marcoulides, 2008). This type of analysis is almost always used during the development or validation process of psychometric scale development. This is because it is important to examine the latent structure of a psychometric test instrument to validate the number of underlying factors and the relationship between each item and factor relationship (Brown, 2006).

2.5.4.3 Exploratory Structural Equation Modelling

It is important to note that within a framework based on latent variables, there are several approaches, including exploratory structural equation modelling (ESEM) that are complementary to CFA and are used to examine the underlying factor structure within a psychological assessment that are predicted to represent a cluster of constructs (Wiesner & Schanding, 2013). Therefore, we can understand structural equation modelling as a specialised flexible statistical model that is used to evaluate a variety of correlations or relationships between a series of latent variables (McGrath, 2011).

An exploratory structural equation model (ESEM) can be understood as an umbrella framework that incorporates several methodologies and allows for the combinations of a confirmatory factor analysis (CFA), an exploratory factor analysis (EFA), as well as a structural equation model (SEM). Therefore, ESEM makes use of the advantages from each analysis method and outputs them into a single systematic analytical framework where a factor is

defined across constraints inherent in the model, where the factors are incorporated across cross-loadings (Howard, Gagné, Morin, & Forest, 2018).

2.5.4.4 Bifactor Confirmatory Factor Analysis

All forms of bifactor models implement one major assumption into the analytical model, and that is the general factor within a model are not higher-order, but rather are direct and independent of the effects of cognitive constructs or abilities (Murray & Johnson, 2013). In a higher order model, or factor model, suggests that the global factor of the psychological construct is not directly related to individual observed sub-tests, but rather only directed to the specific constructs or abilities defined by the researcher. The developments of bifactor models relate to cases where all sub-tests, constructs and abilities are interrelated, and the bifactor analysis would test and account for this interrelationship (Murray & Johnson, 2013; Myers, Martin, Ntoumanis, Celimli, & Bartholomew, 2014).

The importance of a bifactor model is that it provides the analysis with a more flexible approach, allowing for an alternative to the traditional hierarchical models of factor analysis. The bifactor model caters for possibility that all items are directly loaded on one global factor (e.g. cognitive ability), and also takes account of the loadings on individual subfactors (e.g. different cognitive abilities). All factors are thus analysed to be orthogonal results in a more detailed picture of the factor structure (Sánchez-Oliva et al., 2016). Thus, the bifactor model is a major development to the confirmatory factor analysis (CFA) as the CFA has become a universal test for the factor structure within psychological measurement scales. If a measure does not reach the designated goodness-of-fit requirements are regarded as a poor measurement scale in the eyes of psychologists and researchers in behaviour science. Using a bifactor model within the CFA allows for the researcher to understand if the goodness-of-fit of the model is due to the invalidity of the scale, or the unreliability of the analytics methodology.

2.5.4.5 Bifactor Exploratory Structural Equation Modelling

The method of exploratory structural equation modelling (ESEM) is a modelling and analytical technique aimed at overriding the limitations of the CFA, where it allows for cross-loadings among different latent variables and subsets within a measurement scale (Asparouhov & Muthén, 2009). An ESEM allows for items to be loaded on a global factor (G-factors) and also on specific factors (S-factors), it adds to the CFA, and allows for the calculation of model fit with multidimensional data (Gomes, Almeida, & Núñez, 2017).

The CFA has played a major role in psychological research that has pushed psychological researchers to develop more a priori, precise, reliable and valid models to test for psychological constructs. The CFA, that was integrated into the structural equation model framework, has highlighted ways to examine whether and how data fits into a priori hypotheses. This is achieved through a systematic investigation of the statistical significance where a psychological measure is invariant across constructs within a measurement scale (Howard et al., 2018). A perilous limitation of previous research that has focused on the factor structure and validation of psychometric measures, is the methodology relies on the assumption that the sub-scales of visual perception are perfectly unidimensional psychologically, which is also a key assumption of confirmatory factor analysis (CFA). A CFA fails to account for sources of construct-relevant psychometric multidimensionality (visual discrimination and visual memory) which could result in a biased parameter within the statistical model.

An ESEM is thus a model of analysis that combines all the advantages and benefits of the analytical techniques including and EFA, CFA and structural equation model into a single model. Furthermore, using a bifactor approach to an ESEM allows for an even further refined and valid approach to analysing the model of a psychometric measure (Howard et al., 2018).

There are a variety of methodological limitations that have not been addressed in the past research regarding the VPAT, including the fact that no form of factor analytic approaches has been used to examine the structure of the VPAT. There has only been one method of analysis which emphasised construct validity through Pearson Product-Moment correlations. The test claims to measure the unidimensional factor of visual perception by use of nine subtests of visual perception. An appropriate approach for analysing the factorial structure of a model with a general factor is by implementing a bifactor model into the equation. A bifactor model involved extracting a general factor, which is visual perception in the case of the VPAT, that is set to be orthogonal to the subsequently extracted factors within the measure (Ng, Cao, Marsh, Tay, & Seligman, 2016).

There are two major advantages to using bifactor modelling approaches against the related approaches that do not include the bifactor aspect like an EFA or CFA. Firstly, a bifactor analysis allows for a much easier detection and prediction of group factors when the collected group factors are not independent of a hypothesised general factor. Therefore, the model allows for a more representative factor structure that goes beyond only having a general factor included in the analysis. Secondly, bifactor models are not restricted to the amount of variance accounted for by a general factor that is included as a lower-order factor instead of a global factor (Ng et al., 2016).

As this study is aimed at investigating and evaluating the proposed nine factor structure of the VPAT, which was developed with the aim of measuring nine factors of visual perception to quantify the unidimensional factor of visual perception, the use of bifactor models are important as they are at the forefront of experimental factor analysis. With the benefits of using a bifactor model, it is suggestive that using traditional measures of factor analysis such as CFA

and ESEM, together with bifactor modelling approaches will assist to validate the hypothesised structure of the VPAT.

2.6 Chapter Summary

Chapter two started by giving a detailed description of the cognitive construct of perceptual development. The account of the perceptual process, definitions of visual perception, the neuroscience of vision as well as visual information processing were given. An understanding of the two major theories within visual perception, namely the neuropsychological and neurophysiological approaches were then stated, relating both theories to the importance of measuring the construct of visual perception.

A detailed explanation of visual perception and the VPAT was then described. It was deemed important to first give details on visual perception as well as the measure under examination before explaining the approach used to validate the psychometric measure. This is when explanations and reviews on measurements of visual perception are presented, as well as the methods of measuring visual perception. Here, scale validation was introduced, explaining factor analysis and the different forms within the factor analysis methodology. In review, it detailed the newly developed method of bifactor ESEM, that incorporates several of the benefits that previous methods of analysis offered, as well as bringing in a general factor where all items are able to load against. Using this state-of-the-art method of factor analysis is seemingly the method with the highest level of validity in terms of the psychometric test's underlying factor structure and validity.

The primary aim of the research is to evaluate the validity and reliability of the VPAT using a sample group from a different province in South Africa, when compared against the sample that was originally used for the development and validation of the measure. As part of the aim of the research, it was important to determine whether the VPAT holds significant

reliability when analysed according to Cronbach's alpha of the sample group from the Eastern Cape. This is an important step for the validation of the VPAT as the test in its entirety has never been measured for reliability in any instance, let alone in a different region of South Africa when compared to where the test was originally developed. Two of the sub-tests never underwent measures of reliability during the development of the VPAT, and one test failed to meet satisfactory levels of alpha to be deemed reliable. However, all three sub-tests were included in the final VPAT. Therefore, answering the first research question of this research dissertation, namely, does the Visual Perceptual Aspects Test hold significant reliability according to Cronbach's Alpha scores using a South African sample of Foundation Phase learners from Port Elizabeth, will assist in the validation of the VPAT for a second region in the South African context.

The second question that the researcher aims to answer is, whether the VPAT hold statistical significance in terms of the proposed nine factor structure using a South African sample of Foundation Phase learners from Port Elizabeth. By using the factor analytic methods employed, this research will assist in the evaluation of the VPAT to determine whether the scale holds statistical significance in terms of the hypothesised nine factor structure as stated by Clutten (2009). This is an important step in the validation process as the measure has never undergone measures of validity using factorial validity. Factorial validity has become an important measure of validity for the behavioural sciences, and more specifically for cognitive psychometric measures. Commonly, measures are analysed using a CFA or ESEM to determine the fit of the proposed model with the sample, however, bifactor techniques have been introduced to potentially overcome limitations set by the CFA and ESEM models. Answering the two primary research questions will assist in the evaluation of whether the unidimensional latent factors of the VPAT measure the cognitive construct of visual

perception. Finally, it will assist in determining the validity and reliability of the VPAT in a South African context that differs from the region where the test was developed.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The research process and theoretical framework of the dissertation are now introduced. Descriptions of the theoretical perspectives of the methodology, the underpinnings of the data collections method, data analysis and philosophical developments being justified within the study will then follow. The research is based on an information processing approach, using and it involves a quantitative research design within a cross-sectional methodology, with each section being presented for the context of the study.

After introducing the research approach, the sampling and setting of the participants, the data preparation, components of research tools as well as data analysis will be discussed. The primary objective of the empirical investigation was to statistically analyse the reliability and validity of the factor structure for the Visual Perceptual Aspects Test. Therefore, the data analysis framework, together with the reliability and validity of the study will be presented. Lastly the ethical viewpoint and chapter summary will conclude the chapter.

3.2 Information Processing Paradigm

Ulric Neisser (2014) defined the study of human cognition as research that attempts to understand the underlying cognitive and brain processes by which incoming sensory stimuli are translated into information units or 'representations' understandable to us. This definition is in accordance with the view of perception based on the information processing paradigm. According to this scientific approach, our cognitive processors develop in a series of sequential stages (Mulder, 1983).

The general doctrine that subsumes the information processing approach is the scientific paradigm called 'positivism', a philosophical and political movement that was founded by Auguste Comte, who described the doctrine in a series of texts that were published between 1830 and 1842 (Bourdeau, 2018). Comte's (1896) scientific approach can be understood as a research paradigm that emphasised the process of developing knowledge and understanding of the world by developing hypotheses about phenomena and then proving or disproving them using natural scientific principles (Mack, 2010). The information processing approach falls within this paradigm and tries to understand the overall development and functioning of the human mind and the mental structures underlying human cognition and intelligence based on such principles. In the study of human intelligence according to this approach, the focus is therefore on fundamental principles, founded on a solid foundation of proof and scientific methodology (Comte, 1896; 2000).

According to Comte (1896; 2000) the law governing this development of knowledge is that each branch of knowledge successfully passes through three different theoretical settings, namely, the theological or fictitious, the metaphysical, or abstract, and the scientific. The human mind employs three different philosophising modes, each essentially unique and arguably the opposite of the others. Therefore, the human mind approaches general phenomena on the aggregate of three different philosophies, each of which excludes the other. The primary point of departure is the fictitious or understanding, the final is the fixed, or definitive, whereas the second is understood as a mode of transition (the abstract) (Comte, 1896; 2000). In the final state, or positive state, the human mind seeks intelligence from searching for the absolute, definitive or fixed piece of information. This is where ideas of logic, reasoning and observation are intertwined and used as means to apply the study of knowledge, which are now understood as laws of facts (Comte, 1896; 2000). This philosophical theory of Comte was the departure point for the information processing paradigm. In this paradigm, cognition is an information

processing process that tries to make sense of the sensory information received from the world by virtue of ‘computations’ on transductions of this sensory information called ‘mental representations’ (Neisser, 2014).

David Marr (1982) contributed a significant amount of research on visual perception based on the information processing paradigm while focusing on how processes in the visual system extract information from the external world. His research, much of which was published posthumously (Marr, 1982; 2010) was influenced by work in artificial intelligence, and he tried to explain visual perception based on the information processing paradigm. In Marr’s information processing theory he attempted to ‘understand’ visual perception by quantifying the information that flows through the neurophysiology of the visual system (Gordon, 2004). The development of this theory was made possible by the discovery and recording of electric outputs or responses made by cells within the visual cortex of a cat (Hubel & Wiesel, 1962). This initial research led to a theory that the visual system deciphered and analysed visual information into specific components, and that the processes that do this are wired into the central nervous system (Wurtz, 2009). It is therefore clear that Marr (1982) adopted the information processing paradigm to develop a computational approach to visual perception (Passingham, 2017).

Comte (1896; 2000) described this paradigm within disciplines of natural science, including mathematics, physics, chemistry, biology and later went to explain how the paradigm should be used to explain phenomena within social sciences (Bourdeau, 2018). The primary epistemological assumption within this scientific paradigm of information processing and visual perception is that knowledge is objective (Passingham, 2017). Here, knowledge is understood to be generated deductively from a theory or hypothesis and the truth within the knowledge is attained through the understanding that knowledge is based on laws of

indisputable truths achieved by logical, deductive processes (Mack, 2010). The methodological assumptions adopted in the natural sciences are used within this paradigm. From this perspective, Marr (1982) clearly distinguished between three levels of analysis of an information processing paradigm which could be directly related to the performance of a machine or computer. The levels of analysis are the computational level which is related to the function of the system. Secondly, the algorithm level is concerned with the operations of the system, clearly defining the representations of the input and outputs of the process. Lastly, the hardware implementation level is focused on how the hardware and representations of the operations can be carried out or realised in a physical form (Passingham, 2017).

The ontological assumptions associated with the information processing paradigm include the claim that reality is an external force to the researcher, and that it is represented by objects in space and time. Further, it is assumed that each object has specific meaning, independent of any form of consciousness attached to it, and that we make sense of reality by using mental functions such as encoding, storing, retrieving, deciding and comparing based on the information received from external stimuli (Mulder, 1983).

The main epistemological assumption is that reality is capable of being captured through our senses, perceptions and predictions (Mack, 2010). The researcher is the observer and mathematics is the medium used to describe the observations made within reality. Furthermore, we understand all knowledge to come from sensory experience, the only way to describe the sensory experience is through observation and experimentation, and we decipher this knowledge in a systematic manner. Thus, the methodology that is used in natural sciences to describe the world around has been adopted and used in social science, including psychology and is reflected in the information processing paradigm (Mack, 2010). The basic scientific

methodological approach associated with the information processing paradigm is the theoretical departure point of this research dissertation.

3.3 Research Methodology

The purpose of the current study is to conduct a scale validation on the Visual Perceptual Aspects Test with the aid of a bifactor exploratory structural equation model, and using a sample of children from the Port Elizabeth Metropolitan area within South Africa. The study made use of a quantitative research design, using an experimental factor analysis to draw goodness-of-fit statistical readings about the psychometric measure factor structure and validity within this specific sample.

3.3.1 Quantitative Research Design

Within the 19th and 20th century, a variety of strategies aimed at the inquiries associated with quantitative research led to the information processing paradigm and worldview (Creswell, 2009). These inquiries included the less rigorous types of experiments known as quasi-experiments and correlational studies, and the standard or ‘true’ psychological experiments using a randomised selection of subjects (Creswell, 2009). Quantitative methods have developed over time and now include more complex experiments with a variety of variables and treatments within them, including the factorial research designs. Within the current set of quantitative approaches, techniques such as structural equation models are used, as well as more advanced statistical methodologies, for example, the bifactor exploratory structural equation modelling. The latter technique has been developed to elucidate the path links and strengths between multiple variables and factors (Creswell, 2009). This research dissertation makes use of the newly developed experimental factor analyses, embedded in the quantitative methodology.

Key assumptions within the information processing paradigm, and quantitative methodology can be summarised into a cluster of points. Firstly, in the scientific paradigm, knowledge is understood to be conjectural and antifoundational, and it is accepted that an absolute truth that can never actually be found or proven. Thus, researchers in this paradigm recognise that evidence can sometimes be fallible, and that hypotheses are never really proved but that they are just provisionally supported by data. Secondly, it is agreed that data, evidence, as well as rational considerations are key in shaping knowledge and epistemology (Gordon, 2004). Therefore, the researcher collects information on instruments that are based on measures completed by the participants or observations made by the researcher. Finally, quantitative research seeks to develop sound, relevant and empirically ‘true’ statements that serve to describe or explain the phenomenon in question (Gravetter & Wallnau, 2009). The researchers are required to be objective in their stance regarding the inquiry, the methods, measures and relationships between variables within the phenomenon and they should try to ensure that the research is executed with the highest standards of validity and reliability (Creswell, 2009).

This dissertation is based on the information processing framework outlined above, and focuses on analysing the goodness-of-fit factor structure of a psychometric measurement tool that was used to evaluate aspects of the visual perceptual cognitive abilities of young children.

3.4 Research Design

This section provides details regarding the research design, the research procedure, the sampling and setting of the research, the psychometric test used that was used to gather the data, the statistical program used to analyse the data, as well as the different experimental factor analysis types used in this research.

3.4.1 Procedures

The quantitative data was generated by the learners' who were administered the Visual Perceptual Aspects Test (VPAT). The test was administered in a sequential manner; before this administration there were initial interactions with teachers, and after the administration, further discussions were conducted with them. The 443 Foundation Phase learners were selected from five schools in Port Elizabeth, and they completed the VPAT using a computerised version (the VPAT was presented to the learners on a digital format) that was developed for the purpose of the primary study conducted by Brey (2016). The researcher obtained the data by meeting with Brey (2016) during a discussion regarding the use of LEGO Six-Bricks as an intervention for visuo-spatial perception. During this discussion it became apparent that there were no context specific psychometric measures developed for the South African context that have been shown to have sufficient reliability and validity for detecting any developmental problems in visual perception. Brey (2016) agreed to allow the researcher to use the data that she collected to conduct a scale validation of the scale and thus to determine whether the VPAT can be used in future interventions relating to clinical use and policy change.

The data analysis was planned to be conducted in a series of stages. In the first stage, the descriptive statistics of the data were generated. The means, standard deviations and reliability coefficients for all the items and sub-tests of the VPAT were obtained using IBM SPSS Statistics 25. The second stage of the data analysis was aimed at investigating the reliability, construct validity and factor structure of the VPAT. The data analysis was conducted using the statistical modelling program Mplus, version 7.4 (Muthén & Muthén, 1998-2017). A robust maximum likelihood (MLR) estimator was used and missing data was accounted for by employing a full information maximum likelihood estimation. Areas of local misfit was indicated by high modification indexes (MI's) and nonsignificant factor loadings.

Confirmatory Factor analysis, Exploratory Structural Equation Modelling, Bifactor Confirmatory Factor analysis and Bifactor Exploratory Structural Equation Modelling would be used to determine the credibility of the theoretical framework presented by Clutten (2009), and thus to systematically assess the proposed structure model of the measurement scale underlying the VPAT.

It was, furthermore, decided to use various fit indices to assess the fit of the model, including the Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), Sample-Size Adjusted BIC, Chi², Chi² df, P-Value, RMSEA, RMSEA 90% C.I., CFI – Comparative Fit Index, TLI – Tucker-Lewis Fit Index.

3.4.1.1 The Visual Perceptual Aspects Test

The Visual Perceptual Aspects Test (VPAT) is a standardised visual perception test that was developed to address the South African educational context. It was developed by Clutten (2009) in an attempt to address the measure of visual perception which is assumed to facilitate functions and skills that influence an individual's development to acquire the ability of basic literacy, numeracy and proficiency in language (Brey, 2016). The VPAT was designed to measure a collection of distinct visual perceptual aspects of the Foundation Phase learners, living in South Africa, ranging in ages between five and ten years.

Each of the sub-tests comprise of 16 items or tests that are made up of shapes, designs or forms that vary in size, colour, proportion, positional orientation and directional rotation that are arranged from easy to more complex. The nine sub-tests were clustered into four major sections, namely, visual perception discriminatory aspects, visual memory aspects, visual spatial processing aspects and visual analytical aspects. It has been suggested by Clutten (2009) that each section evaluates the identified aspects of visual perception, ranging from the visual discrimination level to more advanced visual information processing and analytical abilities.

3.4.1.2 Sampling and Setting

The data that was used in this dissertation are secondary data that were collected by Brey (2016) to measure a developmental intervention for visual perception. The data that were collected involved children from seven schools who were willing to participate in research on development of visual perception. The researcher contacted 42 schools in the greater Port Elizabeth Metropolitan area, South Africa, and meetings were planned with the Grade two learners' teachers, as well as the principals of the schools. The selection criteria for the school to be selected in the study included: Eastern Cape Department of Education schools which follow the National Curriculum and are not unduly affected by complicating factors such as school functionality and language issues. Furthermore, the primary school should employ teachers who are proficient in the English language. The primary school should have a distributed and diverse learner population. The primary school should have a minimum of three classes of Grade two learners. The primary school should be equipped with a functional computer laboratory for the testing of the participants, and with sufficient computers for each participant to be seated at his/her own computer. The primary school should have teachers who were willing and committed to partake in this study for the full duration of the research project.

Out of the 42 schools that were approached, five schools accepted the request to participate in the study and met all of the requirements. All five of the schools were situated within the greater Port Elizabeth Metropole and represented a lower to middle socio-economic profile within urban South Africa. A large majority of the students who participated within the study were English second-language speakers and a translator was on site to assist with the understanding of instruction when the VPAT was conducted. As the participant sample size was moderate ($n = 443$), the sample size can be considered large enough to ensure a good

probability of producing normally distributed data that can be used within the present study to analyse the factor structure of the VPAT.

3.4.1.3 Reliability

The reliability of a measure is defined by the psychometric measure's consistency of being free from random error. There are many approaches for testing a measure reliability, including test-retest reliability, equivalent-forms reliability, internal consistency and interrater reliability (Stangor, 2011). Internal consistency refers to the extent to which all the items within a test or sub-test are measuring the same construct (Tavakol & Dennick, 2011). Thus, the internal consistency is concerned with the inter-relatedness of the items within each sub-test or test. One method of measuring the internal consistency of a psychometric scale is to evaluate the Cronbach's coefficient alpha (Cronbach, 1951).

As mentioned previously, during the development of the scale, the Visual Perception Aspects Test had good internal consistency, with a Cronbach's alpha coefficient values reported at ranging from 0.72 to 0.84. These alpha values were obtained after several items were omitted from majority of the sub-tests. The visual form constancy sub-test was omitted from her results because the alpha coefficient value was reported at 0.48. It is important to note that the VFC sub-test remained in the final version of the VPAT. Furthermore, visual memory and visual sequential memory were never evaluated for internal consistency and thus there is no previous account regarding the level of reliability of these sub-scales. Brey (2016), whose data are used in this research dissertation as secondary data, never conducted any evaluation for reliability and based her results instead only on what was found during the development of the VPAT by Clutten (2009) in the Western Cape. For this reason, the internal consistency of the nine sub-test used in the VPAT will be analysed in this research.

3.4.1.4 Mplus

Mplus is a statistical modelling program that provides researchers, from a variety of disciplines, with a flexible tool to analyse data. The current development team of the program has backgrounds in research methods, psychology, psychometrics, mathematics, and statistics (Muthén & Muthén, 2012). The program offers a wide variety of models, estimators and algorithms within a coding interface and graphical display of data and analytical results. Mplus allows for the analysis of cross-sectional and longitudinal data, single-level and multilevel data as well as data that are either observed or unobservable (i.e. heterogenic) and it can also deal to some extent with missing data (Muthén & Muthén, 2012).

As a modelling framework drawn from the uniformity of themes of latent variables, the capabilities of the program are vast. The analysis within the program can be carried out using observed variables that are continuous, censored, binary, ordered categorically, nominally, or with a combination of these variable types. The generality of the modelling agenda is drawn from the ubiquitous use of continuous and categorical latent variables in tandem. This is highlighted using continuous latent variables to represent the factors that correspond to latent constructs, including the results of unintended individual differences in the development and effects of variation in coefficients across hierarchical data. Furthermore, categorical latent variables are included as a representation of the latent classes of corresponding homogeneous groups of data (Muthén & Muthén, 2012).

3.4.1.5 Validity

The validation of a psychological measure is an aspect that adds to the broader body of scientific epistemology in psychology. For example, determining the factor structure of an instrument would indicate whether the instrument is consonant with the related theory and model and whether it is indeed 'fit' to measure the constructs it is intended to measure.

According to structural aspects of validity, methods of factor analysis are used when the goal of the research is to determine the structural validity of a measurement after the measurement's structure has been established.

3.4.1.6 Experimental Factor Analysis

A factor is defined as an underlying dimension that represents or accounts for several observed variables within a phenomenon (Kothari, 2004). Depending on the nature of the study and the number of observable variables, the dimensions can be observed to be one or more factors. The primary aim of experimental factor analysis is to determine and describe the correlations, associations and relationships between a small or large number of latent variables. This is achieved by deriving a smaller number of factors that serve to group or 'load' items associated with the variables under them (Hoyle & Duvall, 2004).

All analyses will be conducted using Mplus as the statistical modelling program, where each analysis be estimated with a robust maximum likelihood estimator, which would provide a standard error and test of model fit together with the factor loadings of each item. When interpreting the factor loadings, the guidelines of Comrey and Lee (2013) will be applied. Loadings above 0.71. 0.63 to .070 are regarded as very good. 0.55 to 0.66 is regarded as good, 0.33 to 0.44 is fair and 0.32 or below is regarded as poor (Comrey & Lee, 2013).

Factor loadings are individual values that are associated to each observed variable that indicate how precisely the observable variables are related to one another, as well as how they load onto the factors that were observed within the phenomenon. In statistics, they are defined as factor-variable correlations. Factor loadings are imperative when trying to interpret and allocated a reading to a factor. The factor loadings are understood as the absolute size of the loadings of variables, which is important for understanding and interpreting each factor (Kothari, 2004).

3.4.1.6.1 Goodness-of-fit

Goodness-of-fit indices are commonly used in interpreting the results of a model due to the fact that they provide a variety of different information about the psychometric scale (Tóth-Király et al., 2017). The assessment of a psychometric model using goodness-of-fit indices allow the researcher to understand and analyse how well the data set agrees with, by means of statistical significance, a hypothesised structure of a model. The failure to obtain a statistically significant distribution of assumptions of the hypothesised model results in a lack of validity regarding the proposed structure of the psychological model within that specific context (Rayner & Best, 1989).

A series of different types of analyses are used to assess the model using goodness-of-fit indices. Each type of analysis produces a collection of fit indices that were used to assess the model as there is no prior research or agreement on the model that produces the best measures of fit (Brown & Gaboury, 2006). The first index within the model-fit is the Akaike (AIC) and the next one the Bayesian (BIC) statistic.

The Chi-Squared Test of Model Fit represents the discretionary between the unrestricted sample covariance matrix and the restricted covariance matrix, which therefore represents the Likelihood Ratio Test statistic, which is presented or is expressed as the chi-squared (χ^2) statistic (Byrne, 2012). The null hypothesis postulates that in the specification of the factor loadings, factor variances and covariances, the residual variance (known as the measurement error) within the model under examination is valid. Therefore, the Chi-Squared Test of Model Fit statistic concurrently tests the extent to which this specification within the model is true.

The next statistical output from the model-fit statistics is the Chi-Squared Test of Model Fit for the Baseline Model. The baseline models in Mplus is assumed to have zero covariation

among observed variables. Typically, the value of the χ^2 for the baseline model is hypothesised to be larger than the χ^2 for the structured hypothesised model. The reason for comparing the difference between the χ^2 for the baseline model and the χ^2 for the structured hypothesised model is to assess the extent to which the hypothesised structured model fits into the data, compared to the baseline model of the test. If the value of the χ^2 for hypothesised model is less than the value of the baseline model, one can conclude that the hypothesised structured model has a superior fit over the unstructured model, represented by the baseline model of the test (Byrne, 2012).

The Comparative Fit Index (CFI) and the Tucker-Lewis Fit Index (TLI) are both commonly used incremental indices of fit, used in factor analysis to measure the proportionate improvement in the model fit by comparing the imposed structured hypothesised model to the baseline model.

Whereas CFI and TLI are model fit indices that focus on the comparison of nested models, Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) are used in the comparison of two or more non-nested models, with the smallest value representing the best fit of the hypothesised model (Byrne, 2012). Both types of information criteria consider the χ^2 model fit value as well as the degrees of freedom and estimated parameters.

The Root Mean Square Error of Approximation (RMSEA) is understood as an absolute index of fit. Absolute indices of fit are in contrast to incremental fit indices as they do not rely on the comparison of a reference model to determine the model improvement. The RMSEA relies on only the determination of how well the hypothesised model fits with the sample data. Values that are less than 0.5 indicate a good model fit, whereas values as high as 0.8 represent a reasonable margin of errors of approximation in the population sample. RMSEA makes use of 90% confidence intervals to assess the precision of the approximation's estimates. The

confidence interval yields information that assists the researcher to evaluate the hypothesised model fit. A narrow confidence interval would allow the researcher to argue for good precision of the RMSEA value in accurately determining the degree of model fit.

The Standardized Root Mean Square Residual (SRMR) follows the same guidelines as the RMSEA in that it is an absolute index of fit, and also relies on determining how well the hypothesised model fits the sample data. The SRMR represents the average value that is observed across all standardised residuals, ranging from zero to one. It has been suggested that a well-fitting model will have a value of 0.5 or less.

3.4.1.6.2 Confirmatory Factor Analysis

The factor analysis model known as a confirmatory factor analysis (CFA), uses latent variables to replicate and test previously defined relationships between the indicator variables based on the psychological measure's theory. A CFA is a type of structural equation model that uses a hypothesis driven approach, that requires theoretical backing to assume the relationships among indicator variables within the phenomenon (McGrath, 2011). This theoretical standpoint is important for establishing a starting point for the conditions of the psychological model to be tested (Welch, 2010). The syntax that was coded within the Mplus statistical modelling program for the CFA can be found in Appendix A. As structurally defined by the CFA specification, all the items within the measure are only loaded onto their respective target factor. All other item cross-loadings are constrained to zero (Tóth-Király et al., 2017).

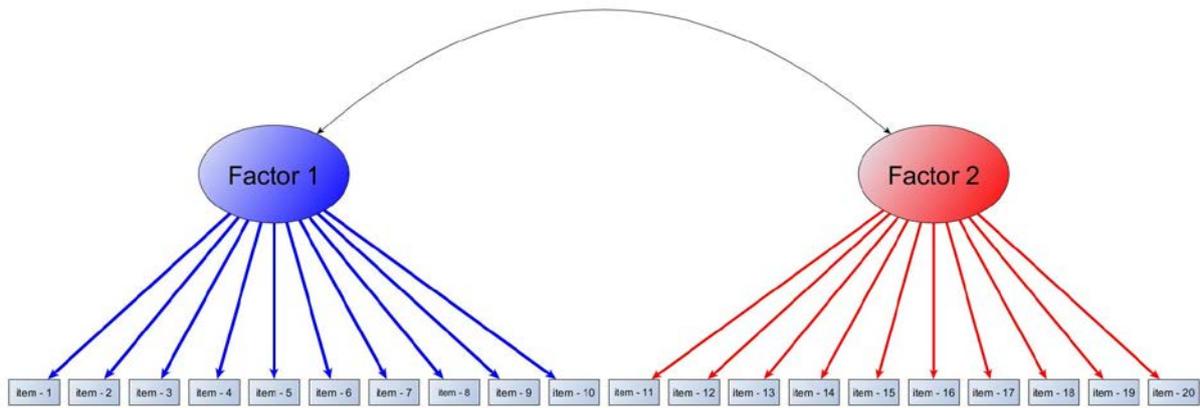


Figure 20: Simplified representation of the confirmatory factor analysis.

An important property of the CFA is that in the analysis, the items are only allowed to load on their main factors. Figure 20 displays a simple representation of the workings of a CFA, indicating how each item is restricted to loading with its designated factor (Tóth-Király et al., 2017). The CFA in this research dissertation will evaluate the nine designated or target factors, with 16 individual items loading specifically on each factor.

3.4.1.6.3 Exploratory Structural Equation Modelling

An Exploratory Structural Equation Model (ESEM) is appropriate for the investigation of situations or models where a particular psychometric item or aspect may have a significant level of variance associated to the theoretically defined factor (McLarnon & Tarraf, 2017). Therefore, it is appropriate to use this method of analysis to measure the goodness-of-fit factor structure of the VPAT. The syntax that was coded within the Mplus statistical modelling program for the ESEM can be found in Appendix B.

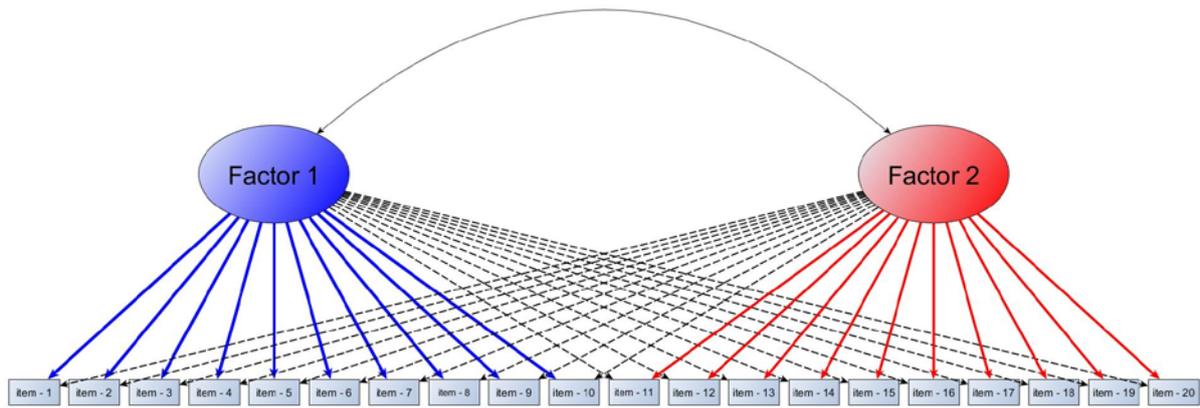


Figure 21: Simplified representation of the Exploratory Structural Equation Model.

The recent development of ESEM has provided an overarching framework combining the strengths of an EFA, CFA and structural equation model (Howard et al., 2018). The ESEM framework is generally used to overcome the limitations of only using a CFA by allowing the model to incorporate the advantages of the EFA, which allows for cross-loadings of item to non-target factors. In Figure 21, the dashed lines represent the cross-loadings of items with non-target factors. It is important to note that the cross-loadings of the ESEM do not tamper with the loadings of items on their target factors, rather they are assumed to reflect on the items and not influence the loadings of non-target items. By forcing items to have zero cross-loadings with non-target factors, (as in a CFA) the model simply ignores a potential influence of the item on a non-target factor. By allowing cross-loadings of the items on non-target factors, the ESEM has potentially accounted for limitations of the CFA.

3.4.1.6.4 Bifactor Confirmatory Factor Analysis

As previously discussed, the reintroduction of the bifactor measurement model within the discipline of psychology has allowed for a more rigorous examination of the factor structure of visual perception with the inclusion of a global factor. This reintroduction of the bifactor, which was heavily dominated by other analysis models, has been included into confirmatory

factor analysis, as well as exploratory structural equation models (Stenling, Ivarsson, Hassmén, & Lindwall, 2015).

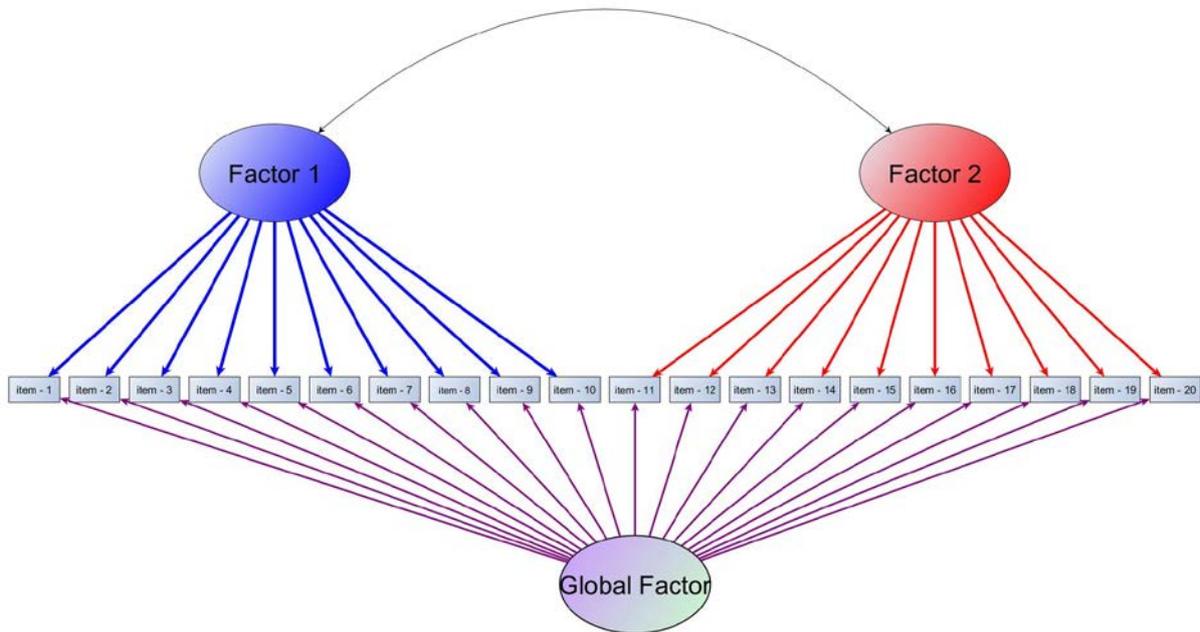


Figure 22: Simplified representation of the Bifactor Confirmatory Factor Analysis.

Bifactor models are typically used when a psychometric measure's goal is to evaluate a construct that could potentially be multidimensional, and the assessment of higher-order constructs are analysed for a general factor (such as in this case of the overarching ability of visual perception). One major drawback of using higher-order models in a CFA is that the analysis relies on restrictive assumptions on each factor, where associations or influences on items and higher-order factors are mediated by first-order factors (Howard et al., 2018). Introducing a global factor into the analysis allows for the model to separate the variances between items and higher order factors, while maintaining the condition that each item loads on the target factor. The syntax that was coded within the Mplus statistical modelling program for the bifactor CFA can be found in Appendix C.

3.4.1.6.5 Bifactor Exploratory Structural Equation Modelling

In a bifactor Exploratory Structural Equation Model (bifactor ESEM), all items within the model are directly loaded onto a global factor (known as a G-factor), which in this case is the construct of visual perception. All the specific items are cross-loaded within the phenomenon and are loaded on their target factor (Sánchez-Oliva et al., 2016). Figure 23 illustrates a simplified representation of a bifactor ESEM of twenty items loading on two factors as well as the global factor. In this research dissertation, there are nine target factors, loading on a collection of 144 items, all loading onto global factor (visual perception).

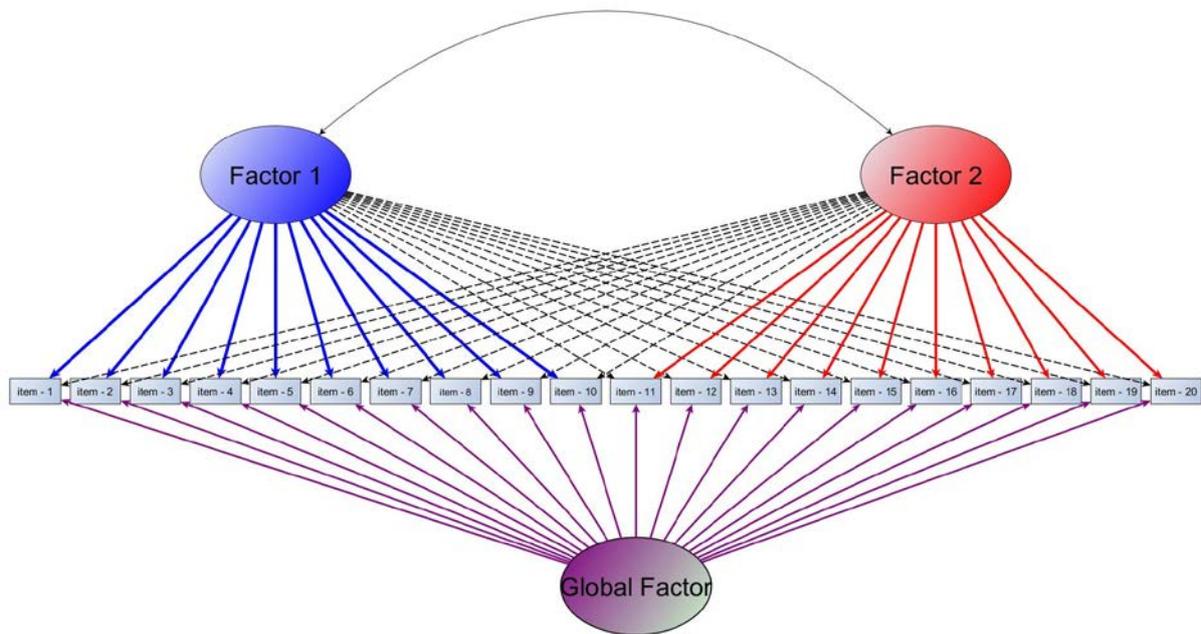


Figure 23: Simplified representation of the Bifactor Exploratory Structural Equation Model.

The bifactor ESEM combines the benefits of an ESEM together with a global factor. This is done when there is an expectation that a measurement scale is aimed at evaluating a unidimensional factor, together with cross loadings of several items on target factors. The development of target rotations within the model result in the bifactor ESEM offering the most detailed and flexible models when compared to a CFA or ESEM alone (Holzinger & Swineford, 1937). All the factors within the model are set to be orthogonal. The syntax that

was coded within the Mplus statistical modelling program for the bifactor ESEM can be found in Appendix D.

3.5 Ethical Considerations

The research dissertation was evaluated for adherence to appropriate ethical standards as required by the Psychology Department of the University of South Africa. The application was approved by the ethics committee of the department of psychology on the understanding that all ethical conditions related to voluntary participation, informed consent, anonymity, confidentiality of the information and the right to withdraw from the research was explained to participants in a way that was clearly understood, and a signed letter of informed consent was obtained from each of the participants in the study.

The ethics committee of the department of psychology at the University of South Africa evaluated this research dissertation's proposal for a Master of Arts in Psychology considering appropriate ethical requirements, with special reference to the requirements of the Code of Conduct for Psychologists of the HPCSA and the Unisa Policy on Research Ethics. As the purpose of this research dissertation was to evaluate the factor structure and unidimensional of the Visual Perceptual Aspects Test, the test was administered to each participant in its entirety instead of being discontinued when the performance of a child reached the threshold score outlined by the attesting instructions.

3.6 Chapter Summary

Chapter three provided and detailed the methodology that this research dissertation is based on. Descriptions of the information processing paradigm, as well as the quantitative methodology were first stated. The research design was then presented, followed by an exploration of the procedure and of the methodology, the acquisition of the secondary data for

this research, and how it was originally obtained, as well as the setting and sampling of the data. The evaluation of the reliability of the secondary data was then explained. It is important to note that no reliability measures were conducted on the data and results were based on a previous study conducted in the Western Cape. The statistical program and approach that were used to analyse the data were then explained, together with the description of the experimental factor analysis, including the CFA, exploratory structural equation modelling, bifactor confirmatory factor analysis and the bifactor exploratory structural equation modelling approach. Finally, the validity of the study and ethical considerations were provided, concluding with this summary.

CHAPTER FOUR: RESULTS

4.1 Introduction

The following chapter reports the results that were obtained through the analysis of the data using IBM SPSS Statistics 25 and the statistical modelling program Mplus, version 7.4 (Muthén & Muthén, 1998-2017). The first section of results presents the descriptive statistics of the data, providing details and background information of the sample group. The second section sets out the reliability analysis regarding the nine sub-tests of the VPAT. The data that were generated from the series of factor analyses, including the CFA, ESEM, bifactor CFA and bifactor ESEM are then presented here in an attempt to answer the research questions as to whether the hypothesised nine factor Visual Perceptual Aspects Test holds significant reliability, factor structure and factor validity, according to the prescribed theory of the test, using a sample of 443 Foundation Phase learners from Port Elizabeth. Where appropriate, the results are presented in descriptive or tabular forms for the ease of reading and understanding of the results of the analysis.

4.2 Descriptive Statistics

The first section within the results provides details about the participants such as distributions of gender, age, primary language, number of attempts of school grade, visual prescription, and medical background. The data generated here are results obtained from secondary data that were collected by Brey (2016) and was analysed using IBM SPSS Statistics 25 as well as Mplus version 7.4.

4.2.1 Participants

A collection of learners from five primary schools, all of which follow the standardised South African National Curriculum, situated within the Port Elizabeth district, South Africa, participated in this research dissertation. Inclusion criterion for the selection of the school were that the school had to be associated with the Eastern Cape Department of Education, which follows the National Curriculum and are not unduly affected by complicating factors such as school functionality and language issues. The schools are required to employ teachers who are English first language speakers and are the teachers to the learners who participate in the research. The primary schools are to host a diverse learner population in terms of gender, race and language. Each school is to have a minimum of three classes of Grade two learners and be equipped with functional computer laboratories for testing learners (VPAT) and with sufficient computers for each learner to be seated at his/her own computer.

In terms of confidentiality, the school's names have been removed and are referred to as School 1, School 2, School 3, School 4, and School 5. Each school is represented by the collection of three classes of learners/ participants. School 1 and School 3 are both regarded as high-performing, well-resourced and are situated within an above average affluent community and, therefore, are presumably drawing in learners from middle-class to above middle-class families. The remaining schools, that is, School 2, School 4, and School 5 are classified as being average-performing, lower-resourced schools that are situated within a middle, to lower-middle class community, and therefore, can be assumed to be drawing in learners from middle, to lower-middle class families. From the collections of the five schools, a total of 443 grade two learners served as participants for the VPAT data generation. The majority of the learners are English second language learners who are all taught in an English medium. Figure 19 below

details a graphical representation of the distribution of learners from the five schools used in this research dissertation.

Each participant was requested to complete a biographical questionnaire before the VPAT was administered to them. The questionnaire included information about their name and surname (which were translated into codes to adhere to the ethical principles of anonymity and confidentiality), gender and age. It also included information regarding the first or home language of the participant, whether this was their first or second attempt at completing Grade two, whether they have to use prescription glasses or contact lenses, and whether they were diagnosed with any form of Attention Deficit Hyperactivity Disorder (ADHD) according to the Diagnostic and Statistical Manual for Mental Disorders – Fifth Edition (DSM-5) by an accredited psychologist or psychiatrist, as well as if they are actively medicated as a result of the diagnosis. The validity and reliability of this information was taken at face value as the questionnaire was handed over to the participant's parents or guardians to complete. No follow-up information was gained by optometrists, psychologists or psychiatrists who could have potentially diagnosed the learners with treatments for vision or attention deficits.

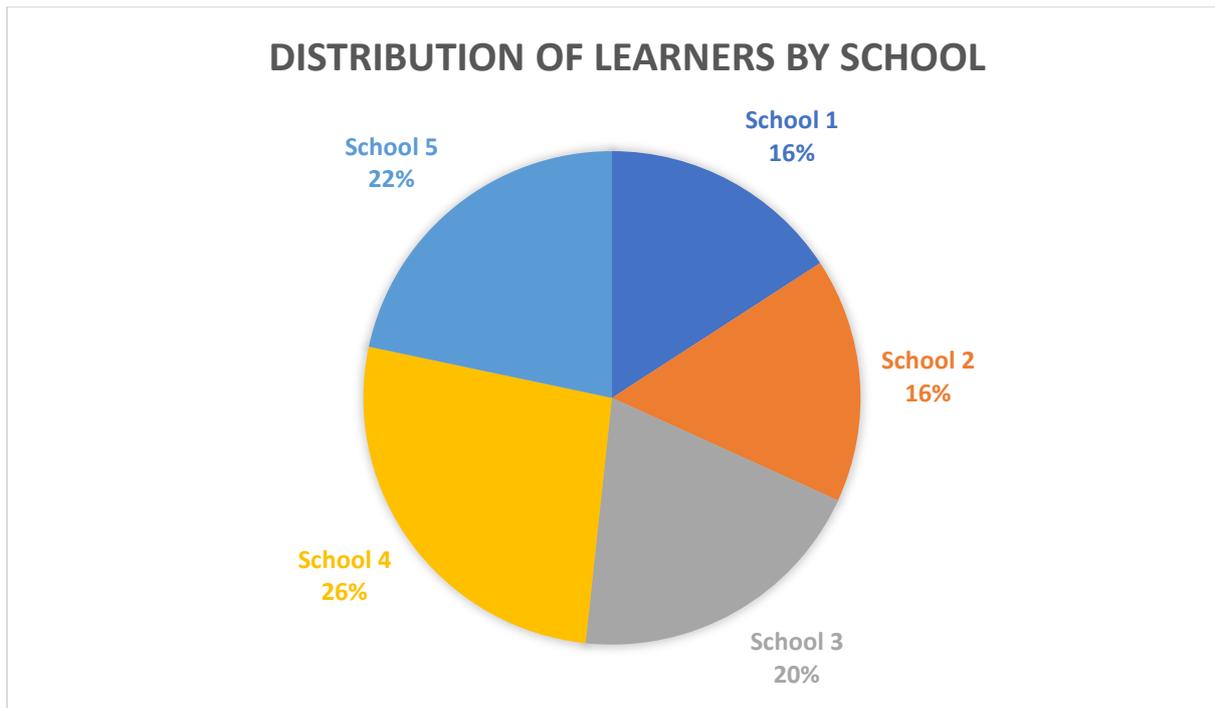


Figure 24: Graphical representation of the distribution of learners by the five participating schools who combined form the sample group that generated the data for the Visual Perceptual Aspects Test.

School 1 comprises of 70 participants, of which 23 are in the first class, 23 are in the second class and 24 are in the third class. School 2 has a total of 71 participants, with 24 participants in the first class, 24 in the second class and 23 in the third class. School 3 has a total of 88 participants, and of these 29 are in the first class, 30 in the second class, and 29 in the third class. The fourth school has a total of 118 participants, and here the first class has 39 participants, the second class has 40 participants, and the third class has 39 students. Finally, School 5 is made up of 96 participants, where 31 are in class 1, 32 are in class 2, and 33 within class 3.

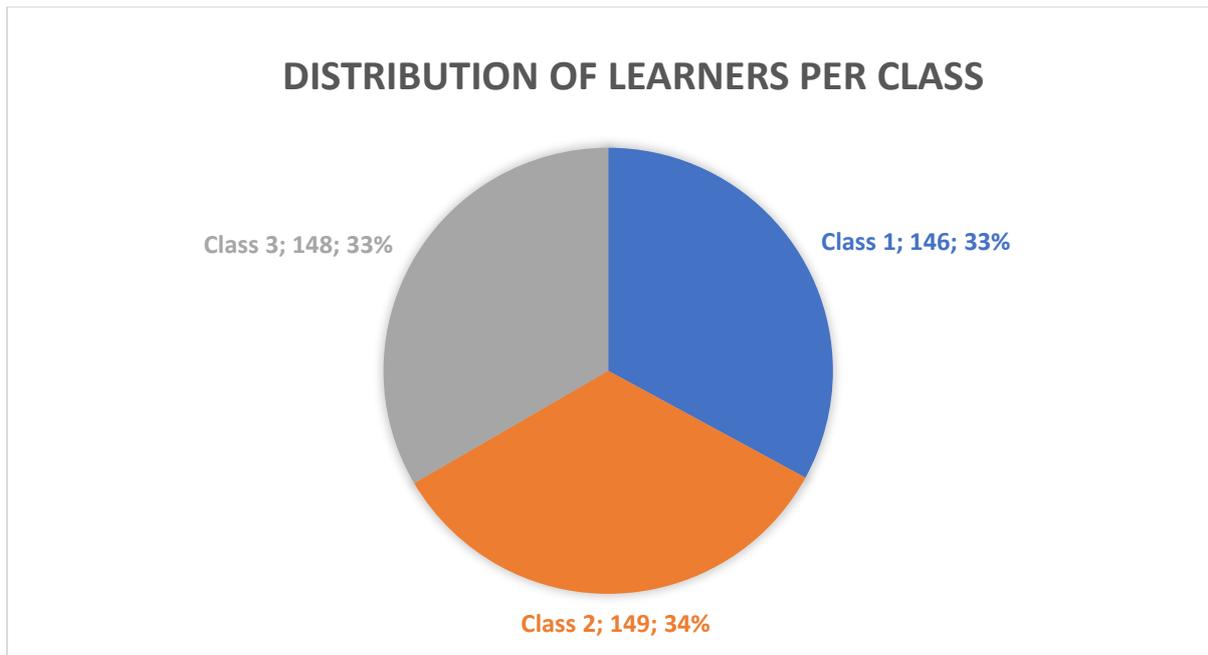


Figure 25: Graphical representation of the distribution of learners by class in the five participating schools who combined form the sample group that generated the data for the Visual Perceptual Aspects Test.

The collective classes from each school are represented as class 1, class 2 and class 3. Class 1 comprises of 146 participants, representing 33% of the sample. Class 2 is made up of 149 participants, representing 34% of the sample and class 3 is comprised of 148 participants, representing 33% of the sample group.

4.2.2 Gender Distribution

Table 1: The Gender distributions of participants per school as a number and percentage.

School	Male	Male Percentage	Female	Female Percentage	Total
School 1	37	53%	33	47%	70
School 2	34	48%	37	52%	71
School 3	47	53%	41	47%	88
School 4	58	49%	60	51%	118
School 5	43	45%	53	55%	96
Total	219	49%	224	51%	443 / 100%

The gender distribution within the sample comprised 224 females which equals to 50.56% of the sample, and 219 males which equals to 49.43% of the sample. The gender demographic split between each school is detailed in Table 1.

4.2.3 Age Distribution

Table 2: The age distributions of participants per school as a number and percentage.

School	Age 7	Age 8	Age 9	Age 10	Total
School 1	0	61	9	0	70
School 2	1	62	8	0	71
School 3	0	77	11	0	88
School 4	0	92	25	1	118
School 5	0	81	15	0	96
Total	1 / 1%	373 / 84%	68 / 14%	1 / 1%	443 / 100%

The age distribution within the sample involves 441 participants of eight to nine years of age. There was one participant who fell into the age group of seven and one participant who was aged ten, and this amounted to less than 1% of the sample.

4.2.4 Primary Language Distributions

Table 3: First language distributions of participants per school as a number as well as a percentage.

<i>School</i>	<i>English</i>	<i>Afrikaans</i>	<i>isiXhosa</i>	<i>Other</i>	<i>Total</i>
<i>School 1</i>	56	1	12	1	70
<i>School 2</i>	11	0	60	0	71
<i>School 3</i>	80	2	6	0	88
<i>School 4</i>	13	0	105	0	118
<i>School 5</i>	41	0	55	0	96
<i>Total</i>	201 / 44%	3 / 2%	238 / 53%	1 / 1%	443 / 100%

The language distribution within the sample comprised 201 participants or 45.37% who had English as their first language, and 238 participants or 53.72% who spoke isiXhosa as their first language, 3 participants or .68% indicated that Afrikaans was their first language, and finally only 1 participant or .23% as stating their home language as another language. Schools 1 and 3 hosted the majority of these participants whereas Schools 2 and 4 only hosted 24 participants collectively. IsiXhosa is predominantly the primary language in participants who attend Schools 4 and 2. isiXhosa and English are closely split as the predominant first language within School 5. It is important to note that all the participants are enrolled at a school that uses an English medium for education, where the teachers are either English first language speakers or are highly proficient in the English language. Although the participants proficiency in English was not measured, it was expected that if the learner was accepted into an English medium school that they would be able to understand the instructions of the VPAT.

4.2.5 Grade Attempt Distributions

The grade attempt distribution details the number of learners who are entering the grade for the first time as opposed to learners who were required to repeat the grade for a second time. The number of participants who were actively entering Grade two for the first time

totalled to 419 individuals, or 95% of the sample population. One individual from School 1, five individuals from School 2, two individuals from School 3, ten individuals from School 4 and six individuals from School 5 were repeating Grade two. A total of 21 of the 24 participants who were repeating Grade two came from an average-performing, lower-resourced school consisting of learners from a lower socio-economic group.

4.2.6 Visual Prescription Distribution

The number of participants who were actively wearing prescription lenses was 31 participants across all five schools, as against the 412 who were not wearing any form of glasses or contact lens. Both School 3 and School 5 had ten participants each who were wearing prescription lenses; School 1 and School 4 had 5 participants each; and School 2 had one participant wearing prescription lenses. Therefore, 7% of the sample across all five school were wearing prescription lenses during the examination of the VPAT.

4.2.7 Participants Medical Background Distribution

The number of participants who were actively diagnosed with and medicated for Attention Deficit Hyperactivity Disorder (ADHD) was 34 participants or 8% of the sample. The remaining 409 participants were never diagnosed or medicated for attention deficits. The individuals who were diagnosed with some form of attention deficit disorder and took medicine for the disorder, involved 8 individuals from School 1, six individuals from School 2, twelve individuals from School 3, three individuals from School 4, and five individuals from School 5.

4.3 Reliability

The reliability of a psychometric measure refers to the extent to which the scores obtained by the instrument are free from errors of measurement (Dornyei, 2003). Standardised

measurement scales are recommended to undergo a variety of rigorous validation procedures. One frequently used indicator of a measure's level of reliability is to test the internal consistency reliability (Pallant, 2005). The internal consistency reliability refers to the homogeneity of the items that make up the various scales within a measure. It is used to determine whether the items within the psychometric test are free from errors of measurement. There are several ways to measure the internal consistency of a psychometric scale. However, Cronbach's coefficient alpha is the most commonly used statistic to determine a measure's reliability.

The Cronbach's alpha coefficient is a statistic that provides an indication of the internal consistency of a scale by indicating the correlation among the items within each factor of a scale. The value of the alpha ranges from zero to one, where higher values of the alpha serve to indicate a measure with a greater level of reliability than those with lower values. There are a variety of different reports detailing acceptable values of Cronbach's alpha reliability coefficient, ranging from 0.70 to 0.95 (Cohen, Manion, & Morrison, 2007; Tavakol & Dennick, 2011). In a measure that comprises of more than one concept or construct, it is deemed important to report the Cronbach's alpha scores for each concept rather than the entire test as a large number of questions could possibly inflate the Cronbach's alpha score (Tavakol & Dennick, 2011).

It is generally accepted that Cronbach's alpha values of a psychometric measure should ideally be above the level of .70 for it to have an acceptable value of reliability (Cohen et al., 2007; Pallant, 2005). As seen in Table 4, the majority of the tests yielded an alpha reliability coefficient of above 0.70. Visual Memory, Visual Sequential Memory, Visual closure, Visual Analysis and Synthesis, and Visual Figure-Ground all reached levels of acceptable reliability with values ranging from 0.72 – 0.75. Position-in-Space and Visual Spatial-Relationships both

yielded alpha scores that can be considered highly reliable with values ranging between 0.80 and 0.81.

Table 4: Cronbach's alpha reliability coefficient values.

<i>The VPAT Subtests</i>	<i>Cronbach Alpha Reliability Coefficient</i>	<i>Number of items</i>
<i>Visual Discrimination (VD)</i>	0.60	16
<i>Visual Form Constancy (VFC)</i>	0.64	16
<i>Visual Memory (VM)</i>	0.74	16
<i>Visual Sequential Memory (VSM)</i>	0.75	16
<i>Visual Spatial-Relationships (VS-R)</i>	0.81	16
<i>Position-in-space (P-S)</i>	0.80	16
<i>Visual Closure (VC)</i>	0.72	16
<i>Visual Figure-Ground (VF-G)</i>	0.67	16
<i>Visual Analysis and Synthesis (VA/S)</i>	0.69	16
<i>The Visual Perceptual Aspects Test</i>	0.85	144
<i>N= 443</i>		

The Cronbach's alpha reliability coefficient values for the VPAT using Foundation Phase learners from five primary schools situated in Port Elizabeth, South Africa are set out in table 4. Each sub-test within the psychometric measure was analysed in terms of their Cronbach's alpha reliability coefficient, as well as the value of the test as a whole. Each analysis was conducted using the entire sample of 443 participants, and included all 16 items of each sub-test. The results for the sub-tests range from 0.60 to 0.81, with the whole VPAT's alpha value at 0.85. The sub-tests, Visual Discrimination (VD), Visual Form Constancy (VFC),

Visual Figure-Ground (VF-G) and Visual Analysis and Synthesis (VA/S) all yielded Alpha values significantly lower than what is considered reliable, with scores ranging from 0.60 to 0.69.

4.4 Factor Analysis

The second section within the results provides details of the model fit information that was gathered for each of the factor analysis methods, including the CFA, ESEM, bifactor CFA and bifactor ESEM. The data was analysed using the statistical modelling program Mplus, version 7.4. In interpreting the results, the researcher relied on a combination of the goodness-of-fit indices because they provide different information about the measurement model. The research conducted a series of factor analyses using maximum likelihood parameter estimates with robust standard errors to test the validity of the model fit for the hypothesised unidimensional nine factor structure of the VPAT.

4.4.1 Goodness-of-fit Indices

The confirmatory factor analysis (CFA), exploratory structural equation model (ESEM), bifactor confirmatory factor analysis (bifactor CFA), as well as the bifactor exploratory structural equation model (bifactor ESEM) are all assessed using goodness-of-fit indices to determine the validity of the proposed nine factor structure of the VPAT. Eight types of goodness-of-fit indices were analysed according to factor structure in each type of analysis as it is currently still disputed as to which index provides the most accurate or best measure of fit for the structure of the scale (Ng et al., 2016).

To account for possible objections regarding the type of factor analysis that is most suitable for evaluating the psychometric model, all four analyses are included in this dissertation. The goodness-of-fit indices that are outputted by each analysis include the Akaike

(AIC), Bayesian (BIC), chi-squared, RMSEA, RMSEA 90% C.I., CFI, TLI, and SRMR. The results of these analyses will be provided in this chapter, and further discussed in chapter 5.

Byrne (2012) has suggested the adequate and valid model fit for each index to be as follows. The results of the Akaike AIC are directly related to the Bayesian Information Criteria (BIC) and generally in psychometric measures, a model with a smaller Bayesian reading due to the narrow difference between the AIC and BIC is preferred and is indicative of a superior goodness-of-fit between the hypothesised factor model and the sample data within the analysis.

In accordance with the chi-squared value, the hypothesized model and the baseline model are compared against each other, to determine the extent to which the hypothesised model has a strong fit with the data, with regard to the value of the baseline model. This is true where the value associated with the χ^2 is less than that of the baseline model χ^2 . If this is the case, the hypothesised model is regarded as having a greater model fit over the proposed baseline model.

The root mean square error of approximation (RMSEA) is regarded as an absolute index of fit. Here, the RMSEA is dependent on determining the goodness-of-fit between the hypothesised model and the sample data. As the value of the RMSEA decreases, the level of goodness-of-fit increases, thereby, the preferable value associated with the RMSEA would be closer to zero. Byrne (2012) states that a RMSEA value that is less than 0.05 indicated a superior goodness-of-fit factor structure within the model. The values of the RMSEA 90% confidence interval are examined to determine the worth of the RMSEA value. If the RMSEA value is small, but the interval between the RMSEA at 90% is wide, the researcher would conclude that the RMSEA value is imprecise. On the other hand, a RMSEA 90% confidence interval (C.I.) with a narrow interval reflects a good precision of the RMSEA value, allowing the researcher to analyse the model as having a good model fit within the population. Finally,

the standardised root mean residual value represents the average of all the standardised residuals within the model, with score ranging from zero to 1.0, where a model with a superior fit would have values reading smaller than 0.05 (Byrne, 2012).

The two major incremental indices of fit in factor analysis are the CFI and TLI. Both of these incremental indices measure the structural fit between the hypothesised model and the less restricted baseline model that is determined by the analysis model. The CFA value that is outputted from the analysis could range from zero to 1.00, with a value that is closer to 1 being an indication of a superior goodness-of-fit factor structure of the model. CFA values above 0.95 are regarded as sufficient for the model to have a superior goodness-of-fit. The values associated with TLI range outside of zero to 1.00, but are analysed in the same fashion as CFI, where values closer to 1 are regarded to have superior fit.

4.4.2 Confirmatory Factor Analysis

Results describing the goodness-of-fit indices from the Confirmatory Factor Analysis of the nine factors that had to be considered to evaluate the proposed factor structure of the VPAT, are presented below. The nine sub-scales were analysed using maximum likelihood parameter estimates with robust standard errors and outputted with standardised modification indices. The model estimation terminated normally with 468 free parameters. The results from the goodness-of-fit indices from the CFA are highly divisive regarding the fit of the hypothesised unidimensional factor structure of the VPAT. The model fit information criteria for the CFA model is described in table 5.

Table 5: Values of the CFA Model Fit Information Criteria.

<i>Model Fit Information – Information Criteria</i>	<i>VALUE</i>
<i>Akaike (AIC)</i>	29055.191
<i>Bayesian (BIC)</i>	30963.528
<i>Sample-Size Adjusted BIC</i>	29478.341

The first goodness-of-fit indices, the Akaike (AIC) and Bayesian (BIC), are both indicative of an inferior or poor fit for the suggested model. The AIC is a summary statistic that is used in the comparison of the relative goodness-of-fit for a hypothesised model and baseline model within a given set of data. The AIC considers the set parameters within the hypothesised model, and the model with the lowest reading of AIC is generally considered the model with the best fit amongst the specified models. The AIC reading of the CFA at 29055 is suggestive of a weak fit, as it is lower than the BIC reading at 30963.528. The Bayesian statistical value is read by comparing the goodness-of-fit of the hypothesised model and a baseline model within a specific set of data.

Table 6: Values of the CFA Chi Squared Test of Model Fit Information.

<i>Model Fit Information – Chi-Square Test of Model Fit</i>	<i>VALUE</i>
<i>Value</i>	16353.951*
<i>Degrees of Freedom</i>	10116
<i>P-Value</i>	0.0000
<i>Scaling Correction Factor for MLR</i>	0.9524

The chi-squared model fit test is understood as a statistical method for the assessment of how well a theoretical hypothesised model fits a set of observed data and is detailed in Table 6. The data is compared against baseline data of the same model. In the CFA, the Chi² value of 16353.951 is lower when analysed against the baseline Chi² value 22766.358. The fact that the chi-squared model fit value is lower than the chi-squared baseline value indicates that the hypothesised model is regarded to have a fair model fit with the data, against the proposed baseline model.

Table 7: Values of the CFA RMSEA Model Fit Information.

<i>Model Fit Information – RMSEA (Root Mean Square Error Of Approximation)</i>	<i>VALUE</i>
<i>Estimate</i>	0.038
<i>90 Percent Confidence Interval</i>	0.037 / 0.039
<i>P-Value</i>	0.0000
<i>CFI</i>	0.500
<i>TLI</i>	0.491
<i>SRMR (Standardized Root Mean Square Residual)</i>	0.058

The Bentler comparative fit index (CFI) is a form of fit index that indicates how well a hypothesised model fits with the sample data when compared to a baseline or null model that hypothesises the variances between the variables, and analyses the variables as having no relationships. The CFI value was 0.500, which is low in comparison to what is typically considered an adequate level for goodness-of-fit. The Tucker Lewis Index (TLI), although a non-normed index, yielded a value that was very similar to the CFI. The TLI value that was obtained was 0.491, and this is also inadequate, just like the CFI value, and well below that which can be considered an acceptable fit. The fact that the model has outputted fit indices with a CFI value of only 0.500 and a TLI value of only 0.491 is a strong indication that there is an inferior goodness-of-fit between the developed hypothesised factor structure of the VPAT and the specific sample data.

The absolute indices of root mean square error of approximation (RMSEA) is dependent on determining the goodness-of-fit between the hypothesised model of the VPAT

together with the sample data. The results of the RMSEA are detailed in Table 7. The RMSEA value of 0.038 indicates a superior goodness-of-fit between the hypothesised model and the data set because the lower the RMSEA is, the closer it is to zero, which is preferred for a superior model fit. The RMSEA 90% confidence interval reflects the level of precision of the RMSEA value. A narrow interval as found in the analysis, ranging from 0.037 to 0.039, suggests that, according to this index, there was a good fit between the model for the VPAT and the sample data. The final goodness-of-fit statistic, the standardised root mean square residual (SRMR), a statistic used to assess the model fit in terms of factor structure, was outputted at 0.058, which is slightly higher than the 0.05 threshold for a well fitted model.

The goodness-of-fit statistics for the CFA primarily indicate an inferior fit for the VPAT with the sample data. The indices that suggest a fair fit are the RMSEA values, with the 90% confidence interval. All other indications from the model outputs indicate a highly inferior factor structure of the VPAT with this sample data. A hypothesised model that has goodness-of-fit outputted indices with a CFI value of 0.500 and a TLI value of 0.491, is highly indicative of an inferior goodness-of-fit between the developed hypothesised factor structure of the VPAT, with the specific sample data. The fit indices that support the hypothesised fit of the model include the chi-squared as well as the chi-squared baseline model, as well as the standardised root mean square residual, however, they are not sufficient to declare statistical significance of the hypothesised measure.

The validity of the model should not only be chosen based on the goodness-of-fit indices, but rather the fit indices should be complemented by the observation and examination of the parameter estimates of the items together with the hypothesised theory (Morin, Arens, & Marsh, 2016). The results of the CFA are examined according to item estimates of the uniquely defined factors within the sub-test. As per the parameters associated with CFA

specification, the items of each sub-test only loaded on their respective specified factor, while cross-loadings with unspecified factors were constrained to zero (Tóth-Király et al., 2017). When interpreting the significance of the factor loadings, a score of at least 0.33 is required to be considered fairly statistically significant (Yong & Pearce, 2013). However, these item estimates of STDYX standardised model results were low, with the following ranges: 0.211 to 0.482 for VD; 0.202 to 0.654 for VM; 0.254 to 0.704 for VSR; 0.096 to 0.818 for VF-G; 0.113 to 0.783 for VA/S. The VFC had several negative estimates and estimates as low as 0.011 to 0.609; VSM ranged from 0.046 to 0.899; P-S ranged from 0.088 to 0.675; VC ranged from 0.093 to 0.811.

When analysing each of the factor loadings associated with the observed variables, there are high levels of unsatisfactory values for each of the latent variables. This could be due to the hypothesised model's restrictive structure in terms of which items are assumed to be unidimensional to the specific factor and uncorrelated with other factors.

4.4.3 Exploratory Structural Equation Model

Results describing the goodness-of-fit indices from the Exploratory Structural Equation Model of the nine sub-scales to evaluate the factor structure of the Visual Perception Aspects Test are presented below. In the ESEM, the model was analysed using an oblique target rotation with a maximum likelihood parameter estimator. The model estimates terminated normally with 1548 free parameters. The first global fit indices which have been routinely used to assess whether the model fit of the hypothesised model is satisfactory, are presented in table 8 below.

Table 8: Values of the ESEM Model Fit Information Criteria.

<i>Model Fit Information – Information Criteria</i>	<i>VALUE</i>
<i>Akaike (AIC)</i>	29241.141
<i>Bayesian (BIC)</i>	35553.332
<i>Sample-Size Adjusted BIC</i>	30640.789

The first goodness-of-fit index, the Akaike (AIC), yielded an output of 29241.141, and Bayesian (BIC) output was 35553.332. Both these indices are again, like the CFA, indicative of an inferior or poor fit for the suggested model. In the analysis using the ESEM model, the value of the BIC is above the AIC value, which is not preferred for the hypothesised model fit.

Table 9: Values of the ESEM Chi Squared Test of Model Fit Information.

<i>Model Fit Information – Chi-Square Test of Model Fit</i>	<i>VALUE</i>
<i>Value</i>	14756.452*
<i>Degrees of Freedom</i>	9036
<i>P-Value</i>	0.0000
<i>Scaling Correction Factor for MLR</i>	0.9217

Table 9 above presents the results of the chi-squared test of model fit with regard to the ESEM. In contrast to the indications set by the AIC and BIC, the chi-squared value of 14756.452* is significantly smaller than the outputted chi-squared value of the baseline model, with a value of 22766.358. According to this chi-squared value, there is an indication that the hypothesised

model has a superior fit to the baseline model with less restrictive set parameters within the model analysis.

Table 10: Values of the ESEM RMSEA Model Fit Information.

<i>Model Fit Information – RMSEA (Root Mean Square Error Of Approximation)</i>	<i>VALUE</i>
<i>Estimate</i>	0.038
<i>90 Percent Confidence Interval</i>	0.037 / 0.039
<i>P-Value</i>	0.0000
<i>CFI</i>	0.541
<i>TLI</i>	0.477
<i>SRMR (Standardized Root Mean Square Residual)</i>	0.043

The RMSEA model fit information values for the ESEM are presented in Table 10. The RMSEA value of 0.038 is a strong indication of a superior goodness-of-fit between the hypothesised model and the sample data. Together with the CFA, the RMSEA 90% confidence interval has a narrow margin level in the range 0.037 to 0.039. These confidence interval levels are indicative of an acceptable goodness-of-fit model in relation to the factor structure of the hypothesised VPAT. The statistical readings for the CFI at 0.541, and TLI at 0.477, are again, albeit higher than the CFA, still significantly low as a fit for the hypothesised unidimensional factor structure of the VPAT. The final statistic for the model fit is the SRMR, which generated a value of 0.043. This value is slightly lower than the recommended 0.05 threshold for a good fitting model. The results in the goodness-of-fit indices are therefore rather mixed, with some indices indicating a strong fit and others indicating a poor fit. However, that the CFI and TLI

are highly indicative of a poor fit, and the researcher is therefore inclined to conclude that the hypothesised nine factor model for the VPAT has a poor fit with the data set.

The item estimates of STDYX standardised model results for the ESEM were significantly poor with the following ranges, 0.125 to 0.369 for VD; 0.174 to 0.523 for VM; 0.098 to 0.668 for VSR; 0.046 to 0.861 for VF-G; 0.088 to 0.789 for VA/S. The VFC had several negative estimates and estimates as low as 0.011 to 0.659; VSM ranged from 0.029 to 0.877; P-S ranged from 0.039 to 0.434; VC ranged from 0.108 to 0.476.

A large portion of these values are below satisfactory levels, which could be the result of the restrictive unidimensional model structure (Brown & Elliott, 2011; Brown et al., 2009).

4.4.4 Bifactor Confirmatory Factor Analysis

Results describing the goodness-of-fit indices from the Bifactor Confirmatory Factor Analysis of the nine factors to evaluate the factor structure of the Visual Perception Aspects Test are presented below. The nine sub-scales were analysed using a robust maximum likelihood estimator, with oblique target rotation and outputted with standardised modification indices. The model terminated normally with 576 free parameters in the analysis. The information criteria model fit information of the bifactor CFA is presented in Table 11 below.

Table 11: Values of the Bifactor CFA Model Fit Information Criteria.

<i>Model Fit Information – Information Criteria</i>	<i>VALUE</i>
<i>Akaike (AIC)</i>	28573.008
<i>Bayesian (BIC)</i>	30921.730
<i>Sample-Size Adjusted BIC</i>	29093.807

From all four analysis models, the bifactor CFA has the lowest AIC value, reading at 28573.008, which is indicative of the best model of analysis for the sample data. However, the BIC value of 30921.730 is still higher than the AIC, which indicates an inferior fit for the hypothesised model. It is important to note that the bifactor CFA outputted a lower score for the AIC than the CFA, which is highly indicative of the stronger method of analysis (Byrne, 2012). The results here are indicative of a good model fit, which are further reinforced by the chi-squared test of model fit information that is described in Table 12 below.

Table 12: Values of the Bifactor CFA Chi Squared Test of Model Fit Information.

<i>Model Fit Information – Chi-Square Test of Model Fit</i>	<i>VALUE</i>
<i>Value</i>	15576.817
<i>Degrees of Freedom</i>	10008
<i>P-Value</i>	0.0000
<i>Scaling Correction Factor for MLR</i>	0.9551

In contrast to the suggestions set by the AIC and BIC values, the chi-squared value of 15576.817* is meaningfully lower than the outputted chi-squared value of the baseline model,

with a result of 22766.358. This chi-squared value could be an indication that the hypothesised model has a better fit to the baseline model with no set parameters. However, this result is not indicative of the whole model having superior fit to the sample data. A model is generally deemed to have poor model fit by levels of CFI and TLI lower than 0.95 (Schreiber, Stage, King, Nora, & Barlow, 2006). Table 13 displays the results of the RMSEA model fit information for the bifactor CFA.

Table 13: Values of the Bifactor CFA RMSEA Model Fit Information.

<i>Model Fit Information – RMSEA (Root Mean Square Error Of Approximation)</i>	<i>VALUE</i>
<i>Estimate</i>	0.036
<i>90 Percent Confidence Interval</i>	0.035 / 0.037
<i>P-Value</i>	0.0000
<i>CFI</i>	0.553
<i>TLI</i>	0.541
<i>SRMR (Standardized Root Mean Square Residual)</i>	0.052

The bifactor CFA produced a RMSEA value of 0.036 which is a good indication of an acceptable goodness-of-fit of the hypothesised factor structure of the VPAT with the sample set. Furthermore, the RMSEA 90% confidence interval was 0.035 to 0.037, which indicates that there is a narrow margin between the readings, and this could suggest a strong fitting model. Once again, the CFI, reading at 0.553, and the TLI one at 0.541 are low when analysed in accordance with the suggested levels for a significant goodness-of-fit of the suggested model. The SRMR is again indicative of a relatively poor model fit with a reading of 0.052. It

is therefore possible to conclude that when the latent structure of the nine-factor unidimensionality VPAT is analysed with the introduction of a global factor, the goodness-of-fit indices are inferior and do not support the hypothesised model of the psychometric measure. However, these item estimates of STDYX standardised model results for the ESEM were poor ranging from 0.142 to 0.472 for VD; 0.172 to 0.527 for VM; 0.113 to 0.606 for VSR; 0.094 to 0.811 for VF-G; 0.031 to 0.915 for VA/S. VFC had several negative estimates and estimates as low as 0.042 to 0.757. VSM ranged from 0.088 to 0.930. P-S ranged from 0.098 to 0.690. VC ranged from 0.092 to 0.662. These significant cross-loadings between factors on several items appear to undermine the unidimensionality of each factor (Tóth-Király et al., 2017).

4.4.5 Bifactor Exploratory Structural Equation Model

The final experimental factor analysis model, the bifactor Exploratory Structural Equation Model estimation of model fit terminated normally. The goodness-of-fit indices for the bifactor ESEM, as seen in the three previous models, again indicate mixed results regarding the fit of the model. Results describing the goodness-of-fit indices from the bifactor ESEM of the nine factors to evaluate the factor structure of the VPAT are presented below. The model estimation was terminated normally with 1683 free parameters in the analysis. Table 14 presents the model fit information criteria for the bifactor ESEM below.

Table 14: Values of the Bifactor ESEM Model Fit Information Criteria.

<i>Model Fit Information – Information Criteria</i>	<i>VALUE</i>
<i>Akaike (AIC)</i>	29039.106
<i>Bayesian (BIC)</i>	35901.778
<i>Sample-Size Adjusted BIC</i>	30560.816

The values for the BIC are exponentially higher than the values produced by the AIC. As explained earlier, this is a strong indication of a poorly fitted model given the sample data. When this model is analysed against the ESEM, the AIC for the bifactor model is slightly lower, which indicates that the bifactor model is a stronger model for the model fit analysis using this sample data. The chi-squared test of model fit information for the bi factor ESEM is presented below in Table 15.

Table 15: Values of the Bifactor ESEM Chi Squared Test of Model Fit Information.

<i>Model Fit Information – Chi-Square Test of Model Fit</i>	<i>VALUE</i>
<i>Value</i>	14273.525
<i>Degrees of Freedom</i>	8901
<i>P-Value</i>	0.0000
<i>Scaling Correction Factor for MLR</i>	0.9198

Regarding the chi-squared values, the bifactor ESEM produced the lowest result at 14273.525*, which is also the biggest difference between the baseline model value at 22766.358. This is a strong suggestion that this type of analysis is the most superior amongst the factor analysis

types. Lastly, the root mean square error of the approximation model fit information is presented in Table 16. Here, the results obtained are insufficient to establish significant validity of the set of hypothesised multiple factor structure for the VPAT.

Table 16: Values of the Bifactor ESEM RMSEA Model Fit Information.

<i>Model Fit Information – RMSEA (Root Mean Square Error Of Approximation)</i>	<i>VALUE</i>
<i>Estimate</i>	0.037
<i>90 Percent Confidence Interval</i>	0.036 / 0.038
<i>P-Value</i>	0.0000
<i>CFI</i>	0.569
<i>TLI</i>	0.502
<i>SRMR (Standardized Root Mean Square Residual)</i>	0.041

The bifactor ESEM outputted the RMSEA value of 0.037, which is indicative of an acceptable goodness-of-fit between the hypothesised nine-factor VPAT and the sample data set. Furthermore, the value associated with the RMSEA 90% confidence interval, falling between 0.036 and 0.039, indicate a narrow margin, and suggest an acceptable goodness-of-fit model for the hypothesised factor structure. Again, as has been seen in the previous models, the CFI and TLI results are significantly lower, with values of 0.569 and 0.502 respectively. This is the highest CFL reading of all the analysis models, indicating the superiority of the bifactor ESEM against other factor analysis methods. Finally, the SRMR value for the bifactor ESEM is 0.041, which is the lowest SRMR value that was outputted from all of the analysis types.

The results here suggest that the bifactor ESEM is the stronger model of analysis for measuring the goodness-of-fit of the hypothesised factor structure of the VPAT. However, these results do not give sufficient support for statistical significance of the nine-factor structure of the VPAT in this context using a bifactor ESEM factor analysis. Results from the STDYX standardisation factor loadings of the bifactor ESEM were significantly poor with the following ranges: 0.178 to 0.420 for VD; 0.159 to 0.552 for VM; 0.129 to 0.621 for VSR; 0.067 to 0.813 for VF-G; 0.077 to 0.792 for VA/S. VFC had several negative estimates and estimates as low as 0.014 to 0.666. VSM ranged from 0.070 to 0.848, P-S ranged from 0.048 to 0.336, and VC ranged from 0.035 to 0.492. Each factor comprises of 16 items, each speculated to measure a unidimensional ability of visual perception. Given the theoretical definition of each construct by Clutten (2009) and Gardner (1996), and when analysed from the perspective of the information processing and the neurophysiology of visual perception, it could be speculated that the items within each sub-test are too similar. The results in each sub-test seem to suggest that there is some incongruity between the items and the theoretical definitions of the subtests, and that each subtest could actually be measuring a variety of different visual perceptual abilities. A discussion of the internal consistency, concurrent validity and criterion factor structure validity, as well as the implications of the VPAT's practical use as a standardised measure of visual perception for Foundation Phase learners in South Africa is presented in Chapter 5.

4.5 Chapter Summary

Chapter four presented the results that were obtained through a variety of validation methods, including measures of internal consistency and factor analysis methodologies. The first section of the chapter explored the descriptive statistics of the sample group from Port Elizabeth. Thereafter, details on the internal consistency that was measured through

Cronbach's alpha was presented. Lastly, the results from the confirmatory factor analysis, exploratory structural equation model, bifactor confirmatory factor analysis, and a bifactor exploratory structural equation model were presented. The purpose of these results was to determine whether the proposed factor structure of the VPAT had a superior goodness-of-fit model structure using a sample from a region within South Africa. The chapter started with descriptive statistics of the secondary data, describing the participants whom made up the sample group. Details of the experimental factor analyses were then followed, describing preferable goodness-of-fit indices as well as the results for each analysis type.

CHAPTER FIVE: DISCUSSION

5.1 Summary of the Study and Introduction to the Chapter

The aim of this study was to determine the validity and reliability of the proposed factor structure of the Visual Perception Aspects Test (VPAT) using a sample from one specific region within South Africa. Furthermore, it was aimed at establishing which method of factor analysis resulted in the best goodness-of-fit for the factor structure of the VPAT, and thus to ensure that the results of the model are valid and not just the result of the specific factor analysis method used. The study paid specific attention to the different types of goodness-of-fit indices of each method of factor analysis, used to determine the validity of the nine-factor unidimensional model that was proposed for the VPAT. The research aim was focused on the VPAT's usability by assessing the validity and reliability of the measurement instrument used to quantify visual perceptual abilities for a sample of Foundation Phase learners from the greater Port Elizabeth Metropole, South Africa. The aim of this study was to investigate the hypothesised unidimensional nine-factor structure of the VPAT using a South African Foundation Phase learner sample from Port Elizabeth, by exploring the reliability and validity of the measure using Cronbach's alpha and goodness-of-fit indices.

This research made use of a variety of experimental factor analyses, embedded in the quantitative methodology, including a CFA, an ESEM, a bifactor CFA and bifactor ESEM. This was done in an attempt to overcome limitations found in past studies. Therefore the researcher included a bifactor modelling approach into the analysis, and applied ESEM models in the analysis in an effort to account for small cross-loadings between items and finally to ensure the unidimensionality of the factor structure. Furthermore, to the researcher's knowledge, this is the first research study to examine the hypothesised factor structure of the VPAT. The participant sample size consisted of 443 grade-2 children from five schools within

the greater Port Elizabeth Metropole, South Africa. The participants visual perception abilities were quantified using the VPAT (Clutten, 2009). The VPAT is aimed at measuring nine constructs, grouped under four aspects, of visual perception that are hypothesised to be unidimensional under the umbrella term of visual perception. The four aspects include visual perception discriminatory aspects, visual memory aspects, visual spatial processing aspects and visual analytical aspects. Together, the aspects are designed to measure the individual constructs of visual perception individually under what is defined as a sub-test. The sub-tests include measuring the aspects that are detailed within the VPAT.

The second chapter reviewed some relevant literature and also described research on the cognitive processes associated with perceptual development. This chapter elaborated on some foundational research about visual perception, the visual system as well as the visual information process. To understand each aspect of perceptual development, a cognitive theory of visual perception, based on the information processing paradigm was presented. Furthermore, the hypothesised nine aspects, combined in the VPAT to measure visual perception, as well as the different types of factor analyses were described to give context to the research.

5.2 Internal Consistency

To measure the VPAT levels of reliability within this context, a test of internal consistency reliability was conducted. This level of reliability refers to the homogeneity of the items and estimates whether the scores obtained by the VPAT are free from errors of measurement. Each of the nine sub-tests were analysed using the sample of 443 participants, including all 16 items within each sub-test. None of the items were omitted during the analysis as the aim of this research was to investigate the reliability of the VPAT by using a sample

from a different region within South Africa, compared to the sample that was used during the development of the scale.

In the only previous study measuring the reliability of the VPAT using Cronbach's alpha coefficient, Clutten (2009) found that the sub-test Visual Form Constancy (VFC) reflected an alpha reliability of 0.48 using a sample of 118 Foundation Phase learners from the Western Cape. Her justification for the poor level of reliability was that it was either due to possible inconsistent or to unsuccessful descriptions of instructions. A third possibility was that the test was above the participants cognitive capabilities.

The sub-test remained part of the final psychometric scale and the results from this research indicated that VFC again did not reach significant alpha levels of reliability. The Cronbach's alpha coefficient value for the VFC sub-test in this study was 0.64. This is substantially larger than what Clutten (2009) found in the Western Cape, and below the recommended threshold value of 0.70 (Cohen et al., 2007; Tavakol & Dennick, 2011). Furthermore, three other sub-tests within the VPAT, namely the sub-tests Visual Discrimination (VD), Visual Figure-Ground (VF-G) and Visual Analysis and Synthesis (VA/S) all had Cronbach's alpha reliability coefficient values significantly lower than what is considered reliable in a psychological measure, ranging from 0.60, 0.64, 0.67 and 0.69 respectively. Clutten (2009) had Cronbach's alpha coefficient for VD at 0.72 after three items were removed from the sub-test. However, after removing the problematic items in this study, the alpha scores only improved to 0.64, which is still below the required value for acceptable reliability.

For the sub-test VF-G, with the use of 15 items, Clutten (2009) found alpha values of 0.80, which is considered highly reliable. These results were not replicated in this research. This could be due to a variety of reasons, including that the cognitive development of this visual

perceptual skill, according to the information processing theory, had not yet been adequately developed in this sample group. The third sub-test was found to be reliable within the sample group from the Western Cape. However, VA/S was not found in this context. The sub-tests VM and VSM were found to hold statistical significance for reliability according to the Cronbach's alpha reliability coefficient, with values of 0.74 and 0.75 respectively. To the researcher's knowledge, this is the first time that these two sub-tests have undergone measures of reliability as Clutten (2009) was unable to analyse these two sub-tests due to administration difficulties and omitted the results from her research. However, the sub-tests remained in the final version of the VPAT and were part of the analysis conducted in the Eastern Cape. Here, it was found that both sub-tests had significant internal reliability and should remain in the VPAT, pending further examination in other regions of South Africa.

Thus, the researcher recommends that in future use of the psychometric scale, the VFC sub-test be omitted from the measure. The sub-tests of VD, VF-G and VA/S did not reach statistical significance in terms of reliability in the Eastern Cape despite the fact that these sub-tests were deemed reliable in the Western Cape. Further research should be conducted on the reliability of these three sub-tests as conflicting reliability values have now emerged from the two different samples used in South Africa.

These results indicate that caution should be exercised when using and interpreting the sub-tests of a scale such as the VPAT in practice. Vigorous reliability analyses should be undertaken of the scale on the targeted sample before use. However, it should be stressed that is not quite clear what confounding variables could have caused the somewhat anomalous results between this analysis and Cutten's (2009) earlier study, and thus a variety of possible reasons are considered later in this chapter.

5.3 Construct Validity

The current study made use of secondary data from of a large sample of 443 Foundation Phase learners from the greater Port Elizabeth Metropole, to whom the VPAT were administered. These data was used by the researcher to attempt to validate the hypothesised factor structure of the VPAT.

The test was analysed using a variety of factor analysis methods. The researcher attempted to overcome limitations of factorial validity found in previous studies of psychological scale validation for cognitive measures in the following way. Firstly, ESEM models were used to account for small cross-loadings between items. Secondly, by implementing bifactor models into each analysis, the researcher tried to account for potential loadings onto a global factor. Finally, he focused on the unidimensionality of the factors within the analyses.

To the researcher's knowledge, this is the first research study that has examined the factor structure of the VPAT, as well as measuring the reliability of the scale using a sample group from a different province in South Africa. According to the results from this dissertation, the factorial validity of the hypothesised nine-factor model of the VPAT did not reach levels of statistical significance according to the goodness-of-fit values. Furthermore, as previously discussed, the subtest within the VPAT lacked significant levels of internal reliability when analysed based on Cronbach's alpha reliability coefficient.

A succession of different types of analysis are measured and analysed to assess the specific model using goodness-of-fit indices. A variety of factor analysis models were used, including structural equation models. Structural equation models are becoming increasingly important in the social sciences because they allow researchers to uncover the latent variables that can influence and have 'causal effects' on the manifest or measurable variables in a model.

Through the methods of factor analysis, including Confirmatory Factor Analysis (CFA), Exploratory Structural Equation modelling (ESEM), bifactor Confirmatory Factor Analysis (bifactor CFA), and bifactor Exploratory Structural Equation modelling (bifactor ESEM), models were used to assess the goodness-of-fit indices of latent variables and factors of the VPAT. The goodness-of-fit data generated from each analysis allows the researcher to conclude which model is most accurate in determining the factor structure within a psychological measurement scale.

In the data analysis the researcher proceeded from the point of departure that when a global factor is introduced into the factor structure of the VPAT, a detailed analysis of each factor, sub-scale and the item relationships will result in a clearer understanding of the factor loadings of each item. In interpreting the model assessment's results, the researcher relied on a combination of the most common goodness-of-fit indices as they provide an assortment of detailed information about the measure. Based on the results from all four factor analysis models, it is apparent that the unidimensional nine-factor structure assumption set by the VPAT is not supported by the data, because each of the nine sub-tests provided poor fit for the combined factor structure within the observed data from the Port Elizabeth sample group.

It is therefore unclear whether each sub-test is measuring the same factor or is consistently being measured by a collection of different factors. According to the information process paradigm and the theory of visual perception relied on in this dissertation, there would not be sufficient justification for alternating the model as it would deviate from the initial theoretical model. As such, no changes in the parameter constraints were made.

A psychometric model with a given CFI, TLI as well as RMSEA value that does not meet the suggestive values for an adequate model fit are strongly indicative of an exceptionally poor factor structure. There are a variety of reasons as to why such results could be obtained,

ranging from the specific sample that was selected for the study where this researcher obtained the data, to the fact that the items within each sub-test could be measuring the same factor, and therefore that the test does not comprise of nine unidimensional factors of visual perception. By using a CFA, ESEM, bifactor CFA and bifactor ESEM, the research evaluated whether the factor structure for all the nine sub-scales as a unidimensional model of visual perception, as stated by Clutten (2009) was valid for the data set used in this study. According to typical interpretation guidelines (Morin et al., 2016; Myers et al., 2014; Tucker & MacCallum, 1997) the results from all four types of factor analysis indicated a poor model fit, implying that the VPAT factor structure is not significantly valid in this particular context.

5.4 The Visual Perception Aspects Test

The aim of this study was to investigate the hypothesised unidimensional nine-factor structure of the VPAT in a South African Foundation Phase learner sample from Port Elizabeth, by exploring the reliability and validity of the measure using Cronbach's alpha and goodness-of-fit indices. In summary, although the results showed marginal model fit and sufficient reliability for certain sub-tests, the VPAT did not meet sufficient levels of reliability and validity to be deemed valid and reliable in its current structure with regard to the sample group of learners based in the Eastern Cape. These results may be due to a variety of factors which will now be discussed.

The first possible reason is that the low levels of internal consistency reliabilities and insufficient model fit obtained in the data analysis may be due to the possibility that specific items within each sub-test that are not able to measure the visual perceptual constructs proposed by the VPAT. On a closer inspection of each specific item, which compose each sub-test within the VPAT, the researcher found that there was a combination of several items that were potentially problematic in each sub-test, and this could account for the questionable

psychometric properties of the measure. In the original development of the scale, certain items were omitted from the sub-test and that resulted in slightly more significant levels of Cronbach's alpha. However, when the same items were removed in the analysis performed in this research, the alpha levels remained below .70, suggesting a low level of internal consistency for the sub-test.

According to neuropsychological models of information processing of visual perception, it is theoretically possible that the Foundation Phase learners that participated in this research had varying levels of visual perception developed, and thus, were unable to consistently complete the items for each sub-test. The development of visual perception, according to the information processing paradigm, is dependent on the receptive fields in the visual cortex and how well the individual is able to respond to the different visual stimuli according to neural networks and the nervous system. If the receptive fields are still unable to properly process the information presented to individuals, they will be unable to differentiate between lines, edges or the orientation of the stimuli. Therefore, they will be unable to complete the tasks set by each sub-test within the VPAT.

The second possible reason for lack of support for the unidimensional hypothesised model of the VPAT could be due to the fact that items from each sub-test did not surpass the factor loading cut-off point of 0.35 with regard to the sub-scales dominant factor. There was not one sub-scale in any of the analyses executed where all the items of each sub-test consistently loaded on their prospective factor. According to Brown et al. (2006), the fact that items for some of the sub-scales consistently loaded on their primary factor, whereas items for other sub-scales loaded on other sub-scales could result in items being multidimensional which would suggest a mixed picture with respect to the factor structure of the VPAT. The point is

that the results from the CFA, bifactor CFA, ESEM and bifactor ESEM do not provide support for the unidimensional assumption regarding the VPAT measure of visual perception.

A third possible reason for the VPAT being inconsistent in the South African context and not replicating the results found in the Western Cape by Clutten (2009) is due to cultural differences. It is possible that visual perception, according to neuropsychological models of information processing, specifically related to visual perception, does not merely transfer cross-culturally as seemly as first predicted for the South African context. Here, it is difficult to claim which of these results are problematic because of cultural differences of the Foundation Phase learners from Port Elizabeth, and which are accounted for by problematic items within each of the sub-tests. Thus, the researcher recommends that future research is required for this to be better understood. It is important that when a measure that has been regarded to be standardised for a whole country, is able to tap into the cultural differences that could possibly effect the development of visual perception. An emic understanding of the development of visual perception according to a neuropsychological information processing approach in the South African context from a bottom-up and top-down perspective will assist in the understanding of the development of visual perceptual constructs in diverse settings.

A fourth possibility for the lack of reliability and validity of the VPAT in this context is that the instructions for taking part in the measurement were not clear enough to be accurately interpreted by the Foundation Phase learners in the Eastern Cape. It is also possible that learners did not have the required level of perceptual skills. Thus, Clutten (2009) argues that, according to the neuropsychological theory of visual perception described by Gordon (2004), aspects of visual perception are acquired over different stages of development, and some individuals mature faster in their acquisition of visual perceptual constructs, such as visual form constancy, compared to other individuals. It is possible that this sample group of Foundation Phase learners

may not have developed the specific visual perceptual skills required to complete the VPAT. Therefore, although the factorial validity of the hypothesised nine factor model of the VPAT showed promise according to specific goodness-of-fit indices specified by Byrne (2012) the hypothesised model still exhibited a marginal model fit with insufficient validity reliability.

A final possible reason for the poor measurement results for the VPAT in the South African context is related to the theoretical underpinnings of the test. Clutten (2009) described the construct of visual perception as being complex in nature. She accepted defined that visual perception is multidisciplinary whereas there is actually no real consensus about the definition of the construct. The test was developed with an overarching definition of visual perception based on theories with roots in neuropsychology, developmental psychology and cognitive psychology (Clutten, 2009). Each sub-factor was defined based on definitions from a variety of visual perception tests with no basis in any one individual theory. This research interpreted the results of the test from the broad perspective of information processing and neurophysiological structures in the brain. It is therefore possible that the constructs as used and described in the VPAT do not fit with the ‘true’ theoretical underpinnings of each sub-factor, resulting in poor levels of reliability and validity.

5.5 Contributions of the Research

The present study, to the researcher’s knowledge, is the first study that has attempted to validate the hypothesised factor structure of the nine sub-scales of the VPAT using a factor analysis methodology. The VPAT was developed in the Western Cape, where a sample of 118 Foundation Phase learners were used to determine the validity and reliability of the scale. According to Clutten (2009) the VPAT was determined to be reliable and valid in the Western Cape context, however, certain sub-tests were never measured for reliability and some items that were deemed problematic remained in the final test. The VPAT was nevertheless claimed

to be useful as a standardised psychometric measurement scale of visual perception for Foundation Phase learners in South Africa.

The study provides researchers and practitioners intending to use the VPAT with a more critical and in-depth review of the VPAT, and also considers the validity of its factor structure. The researcher examined the external validity of the test by attempting to validate it using a sample from the Eastern Cape, a different region of South Africa compared to the sample used for primary validation.

The results of the CFA, bifactor CFA, ESEM, and bifactor ESEM were all indicative of a statistically insignificant factorial validity. The results obtained did not provide support for the hypothesised nine factor structure of the VPAT, and its definition as a unidimensional measurement scale of visual perception. Given these results, it is debatable whether the measure should be used without further research and adaptation as a standardised psychometric scale for Foundation Phase learners in South Africa. Practitioners and researchers should be cognisant of the fact that the VPAT may not be measuring all nine aspects of perception, but possibly only a smaller pool of visual abilities.

This research has hopefully contributed towards our understanding of the VPAT, and this test's reliability and validity when analysed using a variety of techniques, and a data set that is different from the original one used in the development of the test. The analysis conducted with the bifactor ESEM, in particular, has highlighted the need for researchers to be stricter in their consideration and use of specific theories that do not allow for both the specific and general factors that could influence the responses of participants on a psychometric measure. The results obtained from the bifactor model could even encourage future researchers to refine the theory underlying this measure.

In both bifactor instances (the bifactor CFA and bifactor ESEM), a stronger model fit was expressed through the CFI and TLI indices, with values ranging from 0.502 - .0569, and in both instances, the AIC had the lowest value of the analyses. It therefore appears that the analysis type that resulted in the best goodness-of-fit model was the bifactor ESEM, and the results obtained with the ESEM analysis may even suggest that a bifactor ESEM is the most valid model of factor analysis for determining the factor structure of a psychometric measure such as the VPAT.

Finally, this research dissertation may have helped to show how difficult it is to accurately complex cognitive abilities such as visual perception, and also how important it is to develop technologies with the required level of reliability and validity to measure the various aspects of visual perception. Two major theories of visual perception were described in chapter two, both presenting with valid and reliable aspects to define visual perception as a whole. A possible reason for the insufficient model fit using a different sample of participants to test the VPAT, could be due to the theory and assumptions underlying the measure's development. A variety of theories were used for each sub-test, and there could be conflicting theoretical structures for the development and measurement of each construct as described in chapter two. Further research should therefore be conducted on the contextual development of visual perception in South Africa.

5.6 Limitations and Suggestions for Further Research

The present study does have some limitations that should be mentioned here. The most obvious limitation is that data from only a single sample and region were used to draw conclusions about the reliability and validity of the VPAT. It is clear that these results cannot be generalised to the greater South African population, without additional data and research. The secondary data that was used in this research represents only a small sample of children

living in the Eastern Cape, South Africa. Thus, it is important to note that the findings of this study are limited in terms of generalisability as the sample underwent an intervention and the participants were chosen because they had a high chance of completing the study. Likewise, the primary data were obtained based on convenience, because Brey (2106) built a rapport with these schools when she was conducting her research. The schools were selected due to the fact that Brey (2016) believed the children in the school had a reasonable chance to achieve the aim of her study.

Furthermore, the data that was used in this research dissertation was collected in a language medium that was restricted to English, which is not the first language for many of the participants. The secondary data were collected using convenience sampling rather than a random sample, or a sample representative of the different cultures, regions and socio-economic strata in the country. The results of this study should therefore not be considered as a representative of the greater South African population.

Finally, the results and suggested conclusions within this study are statistically motivated to make a significant contribution to the current domain of cognitive neuropsychological research on the possible developments of visual perception, as well as the factor structure of the VPAT, as a tool used to measure specific constructs of visual perception. Additionally, the results here are sufficient to be empirically grounded into the framework of visual perception, as well as give recommendations for further research on the measurement of visual perception, especially in the South African context.

As previously stated, the secondary data that was used within the research dissertation was restricted to five schools based in the Port Elizabeth Metropole, South Africa. Future research based on a similar topic should engage with a much larger sample of participants from the greater South African region. Conducting research over a greater area of South Africa, or

in each province, would enhance the validity and reliability of the VPAT, as well as provide critical insight into the factor structure of the measurement.

An important recommendation for future research is to concentrate on a systematic exploration of the factor structure of the VPAT as opposed to only validating the hypothesised structure according to theory. This would provide details about the development of the measurement scale, giving insight into which aspects of visual perception are loading onto which factor. This could also refine the proposed use of the test measure and spread awareness among researchers in South Africa that there is a need for the development of psychometric measure that applies to aspects of visual perception that were not fitted in this hypothesised model.

5.7 Final Remarks

The current study has served to highlight, once again, that scientific research is a never-ending process of inquiry and critical reflection and that previous research can always be questioned. This is particularly true with regard to the measurement and testing of our cognitive and neuropsychological processes, where statistical approaches and psychometric techniques are always evolving, and therefore enable researchers to conduct ever more sophisticated analyses.

This study employed a variety of reasonably advanced statistical techniques to examine the factorial structure of the VPAT, an instrument used to measure aspects of visual perception. By uncovering some problems with the reliability, external validity, and possibly even the theoretical underpinnings of this instrument, the research has hopefully shown that psychometric instruments should not simply be used in an unreflective manner by clinical, counselling and educational practitioners in psychology, but that there is a need to systematically explore the adequacy of an instrument's psychometric properties, as some of the

discipline's pioneers, such as Spearman and Thurstone, have so convincingly shown in their work. Thus, by doing a systematic evaluation of the VPAT in this study, this researcher has tried to make a small contribution to our main goal as research psychologists, that is, to develop and refine psychological knowledge, techniques and instruments so that we can ultimately explain mind and behaviour as accurately as possible and with theoretically and scientifically sound technologies.

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APPENDIX A: Mplus Syntax - Confirmatory Factor Analysis

Mplus VERSION 7.4
MUTHEN & MUTHEN
07/11/2018 12:13 PM

INPUT INSTRUCTIONS

Data:

File is "C:/Users/klapw/Documents/Dissertation
/Data/Analysis/1007/Postdeleted/tester4.dat";

Variable:

Names are

PreVD1	PreVD2	PreVD3	PreVD4
PreVD5	PreVD6	PreVD7	PreVD8
PreVD9	PreVD10	PreVD11	PreVD12
PreVD13	PreVD14	PreVD15	PreVD16
PreVD_TOTAL			
PreVM1	PreVM2	PreVM3	PreVM4
PreVM5	PreVM6	PreVM7	PreVM8
PreVM9	PreVM10	PreVM11	PreVM12
PreVM13	PreVM14	PreVM15	PreVM16
PreVM_TOTAL			
PreVSR1	PreVSR2	PreVSR3	PreVSR4
PreVSR5	PreVSR6	PreVSR7	PreVSR8
PreVSR9	PreVSR10	PreVSR11	
PreVSR12	PreVSR13	PreVSR14	
PreVSR15	PreVSR16	PreVSR_TOTAL	
PreVF_G1	PreVF_G2	PreVF_G3	
PreVF_G4	PreVF_G5	PreVF_G6	
PreVF_G7	PreVF_G8	PreVF_G9	
PreVF_G10	PreVF_G11	PreVF_G12	
PreVF_G13	PreVF_G14	PreVF_G15	
PreVF_G16	PreVF_G_TOTAL		

PreVA_S1 PreVA_S2 PreVA_S3
 PreVA_S4 PreVA_S5 PreVA_S6
 PreVA_S7 PreVA_S8 PreVA_S9
 PreVA_S10 PreVA_S11 PreVA_S12
 PreVA_S13 PreVA_S14 PreVA_S15
 PreVA_S16 PreVA_S_TOTAL
 PreVFC1 PreVFC2 PreVFC3 PreVFC4
 PreVFC5 PreVFC6 PreVFC7 PreVFC8
 PreVFC9 PreVFC10 PreVFC11
 PreVFC12 PreVFC13 PreVFC14
 PreVFC15 PreVFC16 PreVFC_TOTAL
 PreVSM1 PreVSM2 PreVSM3 PreVSM4
 PreVSM5 PreVSM6 PreVSM7 PreVSM8
 PreVSM9 PreVSM10 PreVSM11
 PreVSM12 PreVSM13 PreVSM14
 PreVSM15 PreVSM16 PreVSM_TOTAL
 PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
 PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
 PreP_S11 PreP_S12 PreP_S13
 PreP_S14 PreP_S15 PreP_S16
 PreP_S_TOTAL
 PreVC1 PreVC2 PreVC3 PreVC4
 PreVC5 PreVC6 PreVC7 PreVC8
 PreVC9 PreVC10 PreVC11 PreVC12
 PreVC13 PreVC14 PreVC15 PreVC16
 PreVC_TOTAL;

Missing are all(-99);

Usevariables are

PreVD1 PreVD2 PreVD3 PreVD4
 PreVD5 PreVD6 PreVD7 PreVD8
 PreVD9 PreVD10 PreVD11 PreVD12
 PreVD13 PreVD14 PreVD15 PreVD16

PreVM1 PreVM2 PreVM3 PreVM4
PreVM5 PreVM6 PreVM7 PreVM8
PreVM9 PreVM10 PreVM11 PreVM12
PreVM13 PreVM14 PreVM15 PreVM16

PreVSR1 PreVSR2 PreVSR3 PreVSR4
PreVSR5 PreVSR6 PreVSR7 PreVSR8
PreVSR9 PreVSR10 PreVSR11
PreVSR12 PreVSR13 PreVSR14
PreVSR15 PreVSR16

PreVF_G1 PreVF_G2 PreVF_G3
PreVF_G4 PreVF_G5 PreVF_G6
PreVF_G7 PreVF_G8 PreVF_G9
PreVF_G10 PreVF_G11 PreVF_G12
PreVF_G13 PreVF_G14 PreVF_G15
PreVF_G16

PreVA_S1 PreVA_S2 PreVA_S3
PreVA_S4 PreVA_S5 PreVA_S6
PreVA_S7 PreVA_S8 PreVA_S9
PreVA_S10 PreVA_S11 PreVA_S12
PreVA_S13 PreVA_S14 PreVA_S15
PreVA_S16

PreVFC1 PreVFC2 PreVFC3 PreVFC4
PreVFC5 PreVFC6 PreVFC7 PreVFC8
PreVFC9 PreVFC10 PreVFC11
PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16

PreVSM1 PreVSM2 PreVSM3 PreVSM4
PreVSM5 PreVSM6 PreVSM7 PreVSM8

PreVSM9 PreVSM10 PreVSM11
PreVSM12 PreVSM13 PreVSM14
PreVSM15 PreVSM16

PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
PreP_S11 PreP_S12 PreP_S13
PreP_S14 PreP_S15 PreP_S16

PreVC1 PreVC2 PreVC3 PreVC4
PreVC5 PreVC6 PreVC7 PreVC8
PreVC9 PreVC10 PreVC11 PreVC12
PreVC13 PreVC14 PreVC15 PreVC16;

Analysis: estimator = MLR;

Model:

VD BY PreVD1* PreVD2 PreVD3 PreVD4
PreVD5 PreVD6 PreVD7 PreVD8
PreVD9 PreVD10 PreVD11 PreVD12
PreVD13 PreVD14 PreVD15 PreVD16;

VM BY PreVM1* PreVM2 PreVM3 PreVM4
PreVM5 PreVM6 PreVM7 PreVM8
PreVM9 PreVM10 PreVM11 PreVM12
PreVM13 PreVM14 PreVM15 PreVM16;

VSR BY PreVSR1* PreVSR2 PreVSR3 PreVSR4
PreVSR5 PreVSR6 PreVSR7 PreVSR8
PreVSR9 PreVSR10 PreVSR11
PreVSR12 PreVSR13 PreVSR14
PreVSR15 PreVSR16;

VF BY PreVF_G1* PreVF_G2 PreVF_G3
PreVF_G4 PreVF_G5 PreVF_G6
PreVF_G7 PreVF_G8 PreVF_G9
PreVF_G10 PreVF_G11 PreVF_G12
PreVF_G13 PreVF_G14 PreVF_G15
PreVF_G16;

VA BY PreVA_S1* PreVA_S2 PreVA_S3
PreVA_S4 PreVA_S5 PreVA_S6
PreVA_S7 PreVA_S8 PreVA_S9
PreVA_S10 PreVA_S11 PreVA_S12
PreVA_S13 PreVA_S14 PreVA_S15
PreVA_S16;

VFC BY PreVFC1* PreVFC2 PreVFC3 PreVFC4
PreVFC5 PreVFC6 PreVFC7 PreVFC8
PreVFC9 PreVFC10 PreVFC11
PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16;

VSM BY PreVSM1* PreVSM2 PreVSM3 PreVSM4
PreVSM5 PreVSM6 PreVSM7 PreVSM8
PreVSM9 PreVSM10 PreVSM11
PreVSM12 PreVSM13 PreVSM14
PreVSM15 PreVSM16;

P_S BY PreP_S1* PreP_S2 PreP_S3 PreP_S4 PreP_S5
PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
PreP_S11 PreP_S12 PreP_S13
PreP_S14 PreP_S15 PreP_S16;

VC BY PreVC1* PreVC2 PreVC3 PreVC4
PreVC5 PreVC6 PreVC7 PreVC8

PreVC9 PreVC10 PreVC11 PreVC12
PreVC13 PreVC14 PreVC15 PreVC16;

!Try freeing the first factor loading of each factor and fixing the factor variances to on

!EG: f BY y1* y2 y3 y4;

!EG: f@1;

VD@1;

VM@1;

VSR@1;

VF@1;

VA@1;

VFC@1;

VSM@1;

P_S@1;

VC@1;

Output:

Standardized Modindices;

APPENDIX B: Mplus Syntax - Exploratory Structural Equation

Modelling

Mplus VERSION 7.4
MUTHEN & MUTHEN
07/11/2018 4:08 PM

INPUT INSTRUCTIONS

TITLE:

VPAT 9 Factor ESEM
MLR estimator
Oblique target rotation

DATA:

File is "C:/Users/klapw/Documents/Dissertation
/Data/Analysis/1007/Postdeleted/tester4.dat";

VARIABLE:

Names are

PreVD1	PreVD2	PreVD3	PreVD4
PreVD5	PreVD6	PreVD7	PreVD8
PreVD9	PreVD10	PreVD11	PreVD12
PreVD13	PreVD14	PreVD15	PreVD16
PreVD_TOTAL			
PreVM1	PreVM2	PreVM3	PreVM4
PreVM5	PreVM6	PreVM7	PreVM8
PreVM9	PreVM10	PreVM11	PreVM12
PreVM13	PreVM14	PreVM15	PreVM16
PreVM_TOTAL			
PreVSR1	PreVSR2	PreVSR3	PreVSR4
PreVSR5	PreVSR6	PreVSR7	PreVSR8
PreVSR9	PreVSR10	PreVSR11	
PreVSR12	PreVSR13	PreVSR14	
PreVSR15	PreVSR16	PreVSR_TOTAL	
PreVF_G1	PreVF_G2	PreVF_G3	

PreVF_G4 PreVF_G5 PreVF_G6
 PreVF_G7 PreVF_G8 PreVF_G9
 PreVF_G10 PreVF_G11 PreVF_G12
 PreVF_G13 PreVF_G14 PreVF_G15
 PreVF_G16 PreVF_G_TOTAL
 PreVA_S1 PreVA_S2 PreVA_S3
 PreVA_S4 PreVA_S5 PreVA_S6
 PreVA_S7 PreVA_S8 PreVA_S9
 PreVA_S10 PreVA_S11 PreVA_S12
 PreVA_S13 PreVA_S14 PreVA_S15
 PreVA_S16 PreVA_S_TOTAL
 PreVFC1 PreVFC2 PreVFC3 PreVFC4
 PreVFC5 PreVFC6 PreVFC7 PreVFC8
 PreVFC9 PreVFC10 PreVFC11
 PreVFC12 PreVFC13 PreVFC14
 PreVFC15 PreVFC16 PreVFC_TOTAL
 PreVSM1 PreVSM2 PreVSM3 PreVSM4
 PreVSM5 PreVSM6 PreVSM7 PreVSM8
 PreVSM9 PreVSM10 PreVSM11
 PreVSM12 PreVSM13 PreVSM14
 PreVSM15 PreVSM16 PreVSM_TOTAL
 PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
 PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
 PreP_S11 PreP_S12 PreP_S13
 PreP_S14 PreP_S15 PreP_S16
 PreP_S_TOTAL
 PreVC1 PreVC2 PreVC3 PreVC4
 PreVC5 PreVC6 PreVC7 PreVC8
 PreVC9 PreVC10 PreVC11 PreVC12
 PreVC13 PreVC14 PreVC15 PreVC16
 PreVC_TOTAL;

Missing are all(-99);

Usevariables are

PreVD1	PreVD2	PreVD3	PreVD4
PreVD5	PreVD6	PreVD7	PreVD8
PreVD9	PreVD10	PreVD11	PreVD12
PreVD13	PreVD14	PreVD15	PreVD16

PreVM1	PreVM2	PreVM3	PreVM4
PreVM5	PreVM6	PreVM7	PreVM8
PreVM9	PreVM10	PreVM11	PreVM12
PreVM13	PreVM14	PreVM15	PreVM16

PreVSR1	PreVSR2	PreVSR3	PreVSR4
PreVSR5	PreVSR6	PreVSR7	PreVSR8
PreVSR9	PreVSR10	PreVSR11	
PreVSR12	PreVSR13	PreVSR14	
PreVSR15	PreVSR16		

PreVF_G1	PreVF_G2	PreVF_G3
PreVF_G4	PreVF_G5	PreVF_G6
PreVF_G7	PreVF_G8	PreVF_G9
PreVF_G10	PreVF_G11	PreVF_G12
PreVF_G13	PreVF_G14	PreVF_G15
PreVF_G16		

PreVA_S1	PreVA_S2	PreVA_S3
PreVA_S4	PreVA_S5	PreVA_S6
PreVA_S7	PreVA_S8	PreVA_S9
PreVA_S10	PreVA_S11	PreVA_S12
PreVA_S13	PreVA_S14	PreVA_S15
PreVA_S16		

PreVFC1	PreVFC2	PreVFC3	PreVFC4
PreVFC5	PreVFC6	PreVFC7	PreVFC8
PreVFC9	PreVFC10	PreVFC11	

PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16

PreVSM1 PreVSM2 PreVSM3 PreVSM4
PreVSM5 PreVSM6 PreVSM7 PreVSM8
PreVSM9 PreVSM10 PreVSM11
PreVSM12 PreVSM13 PreVSM14
PreVSM15 PreVSM16

PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
PreP_S11 PreP_S12 PreP_S13
PreP_S14 PreP_S15 PreP_S16

PreVC1 PreVC2 PreVC3 PreVC4
PreVC5 PreVC6 PreVC7 PreVC8
PreVC9 PreVC10 PreVC11 PreVC12
PreVC13 PreVC14 PreVC15 PreVC16;

ANALYSIS:

type = missing;

ESTIMATOR = MLR;

ROTATION = TARGET; !This is an oblique target rotation

MODEL:

VD BY PreVD1-PreVD16 PreVM1-PreVM16~0
PreVSR1-PreVSR16~0 PreVF_G1-PreVF_G16~0
PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VM BY PreVM1-PreVM16 PreVD1-PreVD16~0
PreVSR1-PreVSR16~0 PreVF_G1-PreVF_G16~0

PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VSR BY PreVSR1-PreVSR16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVF_G1-PreVF_G16~0
PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VF BY PreVF_G1-PreVF_G16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VA BY PreVA_S1-PreVA_S16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VFC BY PreVFC1-PreVFC16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VSM BY PreVSM1-PreVC16 PreVD1-PreVD16~0

PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVFC1-PreVFC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

P_S BY PreP_S1-PreP_S16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVFC1-PreVFC16~0 PreVSM1-PreVC16~0
PreVC1-PreVC16~0 (*1);

VC BY PreVC1-PreVC16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVFC1-PreVFC16~0 PreVSM1-PreVC16~0
PreP_S1-PreP_S16~0 (*1);

OUTPUT:

STDYX mod(3.84) tech1;

APPENDIX C: Mplus Syntax - Bifactor Confirmatory Factor Analysis

Mplus VERSION 7.4
MUTHEN & MUTHEN
07/12/2018 10:11 AM

INPUT INSTRUCTIONS

Data:

File is "C:/Users/klapw/Documents/Dissertation
/Data/Analysis/1007/Postdeleted/tester4.dat";

Variable:

Names are

PreVD1	PreVD2	PreVD3	PreVD4
PreVD5	PreVD6	PreVD7	PreVD8
PreVD9	PreVD10	PreVD11	PreVD12
PreVD13	PreVD14	PreVD15	PreVD16
PreVD_TOTAL			
PreVM1	PreVM2	PreVM3	PreVM4
PreVM5	PreVM6	PreVM7	PreVM8
PreVM9	PreVM10	PreVM11	PreVM12
PreVM13	PreVM14	PreVM15	PreVM16
PreVM_TOTAL			
PreVSR1	PreVSR2	PreVSR3	PreVSR4
PreVSR5	PreVSR6	PreVSR7	PreVSR8
PreVSR9	PreVSR10	PreVSR11	
PreVSR12	PreVSR13	PreVSR14	
PreVSR15	PreVSR16	PreVSR_TOTAL	
PreVF_G1	PreVF_G2	PreVF_G3	
PreVF_G4	PreVF_G5	PreVF_G6	
PreVF_G7	PreVF_G8	PreVF_G9	
PreVF_G10	PreVF_G11	PreVF_G12	
PreVF_G13	PreVF_G14	PreVF_G15	
PreVF_G16	PreVF_G_TOTAL		

PreVA_S1 PreVA_S2 PreVA_S3
 PreVA_S4 PreVA_S5 PreVA_S6
 PreVA_S7 PreVA_S8 PreVA_S9
 PreVA_S10 PreVA_S11 PreVA_S12
 PreVA_S13 PreVA_S14 PreVA_S15
 PreVA_S16 PreVA_S_TOTAL
 PreVFC1 PreVFC2 PreVFC3 PreVFC4
 PreVFC5 PreVFC6 PreVFC7 PreVFC8
 PreVFC9 PreVFC10 PreVFC11
 PreVFC12 PreVFC13 PreVFC14
 PreVFC15 PreVFC16 PreVFC_TOTAL
 PreVSM1 PreVSM2 PreVSM3 PreVSM4
 PreVSM5 PreVSM6 PreVSM7 PreVSM8
 PreVSM9 PreVSM10 PreVSM11
 PreVSM12 PreVSM13 PreVSM14
 PreVSM15 PreVSM16 PreVSM_TOTAL
 PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
 PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
 PreP_S11 PreP_S12 PreP_S13
 PreP_S14 PreP_S15 PreP_S16
 PreP_S_TOTAL
 PreVC1 PreVC2 PreVC3 PreVC4
 PreVC5 PreVC6 PreVC7 PreVC8
 PreVC9 PreVC10 PreVC11 PreVC12
 PreVC13 PreVC14 PreVC15 PreVC16
 PreVC_TOTAL;

Missing are all(-99);

Usevariables are

PreVD1 PreVD2 PreVD3 PreVD4
 PreVD5 PreVD6 PreVD7 PreVD8
 PreVD9 PreVD10 PreVD11 PreVD12
 PreVD13 PreVD14 PreVD15 PreVD16

PreVM1 PreVM2 PreVM3 PreVM4
PreVM5 PreVM6 PreVM7 PreVM8
PreVM9 PreVM10 PreVM11 PreVM12
PreVM13 PreVM14 PreVM15 PreVM16

PreVSR1 PreVSR2 PreVSR3 PreVSR4
PreVSR5 PreVSR6 PreVSR7 PreVSR8
PreVSR9 PreVSR10 PreVSR11
PreVSR12 PreVSR13 PreVSR14
PreVSR15 PreVSR16

PreVF_G1 PreVF_G2 PreVF_G3
PreVF_G4 PreVF_G5 PreVF_G6
PreVF_G7 PreVF_G8 PreVF_G9
PreVF_G10 PreVF_G11 PreVF_G12
PreVF_G13 PreVF_G14 PreVF_G15
PreVF_G16

PreVA_S1 PreVA_S2 PreVA_S3
PreVA_S4 PreVA_S5 PreVA_S6
PreVA_S7 PreVA_S8 PreVA_S9
PreVA_S10 PreVA_S11 PreVA_S12
PreVA_S13 PreVA_S14 PreVA_S15
PreVA_S16

PreVFC1 PreVFC2 PreVFC3 PreVFC4
PreVFC5 PreVFC6 PreVFC7 PreVFC8
PreVFC9 PreVFC10 PreVFC11
PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16

PreVSM1 PreVSM2 PreVSM3 PreVSM4
PreVSM5 PreVSM6 PreVSM7 PreVSM8

PreVSM9 PreVSM10 PreVSM11
PreVSM12 PreVSM13 PreVSM14
PreVSM15 PreVSM16

PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
PreP_S11 PreP_S12 PreP_S13
PreP_S14 PreP_S15 PreP_S16

PreVC1 PreVC2 PreVC3 PreVC4
PreVC5 PreVC6 PreVC7 PreVC8
PreVC9 PreVC10 PreVC11 PreVC12
PreVC13 PreVC14 PreVC15 PreVC16;

Analysis: estimator = MLR;

Model:

VD BY PreVD1* PreVD2 PreVD3 PreVD4
PreVD5 PreVD6 PreVD7 PreVD8
PreVD9 PreVD10 PreVD11 PreVD12
PreVD13 PreVD14 PreVD15 PreVD16;

VM BY PreVM1* PreVM2 PreVM3 PreVM4
PreVM5 PreVM6 PreVM7 PreVM8
PreVM9 PreVM10 PreVM11 PreVM12
PreVM13 PreVM14 PreVM15 PreVM16;

VSR BY PreVSR1* PreVSR2 PreVSR3 PreVSR4
PreVSR5 PreVSR6 PreVSR7 PreVSR8
PreVSR9 PreVSR10 PreVSR11
PreVSR12 PreVSR13 PreVSR14
PreVSR15 PreVSR16;

VF BY PreVF_G1* PreVF_G2 PreVF_G3
PreVF_G4 PreVF_G5 PreVF_G6
PreVF_G7 PreVF_G8 PreVF_G9
PreVF_G10 PreVF_G11 PreVF_G12
PreVF_G13 PreVF_G14 PreVF_G15
PreVF_G16;

VA BY PreVA_S1* PreVA_S2 PreVA_S3
PreVA_S4 PreVA_S5 PreVA_S6
PreVA_S7 PreVA_S8 PreVA_S9
PreVA_S10 PreVA_S11 PreVA_S12
PreVA_S13 PreVA_S14 PreVA_S15
PreVA_S16;

VFC BY PreVFC1* PreVFC2 PreVFC3 PreVFC4
PreVFC5 PreVFC6 PreVFC7 PreVFC8
PreVFC9 PreVFC10 PreVFC11
PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16;

VSM BY PreVSM1* PreVSM2 PreVSM3 PreVSM4
PreVSM5 PreVSM6 PreVSM7 PreVSM8
PreVSM9 PreVSM10 PreVSM11
PreVSM12 PreVSM13 PreVSM14
PreVSM15 PreVSM16;

P_S BY PreP_S1* PreP_S2 PreP_S3 PreP_S4 PreP_S5
PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
PreP_S11 PreP_S12 PreP_S13
PreP_S14 PreP_S15 PreP_S16;

VC BY PreVC1* PreVC2 PreVC3 PreVC4
PreVC5 PreVC6 PreVC7 PreVC8

PreVC9 PreVC10 PreVC11 PreVC12
PreVC13 PreVC14 PreVC15 PreVC16;

VPAT BY PreVD1* PreVD2 PreVD3 PreVD4

PreVD5 PreVD6 PreVD7 PreVD8
PreVD9 PreVD10 PreVD11 PreVD12
PreVD13 PreVD14 PreVD15 PreVD16
PreVM1 PreVM2 PreVM3 PreVM4
PreVM5 PreVM6 PreVM7 PreVM8
PreVM9 PreVM10 PreVM11 PreVM12
PreVM13 PreVM14 PreVM15 PreVM16
PreVSR1 PreVSR2 PreVSR3 PreVSR4
PreVSR5 PreVSR6 PreVSR7 PreVSR8
PreVSR9 PreVSR10 PreVSR11
PreVSR12 PreVSR13 PreVSR14
PreVSR15 PreVSR16
PreVF_G1 PreVF_G2 PreVF_G3
PreVF_G4 PreVF_G5 PreVF_G6
PreVF_G7 PreVF_G8 PreVF_G9
PreVF_G10 PreVF_G11 PreVF_G12
PreVF_G13 PreVF_G14 PreVF_G15
PreVF_G16
PreVA_S1 PreVA_S2 PreVA_S3
PreVA_S4 PreVA_S5 PreVA_S6
PreVA_S7 PreVA_S8 PreVA_S9
PreVA_S10 PreVA_S11 PreVA_S12
PreVA_S13 PreVA_S14 PreVA_S15
PreVA_S16
PreVFC1 PreVFC2 PreVFC3 PreVFC4
PreVFC5 PreVFC6 PreVFC7 PreVFC8
PreVFC9 PreVFC10 PreVFC11
PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16
PreVSM1 PreVSM2 PreVSM3 PreVSM4

PreVSM5	PreVSM6	PreVSM7	PreVSM8	
PreVSM9	PreVSM10	PreVSM11		
PreVSM12	PreVSM13	PreVSM14		
PreVSM15	PreVSM16			
PreP_S1	PreP_S2	PreP_S3	PreP_S4	PreP_S5
PreP_S6	PreP_S7	PreP_S8	PreP_S9	PreP_S10
PreP_S11	PreP_S12	PreP_S13		
PreP_S14	PreP_S15	PreP_S16		
PreVC1	PreVC2	PreVC3	PreVC4	
PreVC5	PreVC6	PreVC7	PreVC8	
PreVC9	PreVC10	PreVC11	PreVC12	
PreVC13	PreVC14	PreVC15	PreVC16;	

!Try freeing the first factor loading of each factor and fixing the factor variances to on

!EG: f BY y1* y2 y3 y4;

!EG: f@1;

VD@1;

VM@1;

VSR@1;

VF@1;

VA@1;

VFC@1;

VSM@1;

P_S@1;

VC@1;

VPAT@1;

VD with VM@0;

VD with VSR@0;

VD with VF@0;

VD with VA@0;

VD with VFC@0;

VD with VSM@0;
VD with P_S@0;
VD with VC@0;
VD with VPAT@0;

VM with VD@0;
VM with VSR@0;
VM with VF@0;
VM with VA@0;
VM with VFC@0;
VM with VSM@0;
VM with P_S@0;
VM with VC@0;
VM with VPAT@0;

VSR with VD@0;
VSR with VM@0;
VSR with VF@0;
VSR with VA@0;
VSR with VFC@0;
VSR with VSM@0;
VSR with P_S@0;
VSR with VC@0;
VSR with VPAT@0;

VF with VD@0;
VF with VM@0;
VF with VSR@0;
VF with VA@0;
VF with VFC@0;
VF with VSM@0;
VF with P_S@0;
VF with VC@0;
VF with VPAT@0;

VA with VD@0;
VA with VM@0;
VA with VSR@0;
VA with VF@0;
VA with VFC@0;
VA with VSM@0;
VA with P_S@0;
VA with VC@0;
VA with VPAT@0;

VFC with VD@0;
VFC with VM@0;
VFC with VSR@0;
VFC with VF@0;
VFC with VA@0;
VFC with VSM@0;
VFC with P_S@0;
VFC with VC@0;
VFC with VPAT@0;

VSM with VD@0;
VSM with VM@0;
VSM with VSR@0;
VSM with VF@0;
VSM with VA@0;
VSM with VFC@0;
VSM with P_S@0;
VSM with VC@0;
VSM with VPAT@0;

P_S with VD@0;
P_S with VM@0;
P_S with VSR@0;

P_S with VF@0;
P_S with VA@0;
P_S with VFC@0;
P_S with VSM@0;
P_S with VC@0;
P_S with VPAT@0;

VC with VD@0;
VC with VM@0;
VC with VSR@0;
VC with VF@0;
VC with VA@0;
VC with VFC@0;
VC with VSM@0;
VC with P_S@0;
VC with VPAT@0;

VPAT with VD@0;
VPAT with VM@0;
VPAT with VSR@0;
VPAT with VF@0;
VPAT with VA@0;
VPAT with VFC@0;
VPAT with VSM@0;
VPAT with P_S@0;
VPAT with VC@0;

Output:

!Standardized Modindices;
STDYX mod(3.84) tech1;

APPENDIX D: Mplus Syntax - Bifactor Exploratory Structural Equation Modelling

Mplus VERSION 7.4
MUTHEN & MUTHEN
07/12/2018 10:49 AM

INPUT INSTRUCTIONS

TITLE:

VPAT 9 bifactor ESEM
MLR estimator
Oblique target rotation

DATA:

File is "C:/Users/klapw/Documents/Dissertation
/Data/Analysis/1007/Postdeleted/tester4.dat";

VARIABLE:

Names are

PreVD1	PreVD2	PreVD3	PreVD4
PreVD5	PreVD6	PreVD7	PreVD8
PreVD9	PreVD10	PreVD11	PreVD12
PreVD13	PreVD14	PreVD15	PreVD16
PreVD_TOTAL			
PreVM1	PreVM2	PreVM3	PreVM4
PreVM5	PreVM6	PreVM7	PreVM8
PreVM9	PreVM10	PreVM11	PreVM12
PreVM13	PreVM14	PreVM15	PreVM16
PreVM_TOTAL			
PreVSR1	PreVSR2	PreVSR3	PreVSR4
PreVSR5	PreVSR6	PreVSR7	PreVSR8
PreVSR9	PreVSR10	PreVSR11	
PreVSR12	PreVSR13	PreVSR14	
PreVSR15	PreVSR16	PreVSR_TOTAL	
PreVF_G1	PreVF_G2	PreVF_G3	

PreVF_G4 PreVF_G5 PreVF_G6
 PreVF_G7 PreVF_G8 PreVF_G9
 PreVF_G10 PreVF_G11 PreVF_G12
 PreVF_G13 PreVF_G14 PreVF_G15
 PreVF_G16 PreVF_G_TOTAL
 PreVA_S1 PreVA_S2 PreVA_S3
 PreVA_S4 PreVA_S5 PreVA_S6
 PreVA_S7 PreVA_S8 PreVA_S9
 PreVA_S10 PreVA_S11 PreVA_S12
 PreVA_S13 PreVA_S14 PreVA_S15
 PreVA_S16 PreVA_S_TOTAL
 PreVFC1 PreVFC2 PreVFC3 PreVFC4
 PreVFC5 PreVFC6 PreVFC7 PreVFC8
 PreVFC9 PreVFC10 PreVFC11
 PreVFC12 PreVFC13 PreVFC14
 PreVFC15 PreVFC16 PreVFC_TOTAL
 PreVSM1 PreVSM2 PreVSM3 PreVSM4
 PreVSM5 PreVSM6 PreVSM7 PreVSM8
 PreVSM9 PreVSM10 PreVSM11
 PreVSM12 PreVSM13 PreVSM14
 PreVSM15 PreVSM16 PreVSM_TOTAL
 PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
 PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
 PreP_S11 PreP_S12 PreP_S13
 PreP_S14 PreP_S15 PreP_S16
 PreP_S_TOTAL
 PreVC1 PreVC2 PreVC3 PreVC4
 PreVC5 PreVC6 PreVC7 PreVC8
 PreVC9 PreVC10 PreVC11 PreVC12
 PreVC13 PreVC14 PreVC15 PreVC16
 PreVC_TOTAL;

Missing are all(-99);

Usevariables are

PreVD1	PreVD2	PreVD3	PreVD4
PreVD5	PreVD6	PreVD7	PreVD8
PreVD9	PreVD10	PreVD11	PreVD12
PreVD13	PreVD14	PreVD15	PreVD16

PreVM1	PreVM2	PreVM3	PreVM4
PreVM5	PreVM6	PreVM7	PreVM8
PreVM9	PreVM10	PreVM11	PreVM12
PreVM13	PreVM14	PreVM15	PreVM16

PreVSR1	PreVSR2	PreVSR3	PreVSR4
PreVSR5	PreVSR6	PreVSR7	PreVSR8
PreVSR9	PreVSR10	PreVSR11	
PreVSR12	PreVSR13	PreVSR14	
PreVSR15	PreVSR16		

PreVF_G1	PreVF_G2	PreVF_G3
PreVF_G4	PreVF_G5	PreVF_G6
PreVF_G7	PreVF_G8	PreVF_G9
PreVF_G10	PreVF_G11	PreVF_G12
PreVF_G13	PreVF_G14	PreVF_G15
PreVF_G16		

PreVA_S1	PreVA_S2	PreVA_S3
PreVA_S4	PreVA_S5	PreVA_S6
PreVA_S7	PreVA_S8	PreVA_S9
PreVA_S10	PreVA_S11	PreVA_S12
PreVA_S13	PreVA_S14	PreVA_S15
PreVA_S16		

PreVFC1	PreVFC2	PreVFC3	PreVFC4
PreVFC5	PreVFC6	PreVFC7	PreVFC8
PreVFC9	PreVFC10	PreVFC11	

PreVFC12 PreVFC13 PreVFC14
PreVFC15 PreVFC16

PreVSM1 PreVSM2 PreVSM3 PreVSM4
PreVSM5 PreVSM6 PreVSM7 PreVSM8
PreVSM9 PreVSM10 PreVSM11
PreVSM12 PreVSM13 PreVSM14
PreVSM15 PreVSM16

PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
PreP_S11 PreP_S12 PreP_S13
PreP_S14 PreP_S15 PreP_S16

PreVC1 PreVC2 PreVC3 PreVC4
PreVC5 PreVC6 PreVC7 PreVC8
PreVC9 PreVC10 PreVC11 PreVC12
PreVC13 PreVC14 PreVC15 PreVC16;

ANALYSIS:

type = missing;

ESTIMATOR = MLR;

ROTATION = TARGET; !This is an oblique target rotation

MODEL:

VD BY PreVD1-PreVD16 PreVM1-PreVM16~0
PreVSR1-PreVSR16~0 PreVF_G1-PreVF_G16~0
PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VM BY PreVM1-PreVM16 PreVD1-PreVD16~0
PreVSR1-PreVSR16~0 PreVF_G1-PreVF_G16~0

PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VSR BY PreVSR1-PreVSR16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVF_G1-PreVF_G16~0
PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VF BY PreVF_G1-PreVF_G16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVA_S1-PreVA_S16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VA BY PreVA_S1-PreVA_S16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVFC1-PreVFC16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VFC BY PreVFC1-PreVFC16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVSM1-PreVC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

VSM BY PreVSM1-PreVC16 PreVD1-PreVD16~0

PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVFC1-PreVFC16~0 PreP_S1-PreP_S16~0
PreVC1-PreVC16~0 (*1);

P_S BY PreP_S1-PreP_S16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVFC1-PreVFC16~0 PreVSM1-PreVC16~0
PreVC1-PreVC16~0 (*1);

VC BY PreVC1-PreVC16 PreVD1-PreVD16~0
PreVM1-PreVM16~0 PreVSR1-PreVSR16~0
PreVF_G1-PreVF_G16~0 PreVA_S1-PreVA_S16~0
PreVFC1-PreVFC16~0 PreVSM1-PreVC16~0
PreP_S1-PreP_S16~0 (*1);

VPAT BY PreVD1* PreVD2 PreVD3 PreVD4
PreVD5 PreVD6 PreVD7 PreVD8
PreVD9 PreVD10 PreVD11 PreVD12
PreVD13 PreVD14 PreVD15 PreVD16
PreVM1 PreVM2 PreVM3 PreVM4
PreVM5 PreVM6 PreVM7 PreVM8
PreVM9 PreVM10 PreVM11 PreVM12
PreVM13 PreVM14 PreVM15 PreVM16
PreVSR1 PreVSR2 PreVSR3 PreVSR4
PreVSR5 PreVSR6 PreVSR7 PreVSR8
PreVSR9 PreVSR10 PreVSR11
PreVSR12 PreVSR13 PreVSR14
PreVSR15 PreVSR16
PreVF_G1 PreVF_G2 PreVF_G3
PreVF_G4 PreVF_G5 PreVF_G6

PreVF_G7 PreVF_G8 PreVF_G9
 PreVF_G10 PreVF_G11 PreVF_G12
 PreVF_G13 PreVF_G14 PreVF_G15
 PreVF_G16
 PreVA_S1 PreVA_S2 PreVA_S3
 PreVA_S4 PreVA_S5 PreVA_S6
 PreVA_S7 PreVA_S8 PreVA_S9
 PreVA_S10 PreVA_S11 PreVA_S12
 PreVA_S13 PreVA_S14 PreVA_S15
 PreVA_S16
 PreVFC1 PreVFC2 PreVFC3 PreVFC4
 PreVFC5 PreVFC6 PreVFC7 PreVFC8
 PreVFC9 PreVFC10 PreVFC11
 PreVFC12 PreVFC13 PreVFC14
 PreVFC15 PreVFC16
 PreVSM1 PreVSM2 PreVSM3 PreVSM4
 PreVSM5 PreVSM6 PreVSM7 PreVSM8
 PreVSM9 PreVSM10 PreVSM11
 PreVSM12 PreVSM13 PreVSM14
 PreVSM15 PreVSM16
 PreP_S1 PreP_S2 PreP_S3 PreP_S4 PreP_S5
 PreP_S6 PreP_S7 PreP_S8 PreP_S9 PreP_S10
 PreP_S11 PreP_S12 PreP_S13
 PreP_S14 PreP_S15 PreP_S16
 PreVC1 PreVC2 PreVC3 PreVC4
 PreVC5 PreVC6 PreVC7 PreVC8
 PreVC9 PreVC10 PreVC11 PreVC12
 PreVC13 PreVC14 PreVC15 PreVC16 (*1);

OUTPUT:

STDYX mod(3.84) tech1;

APPENDIX E: The Visual Perceptual Aspects Test

VISUAL PERCEPTUAL ASPECTS TEST (VPAT) SCORE SHEET

				Coding numbers	Column
Name:			(001-150)	<input type="text"/> <input type="text"/> <input type="text"/>	c 1-3
Gender:	male	=	1		c 4
	female	=	2	<input type="checkbox"/>	
Date of Assessment:	/ /	=	yymmdd		
Date of Birth:	/ /	=	yymmdd		
Chronological Age:	:	=	yy:mm	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	c 5-9
Language:	English	=	1		
	Afrikaans	=	2		
	isiXhosa	=	3		
	isiZulu	=	4		
	Other	=	5	<input type="checkbox"/>	c 10
Relevant Background Information:	no prescription lenses	=	0		
	wears prescription lenses	=	1		
	diagnosed with Attention Deficit Disorder	=	2		
	a learner with ADHD who is medicated	=	3	<input type="checkbox"/>	c 11
School:	Private	=	1		
	Government - urban	=	2		
	Government - rural	=	3	<input type="checkbox"/>	c 12
Grade:	1	=	1		
	2	=	2		
	3	=	3	<input type="checkbox"/>	c 13

Visual Discriminatory Aspects
 VD (c 14-29) + VFC (c 30-45) = c 14-45

Visual Discrimination (VD)		A	B	C	D	E	F	G	c 14-29	
Item 1	response = 0 or 1	1	0						<input type="checkbox"/>	c 14
2		1	0						<input type="checkbox"/>	c 15
3		0	1						<input type="checkbox"/>	c 16
4		0	1						<input type="checkbox"/>	c 17
5		0	0	1					<input type="checkbox"/>	c 18
6		0	0	1					<input type="checkbox"/>	c 19
7		0	1	0					<input type="checkbox"/>	c 20
8		0	0	1					<input type="checkbox"/>	c 21
9		0	0	1	0	0			<input type="checkbox"/>	c 22
10		0	0	0	0	1			<input type="checkbox"/>	c 23
11		0	0	0	1	0			<input type="checkbox"/>	c 24
12		0	1	0	0	0			<input type="checkbox"/>	c 25
13		0	0	0	0	1	0	0	<input type="checkbox"/>	c 26
14		0	0	0	0	0	0	1	<input type="checkbox"/>	c 27
15		0	0	1	0	0	0	0	<input type="checkbox"/>	c 28
16		0	0	0	1	0	0	0	<input type="checkbox"/>	c 29

Visual Form Constancy (VFC)		A	B	C	D	E	F	G	c 30-45	
Item 1	response = 0 or 1	1	0						<input type="checkbox"/>	c 30
2		0	1						<input type="checkbox"/>	c 31
3		0	1						<input type="checkbox"/>	c 32
4		0	1						<input type="checkbox"/>	c 33
5		0	0	1					<input type="checkbox"/>	c 34
6		0	1	0					<input type="checkbox"/>	c 35
7		0	1	0					<input type="checkbox"/>	c 36
8		0	0	1					<input type="checkbox"/>	c 37
9		0	0	1	0	0			<input type="checkbox"/>	c 38
10		1	0	0	0	0			<input type="checkbox"/>	c 39
11		0	0	0	1	0			<input type="checkbox"/>	c 40
12		0	1	0	0	0			<input type="checkbox"/>	c 41
13		1	0	0	0	0	0	0	<input type="checkbox"/>	c 42
14		0	0	0	1	0	0	0	<input type="checkbox"/>	c 43
15		0	0	0	0	1	0	0	<input type="checkbox"/>	c 44
16		0	1	0	0	0	0	0	<input type="checkbox"/>	c 45

Visual Memory Aspects
 VM (c 46-61) + VSM (c 62-77) = c 46 - 77

Visual Memory (VM)		A	B	C	D	E	F	G	c 46-61	
Item 1	response = 0 or 1	1	0						<input type="checkbox"/>	c 46
2		0	1						<input type="checkbox"/>	c 47
3		0	0	1					<input type="checkbox"/>	c 48
4		0	1	0					<input type="checkbox"/>	c 49
5		0	1	0	0				<input type="checkbox"/>	c 50
6		0	0	1	0				<input type="checkbox"/>	c 51
7		0	0	0	1				<input type="checkbox"/>	c 52
8		0	1	0	0				<input type="checkbox"/>	c 53
9		0	0	1	0	0			<input type="checkbox"/>	c 54
10		0	0	0	0	1			<input type="checkbox"/>	c 55
11		0	0	0	1	0			<input type="checkbox"/>	c 56
12		0	0	0	0	0	1		<input type="checkbox"/>	c 57
13		0	0	0	0	1	0		<input type="checkbox"/>	c 58
14		0	0	1	0	0	0		<input type="checkbox"/>	c 59
15		0	1	0	0	0	0		<input type="checkbox"/>	c 60
16		0	0	1	0	0	0		<input type="checkbox"/>	c 61

Visual Sequential Memory (VSM)

		A	B	C	D	E	F	G		c 62-77
Item 1	response = 0 or 1	0	1							c 62
2		1	0							c 63
3		0	1	0						c 64
4		0	0	1						c 65
5		1	0	0						c 66
6		0	0	1	0					c 67
7		1	0	0	0					c 68
8		0	1	0	0					c 69
9		0	0	0	1					c 70
10		0	0	0	1					c 71
11		1	0	0	0					c 72
12		0	0	0	1					c 73
13		0	0	0	1					c 74
14		0	0	1	0					c 75
15		0	0	0	1					c 76
16		0	1	0	0					c 77

Visual Spatial Processing Aspects

VSR (c 78 - 93) + P-S (c 94 - 109) = c 78 - 109

Visual Spatial Relationships

		A	B	C	D	E	F	G		c 78-93
Item 1	response = 0 or 1	0	1							c 78
2		1	0							c 79
3		0	1							c 80
4		0	1							c 81
5		1	0	0						c 82
6		0	0	1						c 83
7		1	0	0						c 84
8		0	0	1						c 85
9		0	0	1	0	0				c 86
10		0	0	0	1	0				c 87
11		1	0	0	0	0				c 88
12		0	0	0	1	0				c 89
13		0	0	0	0	1	0	0		c 90
14		0	0	1	0	0	0	0		c 91
15		0	0	0	0	1	0	0		c 92
16		1	0	0	0	0	0	0		c 93

Position-in-Space (P-S)

		A	B	C	D	E	F	G		c 94-109
Item 1	response = 0 or 1	0	1	0						c 94
2		0	0	1						c 95
3		0	1	0						c 96
4		0	0	1						c 97
5		0	0	1	0					c 98
6		1	0	0	0					c 99
7		1	0	0	0					c 100
8		0	0	0	1					c 101
9		0	0	0	0	1				c 102
10		1	0	0	0	0				c 103
11		0	0	0	1	0				c 104
12		0	1	0	0	0				c 105
13		0	1	0	0	0	0	0		c 106
14		0	0	0	0	0	0	1		c 107
15		0	0	0	1	0	0	0		c 108
16		0	0	0	0	1	0	0		c 109

Visual Analysis Aspects

VC (c 110-125) + VF-G (c126-141) + VA/S (c 142-157) = c 110-157

Visual Closure (VC)		A	B	C	D	E	F	G	c 110-125	
Item 1	response = 0 or 1	0	1						<input type="checkbox"/>	c 110
2		1	0						<input type="checkbox"/>	c 111
3		1	0						<input type="checkbox"/>	c 112
4		0	1						<input type="checkbox"/>	c 113
5		0	0	1					<input type="checkbox"/>	c 114
6		0	0	1					<input type="checkbox"/>	c 115
7		1	0	0					<input type="checkbox"/>	c 116
8		0	1	0					<input type="checkbox"/>	c 117
9		0	0	0	1	0			<input type="checkbox"/>	c 118
10		0	1	0	0	0			<input type="checkbox"/>	c 119
11		0	0	0	1	0			<input type="checkbox"/>	c 120
12		0	1	0	0	0			<input type="checkbox"/>	c 121
13		0	0	0	0	1	0	0	<input type="checkbox"/>	c 122
14		0	0	0	0	1	0	0	<input type="checkbox"/>	c 123
15		1	0	0	0	0	0	0	<input type="checkbox"/>	c 124
16		0	0	0	0	0	1	0	<input type="checkbox"/>	c 125
Visual Figure-Ground (VFG)		A	B	C	D	E	F	G	c 126 -141	
Item 1	response = 0 or 1	0	1						<input type="checkbox"/>	c 126
2		0	1						<input type="checkbox"/>	c 127
3		0	1						<input type="checkbox"/>	c 128
4		1	0						<input type="checkbox"/>	c 129
5		0	0	1					<input type="checkbox"/>	c 130
6		1	0	0					<input type="checkbox"/>	c 131
7		0	0	1					<input type="checkbox"/>	c 132
8		0	1	0					<input type="checkbox"/>	c 133
9		0	0	0	1	0			<input type="checkbox"/>	c 134
10		0	0	1	0	0			<input type="checkbox"/>	c 135
11		1	0	0	0	0			<input type="checkbox"/>	c 136
12		0	0	0	0	1			<input type="checkbox"/>	c 137
13		0	0	0	0	0	1	0	<input type="checkbox"/>	c 138
14		0	0	0	0	1	0	0	<input type="checkbox"/>	c 139
15		0	0	0	0	0	0	1	<input type="checkbox"/>	c 140
16		0	0	1	0	0	0	0	<input type="checkbox"/>	c 141
Visual Analysis and Synthesis (VA/S)		A	B	C	D	E	F	G	c142-157	
Item 1	response = 0 or 1	1	0						<input type="checkbox"/>	c 142
2		0	1						<input type="checkbox"/>	c 143
3		1	0						<input type="checkbox"/>	c 144
4		1	0						<input type="checkbox"/>	c 145
5		0	1	0					<input type="checkbox"/>	c 146
6		0	0	1					<input type="checkbox"/>	c 147
7		1	0	0					<input type="checkbox"/>	c 148
8		0	0	1					<input type="checkbox"/>	c 149
9		0	0	1	0	0			<input type="checkbox"/>	c 150
10		0	0	0	0	1			<input type="checkbox"/>	c 151
11		0	0	0	1	0			<input type="checkbox"/>	c 152
12		0	0	1	0	0			<input type="checkbox"/>	c 153
13		0	0	0	1	0	0	0	<input type="checkbox"/>	c 154
14		0	0	0	1	0	0	0	<input type="checkbox"/>	c 155
15		0	0	1	0	0	0	0	<input type="checkbox"/>	c 156
16		0	0	0	0	1	0	0	<input type="checkbox"/>	c 157

Achievement Performance

Reading

Performance has not satisfied the requirements of Learning Area	1		
Performance has partially satisfied the requirements of Learning Area	2		
Performance has satisfied the requirements of Learning Area	3		
Performance has exceeded the requirements of Learning Area	4		
Performance has far exceeded the requirements of Learning Area	5	<input type="checkbox"/>	c 158

Spelling

Performance has not satisfied the requirements of Learning Area	1		
Performance has partially satisfied the requirements of Learning Area	2		
Performance has satisfied the requirements of Learning Area	3		
Performance has exceeded the requirements of Learning Area	4		
Performance has far exceeded the requirements of Learning Area	5	<input type="checkbox"/>	c 159

Mathematics

Performance has not satisfied the requirements of Learning Area	1		
Performance has partially satisfied the requirements of Learning Area	2		
Performance has satisfied the requirements of Learning Area	3		
Performance has exceeded the requirements of Learning Area	4		
Performance has far exceeded the requirements of Learning Area	5	<input type="checkbox"/>	c 160

Intellectual Functioning - SSAIS-R

130 -	Very Superior		
120 - 129	Superior		
110 - 119	High Average		
90 - 109	Low Average		
		Full scaled IQ	
		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	c 161-163

	Scaled score	Verbal IQ	
Verbal Tests	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		c 164-168
	Raw Score	Stanine	

Vocabulary			c 169-171
Comprehension			c 172-174
Similarities			c 175-177
Number Problems			c 178-180
Story Memory			c 181-183
Memory for Digits			c 184-186

	Scaled score	Nonverbal IQ	
Non-Verbal Tests	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		c 187-191
	Raw Score	Stanine	

Pattern Completion			c 192-194
Block Designs			c 195-197
Missing Parts			c 198-200
Form Board			c 201-203
Coding			c 204-206

	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		c 207-210

SUBTEST: VISUAL DISCRIMINATION (VD)

VISUAL DISCRIMINATORY ASPECTS

(Similar Test: Gardiner's TVPS: Subtest - Visual Discrimination)

- Task:** To locate the exact two or three dimensional (2- 3D) view of a form (the target item) in the midst of other represented form views (the response items).
- Purpose:** To evaluate the learner's ability to observe swiftly, as well as accurately, concrete differences and/or similarities in presented 2- or 3D printed form views represented on blue paper.
- Over and above:** requires visual attention, visual scanning, reasoning and motor planning (to point to an elected response item) aspects
- Ceiling:** Three consecutive unsuccessful responses
- Time Allocation:** 2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
- Material:**
- ✓ 3D plastic shapes: one oval and two circles
 - ✓ Test Booklet containing 16 Visual Discrimination (VD) Plates

Procedure:

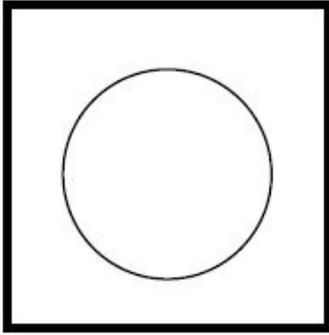
❖ Concrete Example: plastic 3-dimensional shapes (an oval and two circles of the same colour)

Instructions: The tester places an oval and two circles, which are the same in colour vertically in front of the learner. Say to the learner, "**See this shape...**" (whilst **pointing to a circle**) "**...look and find it amongst these**" (whilst **pointing to the remaining shapes** [one circle and an oval] on the table). If learner selects the circle say, "**Yes, it is exactly the same... same shape, size and colour.**" If learner is unsuccessful take time to explain what makes the two circles similar (i.e. the colour, shape and size) as well as what makes the oval differ to the circle.

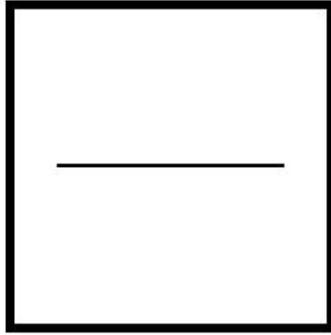
❖ Test Booklet: 16 VD Plates – 2- or 3D represented views of black stimuli on blue paper arranged from easy to more complicated form views

Instructions: Present the VD Test booklet by placing it in front of the learner. Open the VD Plate 1 in front of the learner. Say to the learner, "**See this form...**" (whilst **placing the circle** on the plate's target item) "**...see that it is the same as the one drawn on this paper?**" Remove the circle. Say to the learner, "**See this form in this block...**" (whilst **pointing to the target block** containing a the single 2D form view). Then say, "**Look and find it among these forms below.**" (**pointing** now to the blocks below containing the various choices). If the learner identifies and nominates the correct response **continue** with the next plate of the VD subtest **until the ceiling is reached**. If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response. This can assist with a possible diagnostic evaluation, as well as to delineate the visual perceptual aspect which may require remediation.

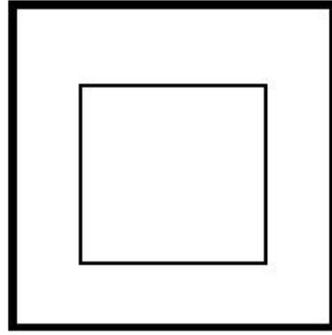
1



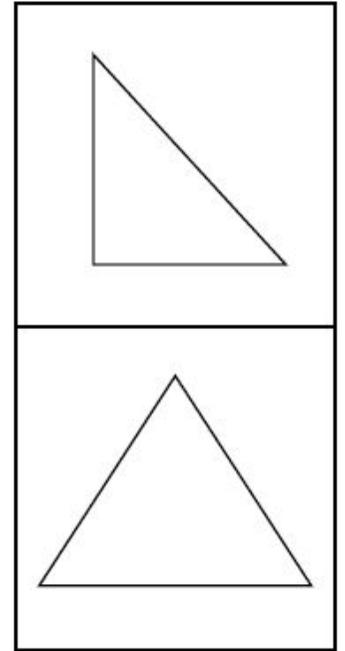
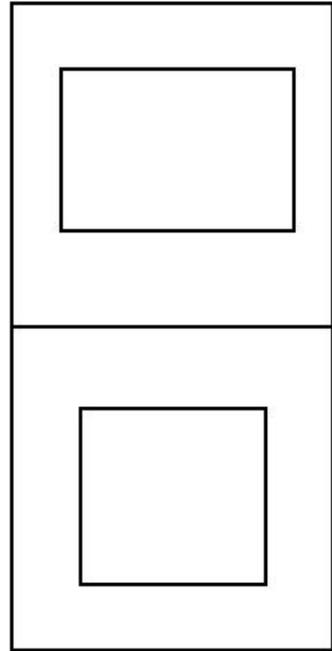
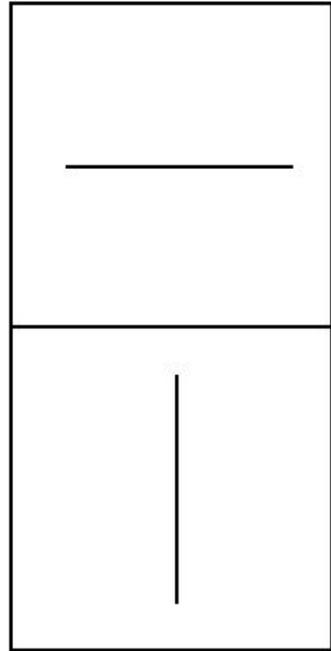
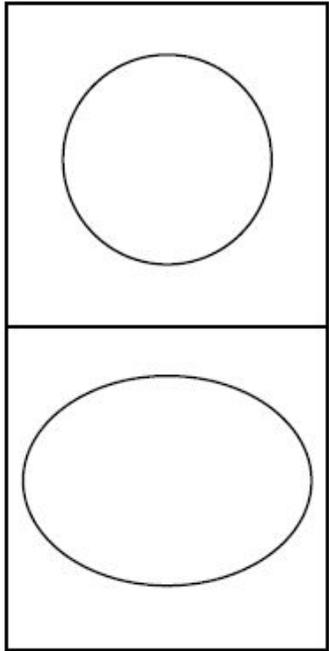
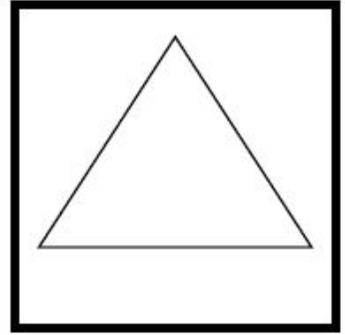
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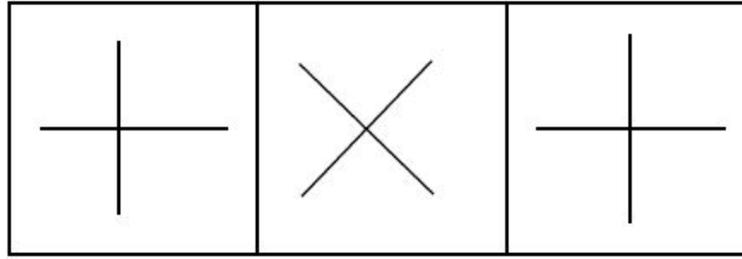
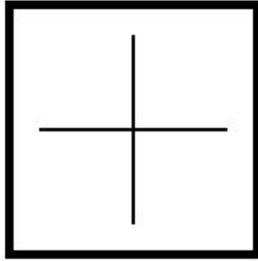


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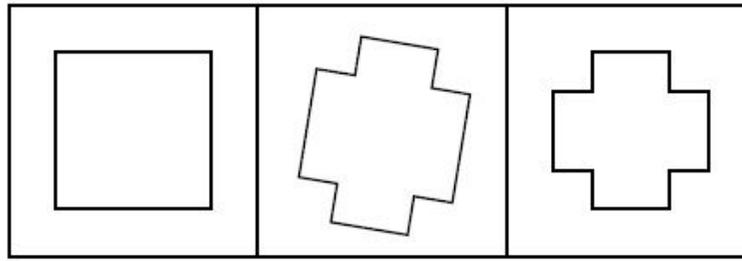
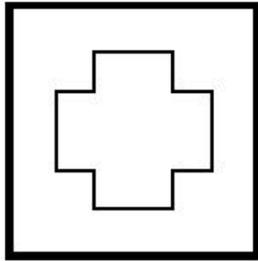


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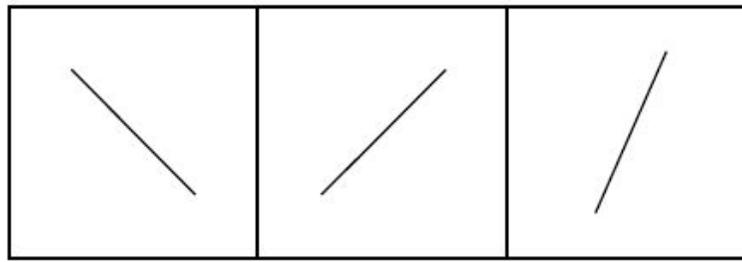
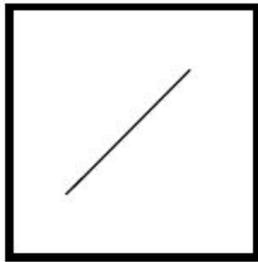
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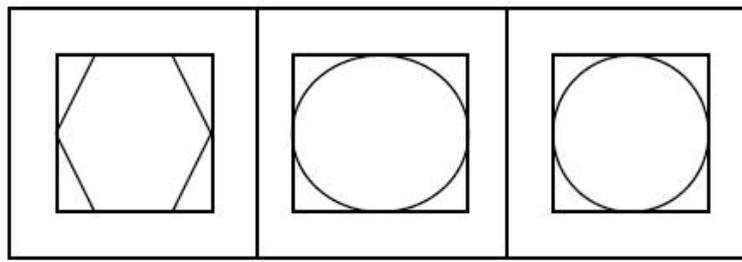
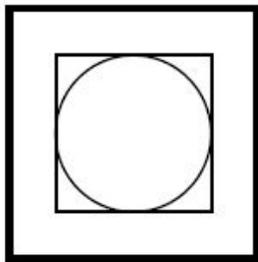
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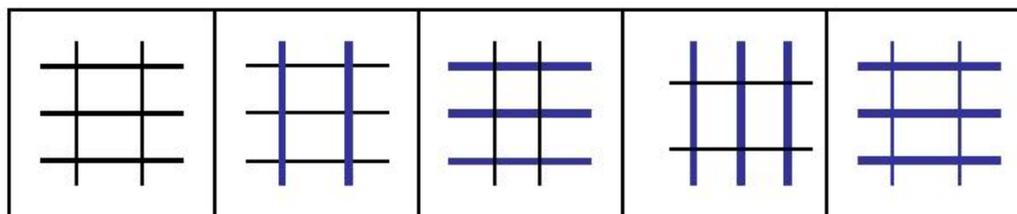
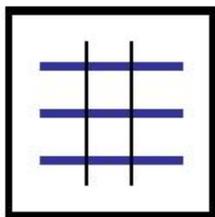
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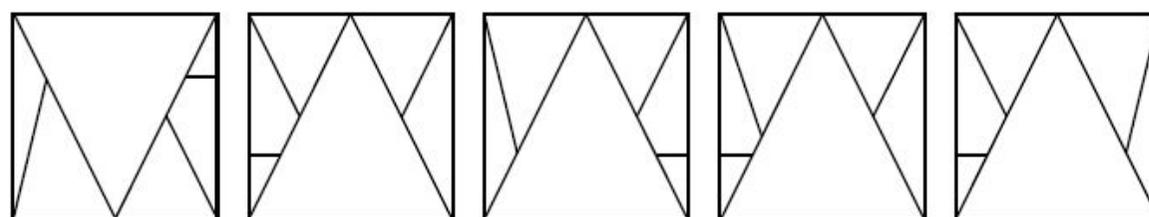
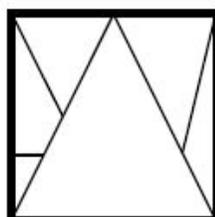
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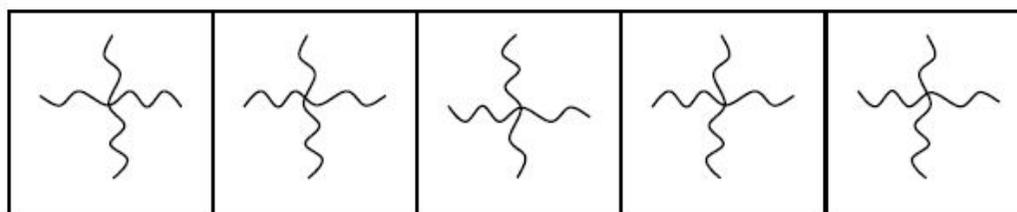
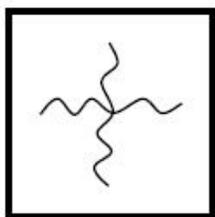
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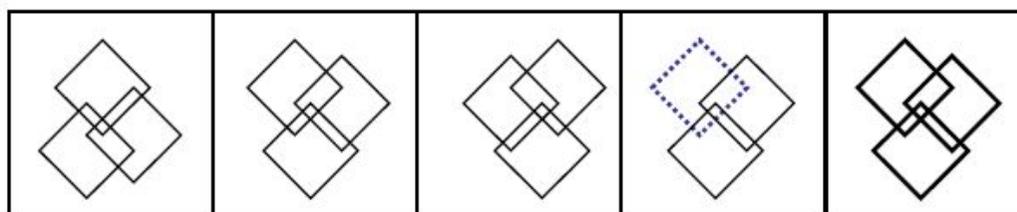
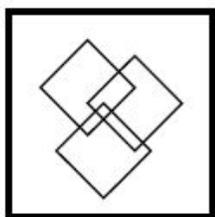
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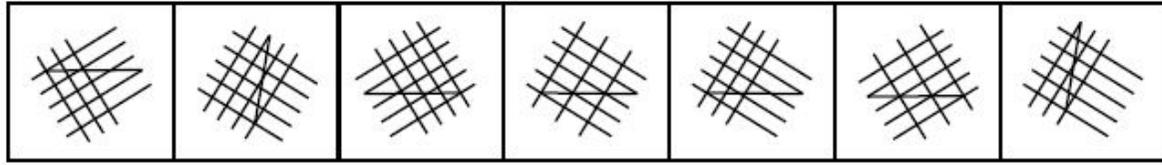
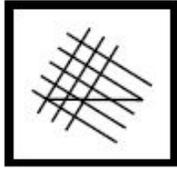
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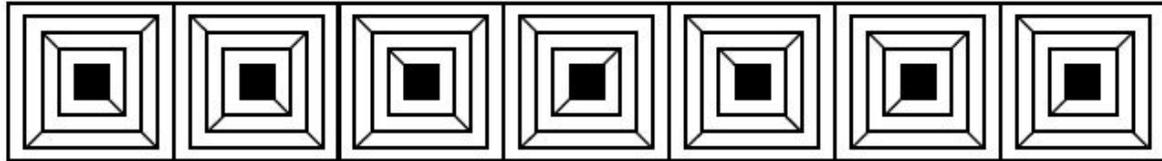
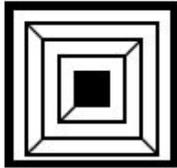
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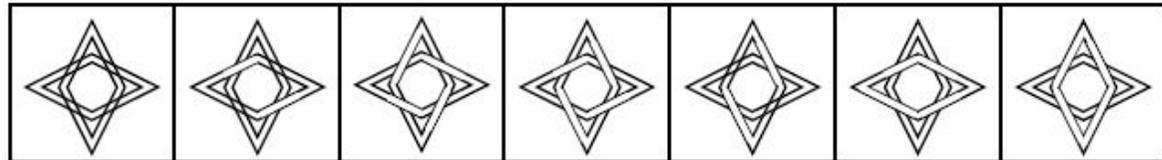
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16



SUBTEST: VISUAL FORM CONSTANCY (VFC)

VISUAL DISCRIMINATORY ASPECTS

(Similar Tests: Gardiner's TVPS: Subtest - Form Constancy; DVPT: Subtest 8 - Form Constancy)

Task:	To locate the same 2-3D view of a form even though it has changed in colour, direction or size, amongst other form views
Purpose:	To locate the same form regardless of size, colour or directional orientation
Over and above:	Requires visual attention, visual scanning, reasoning and comprehension
Ceiling:	Three consecutive unsuccessful responses
Time allocation:	2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
Material:	<ul style="list-style-type: none">✓ Form constancy board contain 8 (4 x 2) shapes varying in colour, size and directional orientation✓ Test Booklet containing 16 Visual Form Constancy Plates

Procedure:

❖ **Concrete Example: plastic form constancy board with various shapes**

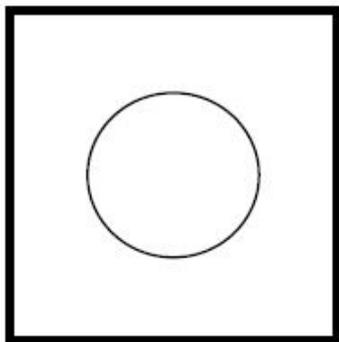
Instructions:

The tester places the form constancy board in front of the learner. Say to the learner, **"See this board it contains various shapes find all the shape which look like this one"** (pointing to a rectangle). Say, **"Look very carefully ... remember it may have changed its size, direction or colour ..."** Then say to the learner, **"...look and find any other rectangles on this board"** (whilst **pointing** to the shapes on the board). Say, **"Look very carefully ... it may have changed its size, colour or direction"**.

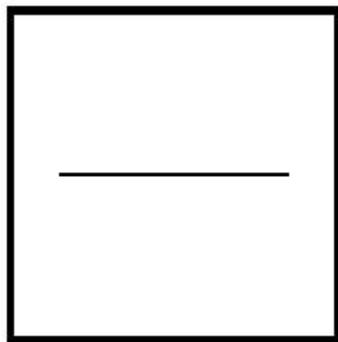
❖ **Test Booklet: 16 VFC Plates – 2- or 3D black stimuli on blue paper**

Instructions: Present the VFC Test booklet to the learner, placing it in front of the learner. Open VFC Plate 1 in front of the learner. Say to the learner, **"See this form in this block..."** (whilst **pointing to the target block** containing the single form). Then say to the learner, **"Look and find it amongst these forms."** (**pointing now to the blocks below** containing the choices for an elected response) Say, **"Look very carefully ... remember it may have changed its size, direction or colour"**. If the learner identifies the correct response **continue** with the next plate of the VFC subtest **until the ceiling is reached**. If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation and to delineate the areas required for remediation.

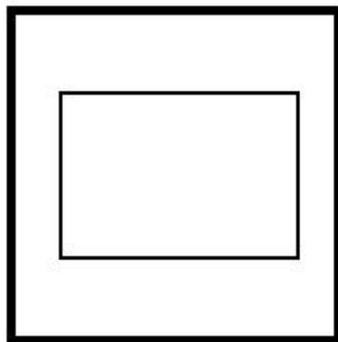
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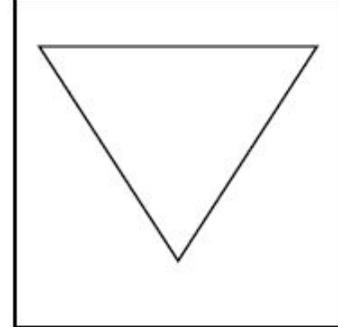
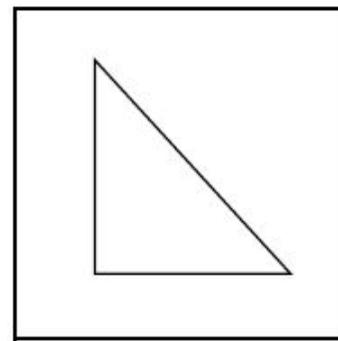
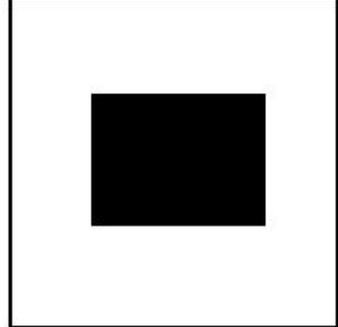
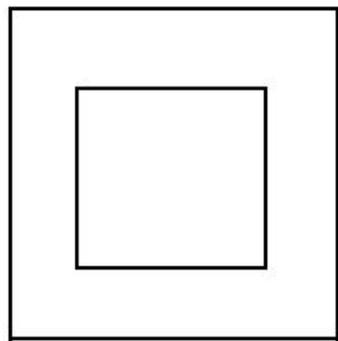
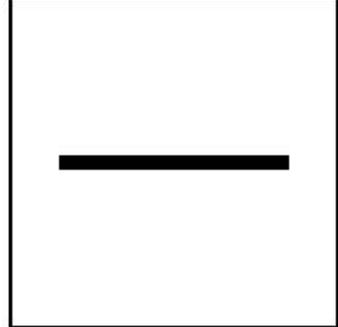
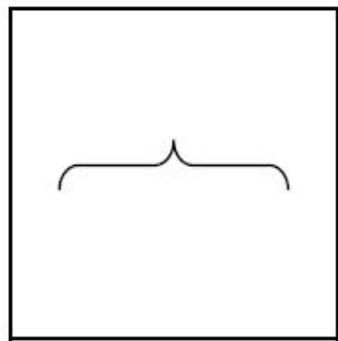
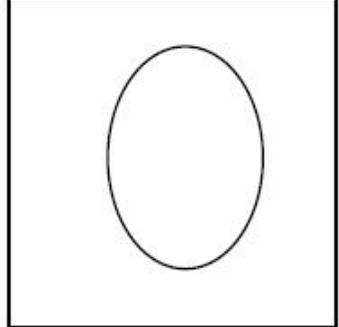
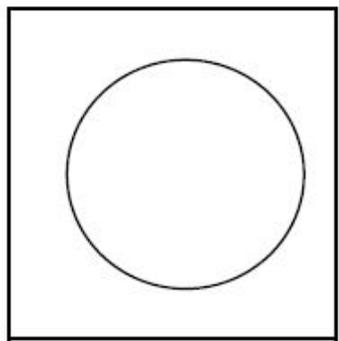
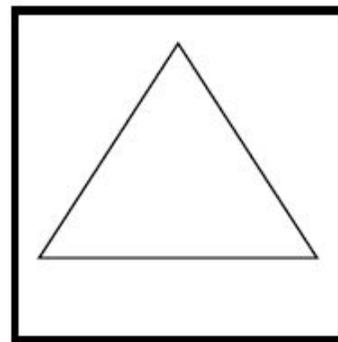
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c 31

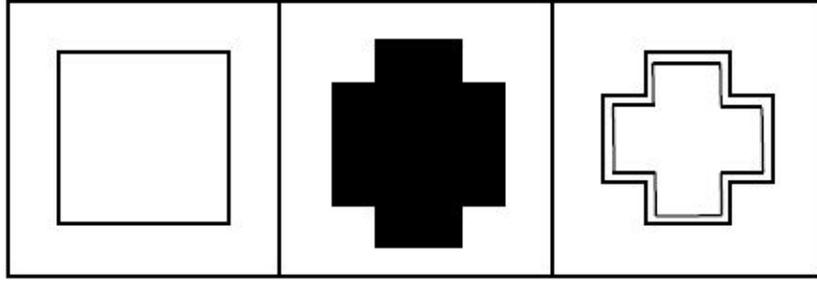
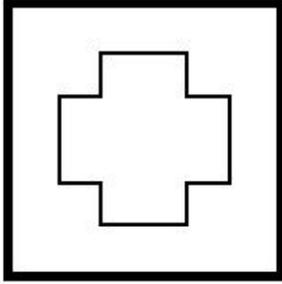


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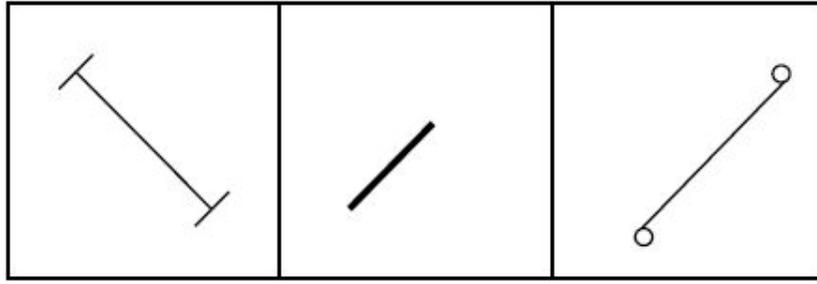
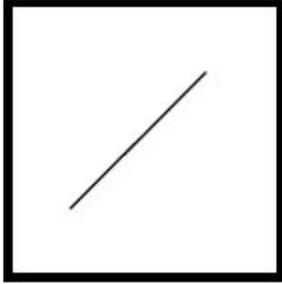


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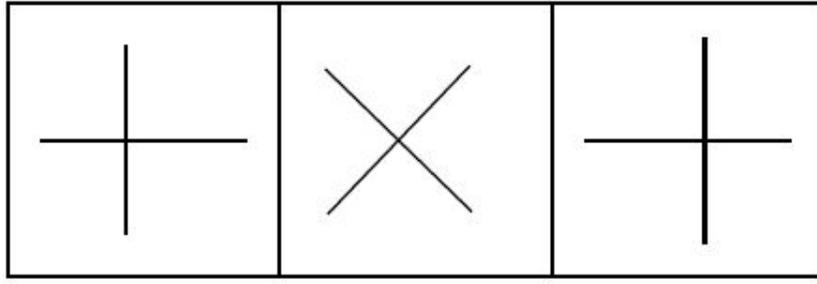
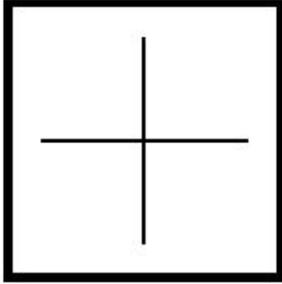
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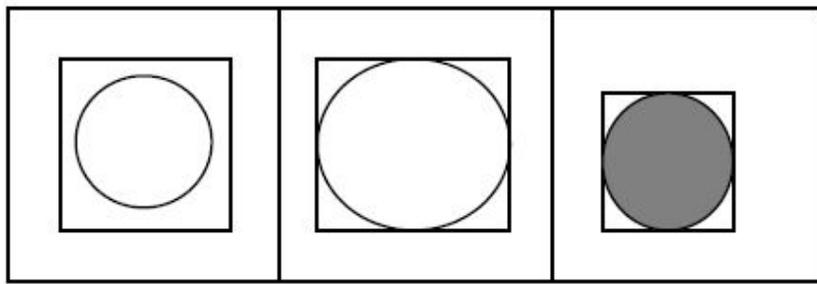
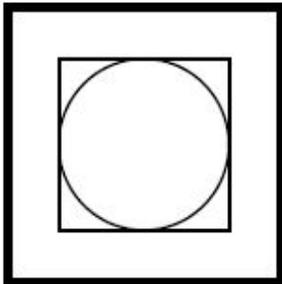
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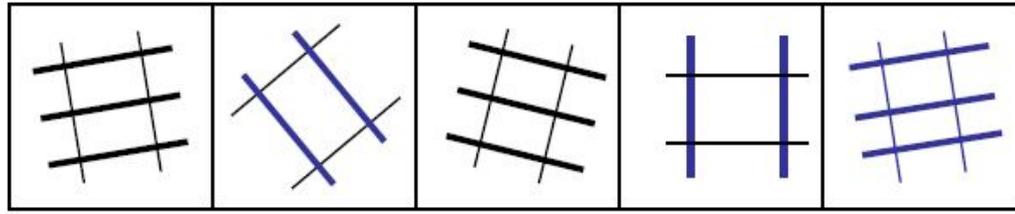
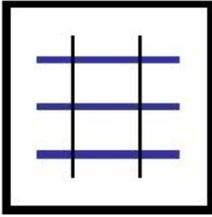
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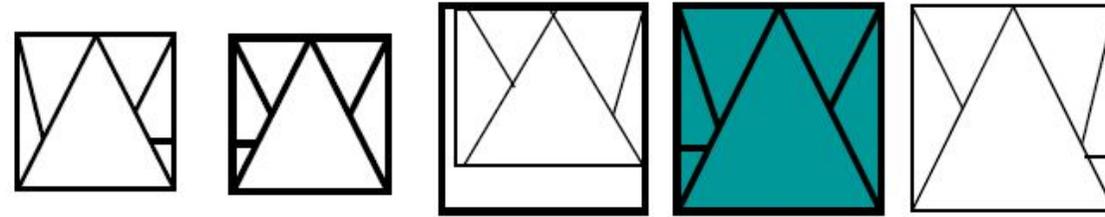
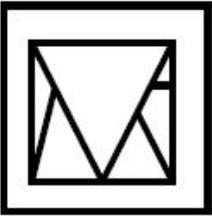


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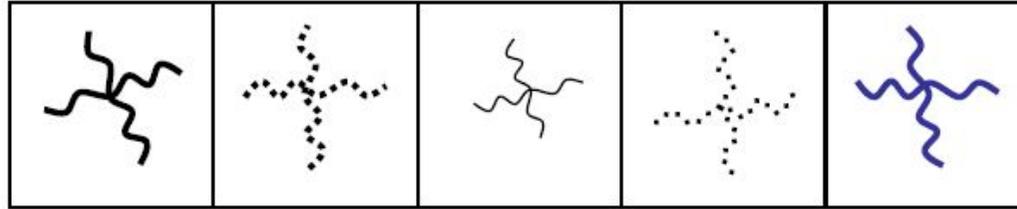
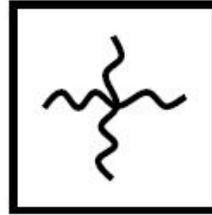
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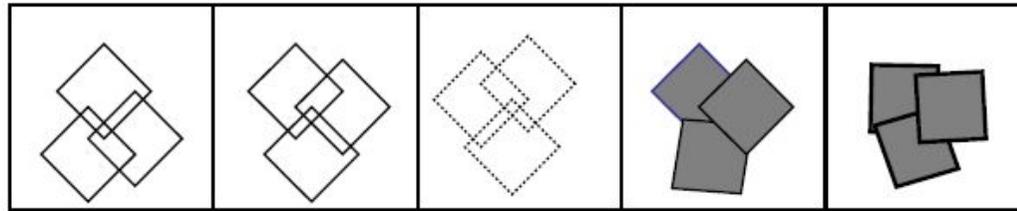
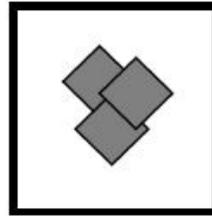
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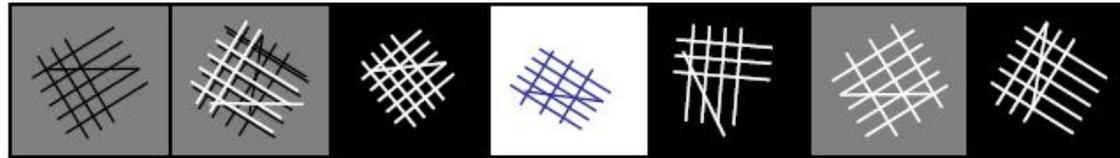
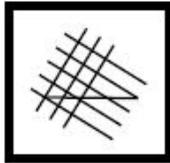
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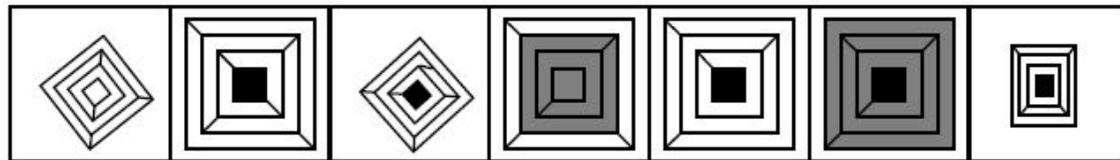
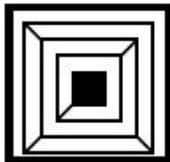
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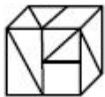
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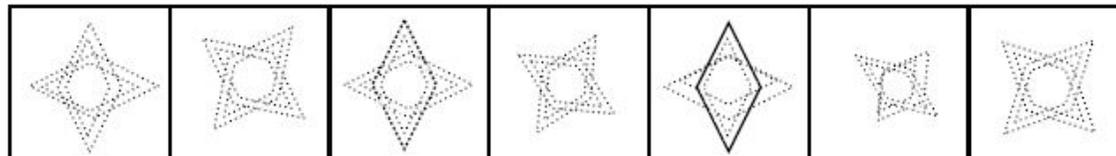
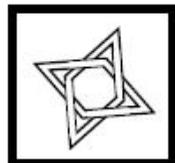
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c 44

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c 45

SUBTEST: VISUAL MEMORY (VM)

VISUAL MEMORY ASPECTS

(Similar Test: Gardiner's TVPS – Subtest: Visual Memory)

Task:	To identify and hold a 2- or 3 D represented form view in the working memory
Purpose:	To evaluate the learner's ability to remember and to recognise and recall a visually presented 2- or 3D form view
Over and above:	requires visual attention, visual scanning, reasoning and comprehending
Ceiling:	Three consecutive unsuccessful responses
Time Allocation:	8 seconds for younger learners and 4 to 5 seconds for older learners
Material:	<ul style="list-style-type: none">✓ 3D plastic shapes: the same coloured square and triangle shapes✓ Test Booklet containing 32 Visual Memory Plates

Procedure:

❖ Concrete Example: plastic 3-dimensional shapes (triangle and square)

Instructions:

The tester places the triangle on the table in front of the learner. Say to the learner, “**See this shape... look carefully you must remember it so that you can find it again...**” (whilst **pointing to the shape**). Allow the learner time to view the shape (see time allocation) before removing it. Then say, “**...which shape did I show you**” (whilst **placing both shapes** [square and triangle] on the table in front of the learner).

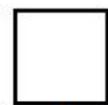
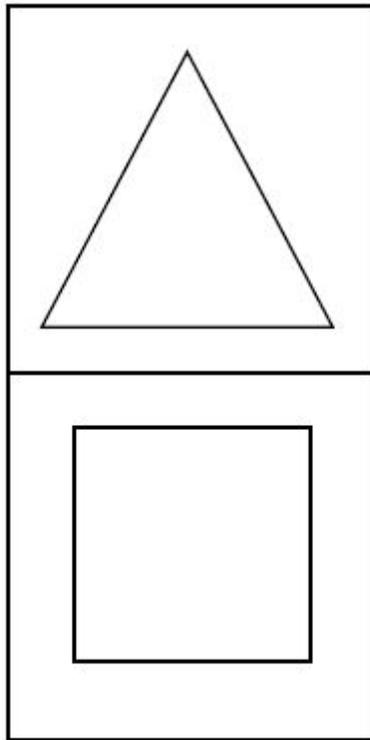
❖ Test Booklet: 32 VM Plates - 2D black stimuli on blue paper

Instructions:

Place the VM Test booklet in front of the learner. Open VM Plate 1 in front of the learner. Say to the learner, “**See this form... look carefully as you must remember it so that you can find it on the next page...**” (whilst **pointing to the single target form** on the plate). After you have returned the page say, “**... look and find it between these forms**” (whilst **pointing to the choice of response items** on the plate). Allocated time for the learner to view the design (see time allocation above). If the learner identifies and nominates the correct response **continue** with the next plate of the VM subtest **until the ceiling is reached**.

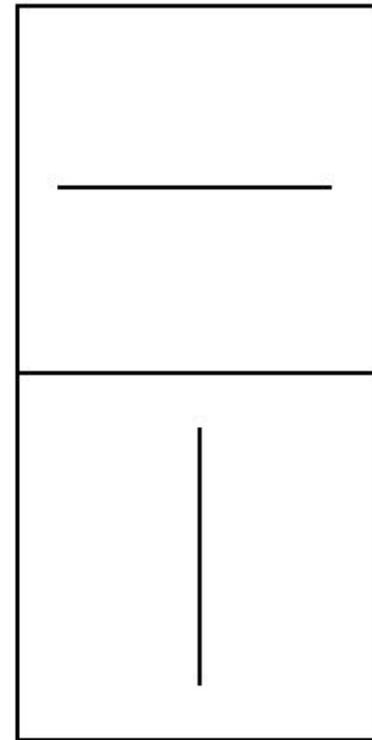
If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Remember a majority of learners will can require allocated time, then proceed at the pace set by the individual learner. Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation.

1



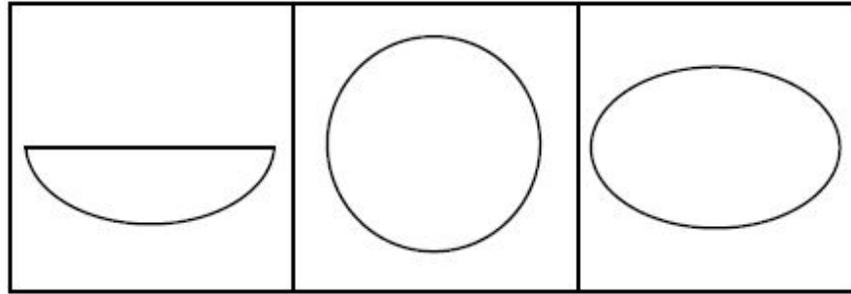
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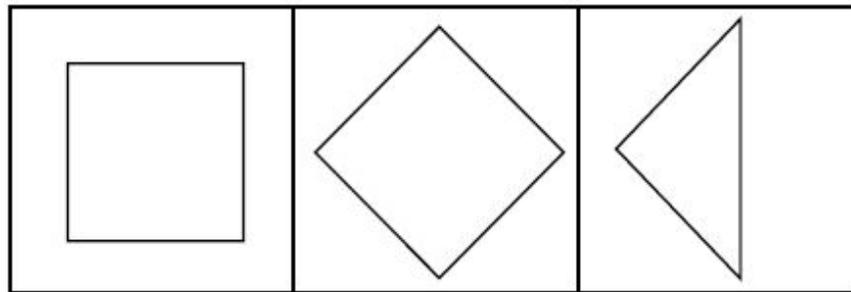


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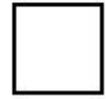
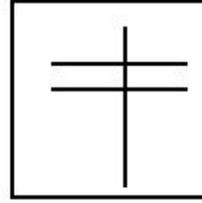
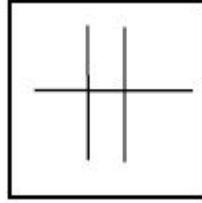
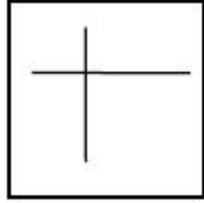
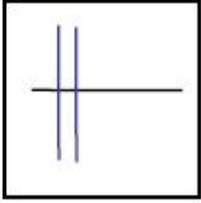
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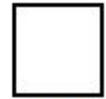
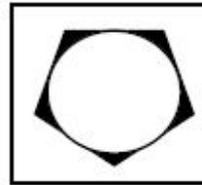
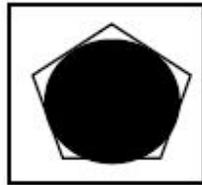
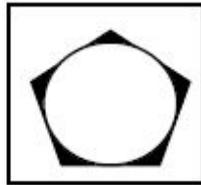
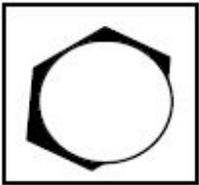


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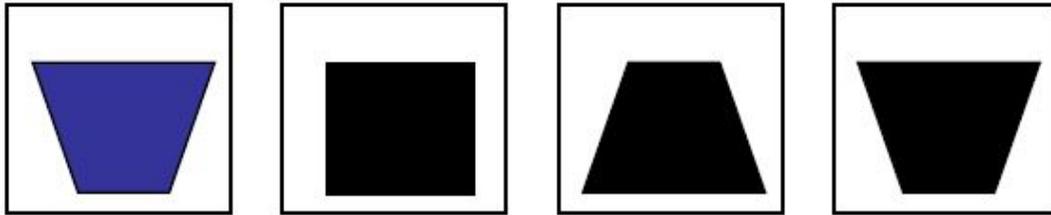
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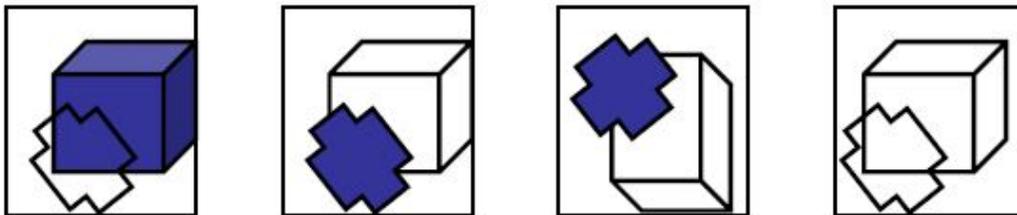
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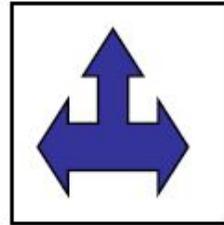
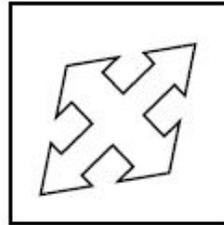
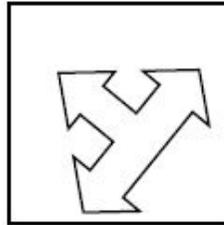
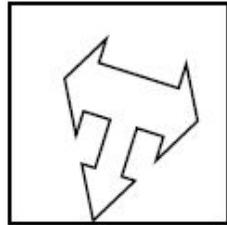
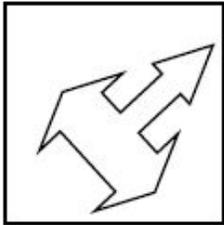
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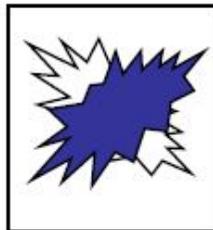
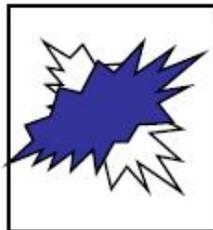
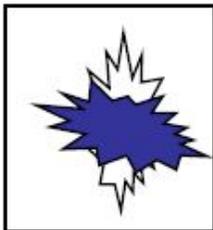
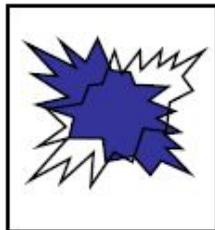
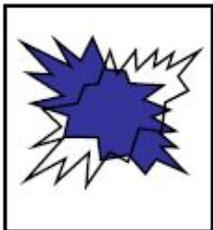
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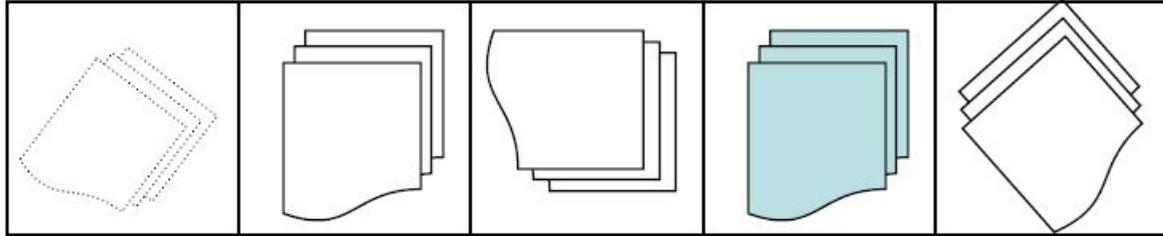
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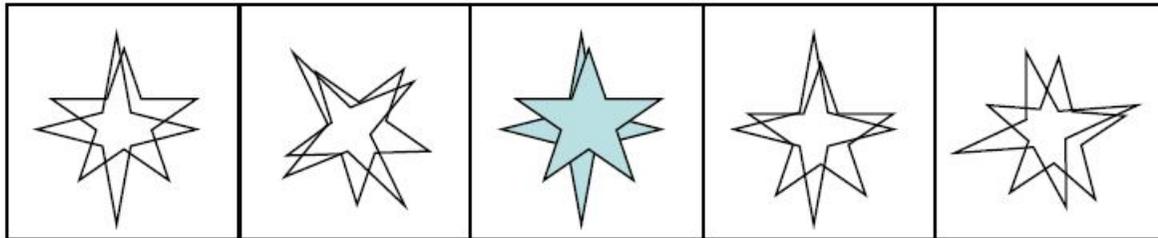
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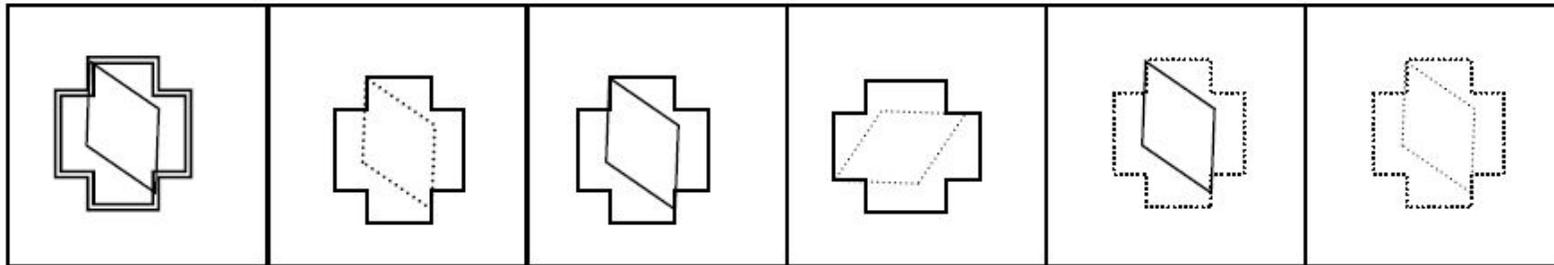
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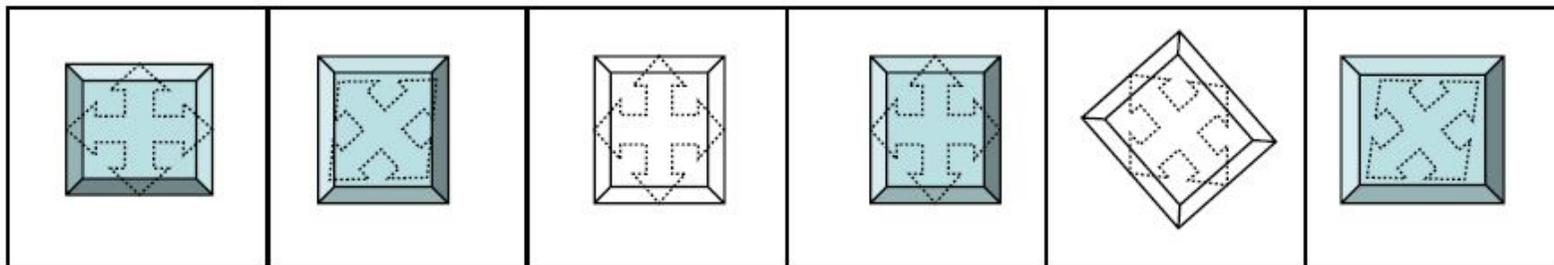
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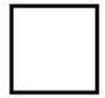
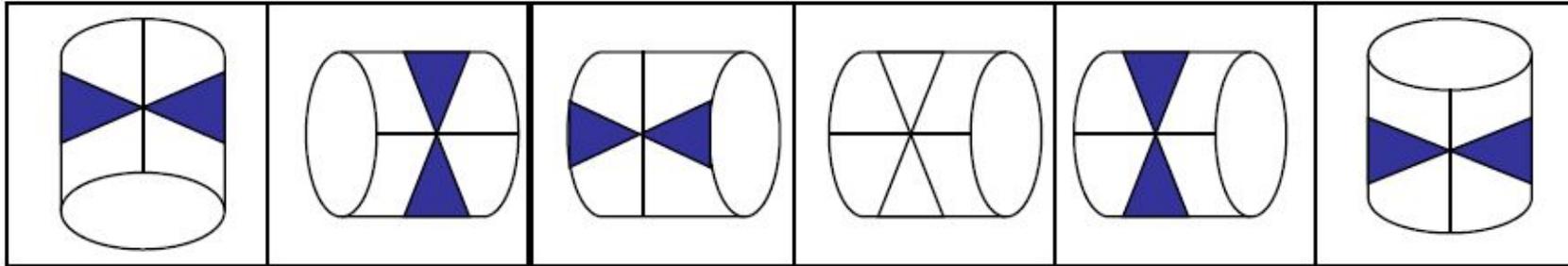
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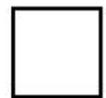
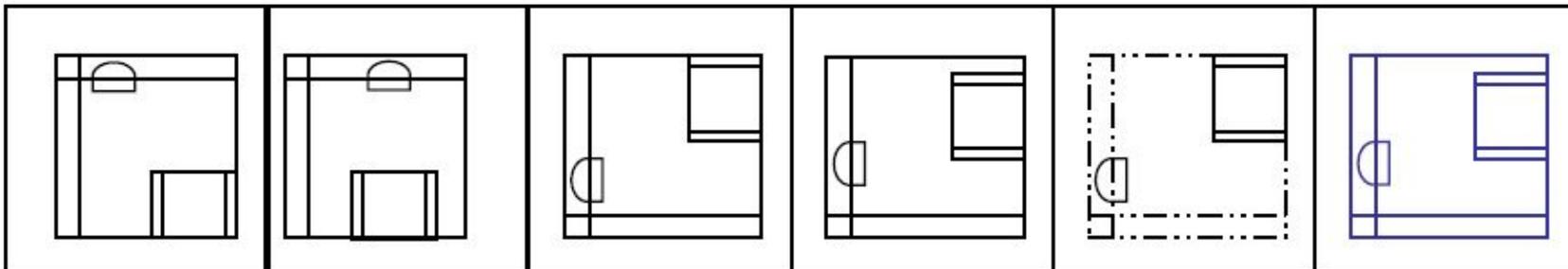
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SUBTEST: VISUAL SEQUENTIAL MEMORY (VSM)

VISUAL MEMORY ASPECTS

(Similar Tests: Gardiner's TVPS – Subtest: Visual Sequential Memory, ITPA's Visual Sequential Memory Subtest)

Task:	To identify and hold a 2- or 3 D represented sequential pattern of forms in the working memory to be able to accurately recall it	
Purpose:	To evaluate the learner's ability to remember a non meaningful sequential pattern of a visual stimuli previously seen	
Over and above:	Requires visual attention, visual scanning, reasoning, comprehending and planning	
Ceiling:	Three consecutive unsuccessful responses	
Time Allocation:	5 seconds for 2 to 3 sequential forms (items 1 - 5); 9 seconds for 4 to 5 sequential forms (items 6 - 9)	12 seconds for 6 to 7 sequential forms (items 10 – 13) 14 seconds for 8 to 9 sequential forms (items 14 - 16)
Time Prod:	6 to 10 seconds (taking into account the learner's age and the item's difficulty)	
Material:	<ul style="list-style-type: none">✓ 3D plastic shapes: the same coloured circle and cross shapes✓ Test Booklet containing 32 Visual Memory Plates	

Procedure:

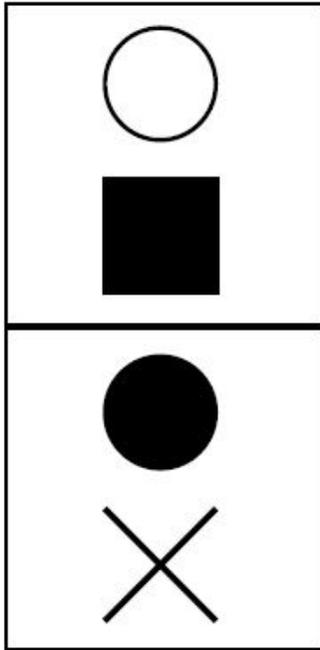
❖ Concrete Example: plastic 3-dimensional shapes (circle, and two cross shapes)

Instructions: The tester builds a form pattern (i.e. x o x) on the table in front of the learner. Say to the learner, “**See this pattern of shapes... look carefully as you must remember it so that you can copy it...**” (whilst **pointing to the pattern of shapes**). Allow the learner time to view the shape before removing it. Then say, “**...build the pattern you saw**” (whilst **placing the removed shapes** back on the table in front of the learner).

❖ Test Booklet: 32 VSM Plates - 2D black stimuli on blue paper

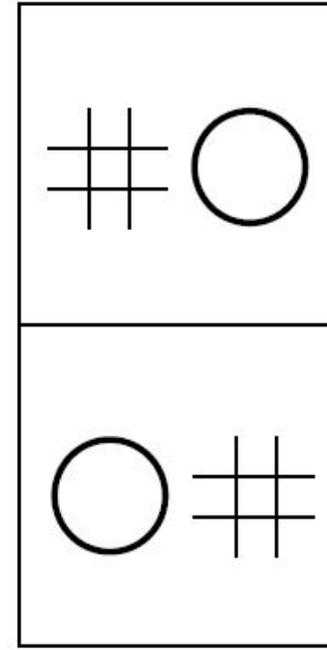
Instructions: Place the VSM Test booklet in front of the learner. Open VSM Plate 1 in front of the learner. Say to the learner, “**See this pattern... look carefully as you must remember it, so that you can find it on the next page...**” (whilst **pointing to the single target form** on the plate). After you have returned the page say, “**... look and find the same pattern**” (whilst **pointing to the choice of response items** on the plate). Allocated time for the learner to view the design (see time allocation above). If the learner identifies and nominates the correct response **continue** with the next plate of the VSM subtest **until the ceiling is reached**. If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Remember a majority of learners will require less allocated time, then proceed at the pace set by the individual learner. Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation.

1



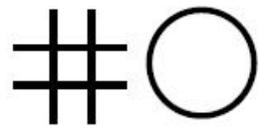
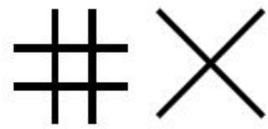
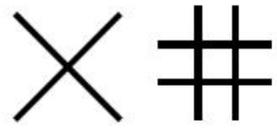
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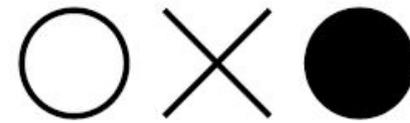
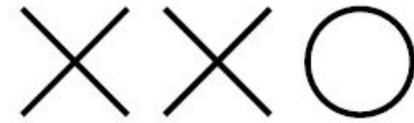
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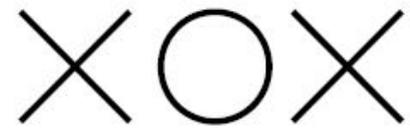
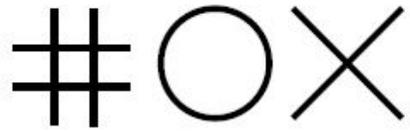
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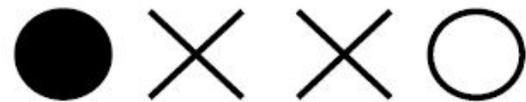
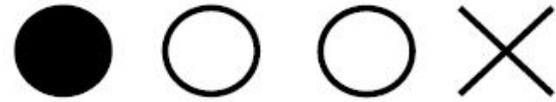
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c 67

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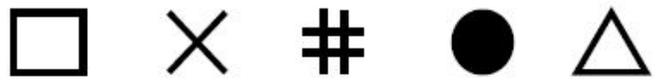
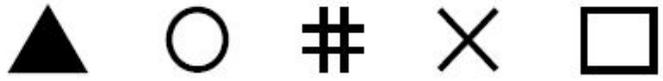
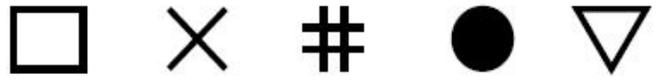
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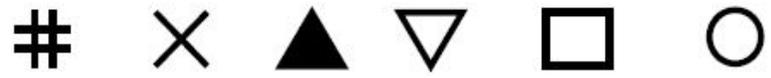
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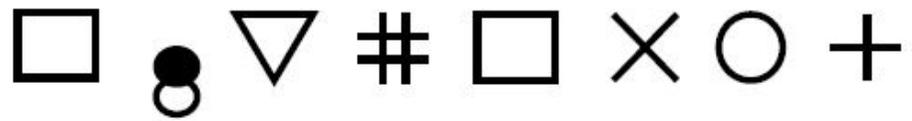
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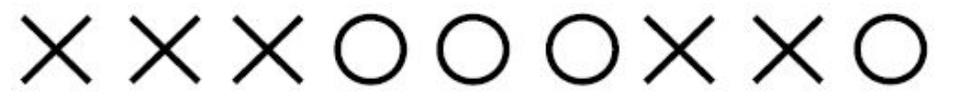
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16



SUBTEST: VISUAL SPATIAL RELATIONSHIPS (VSR)

VISUAL SPATIAL PROCESSING ASPECTS

(Similar Tests: SSAIS-R: Subtest Pattern Completion; Gardiner's TVPS: Subtest Visual Spatial Relationship)

Task:	To locate a 2- or 3D view of a form which presents in a different directional orientation amongst a choice of other presented form views
Purpose:	To evaluate the learner's ability to be aware of the directional orientation of forms
Over and above:	Requires visual attention, visual scanning, directionality, reasoning and comprehension
Ceiling:	Three consecutive unsuccessful responses
Time Allocation:	2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
Material:	<ul style="list-style-type: none">✓ 3D Shapes: four triangles✓ Test Booklet containing 16 Visual Spatial Relationship Plates

Procedure:

❖ Concrete Example: four plastic 3-dimensional triangle shapes

Instructions:

The tester places a row of triangles in front of the learner in an array of different directional positions (i.e. $\leftarrow\uparrow\rightarrow\downarrow$). Say to the learner, "**See these forms are the same shape...**" (whilst **pointing to a triangle**). Then say, "**...but look how they can change the way that they point**" (whilst **pointing** to the remaining triangles on the table and **remarking** on their directional position) For example, "**This one is pointing to the top; is pointing to the side, is pointing to the bottom**".

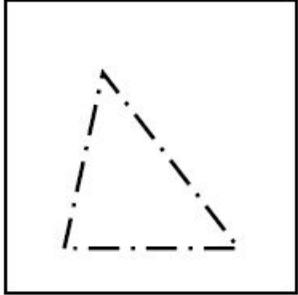
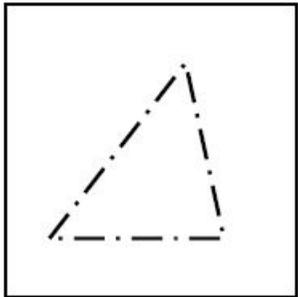
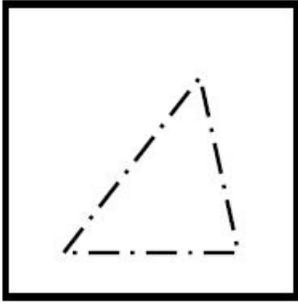
❖ Test Booklet: 16 VSR Plates – 2- or 3D represented views of black stimuli on blue paper

Instructions:

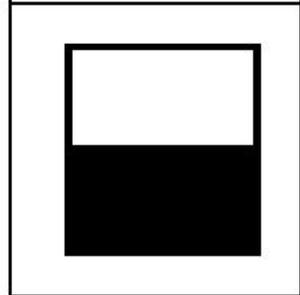
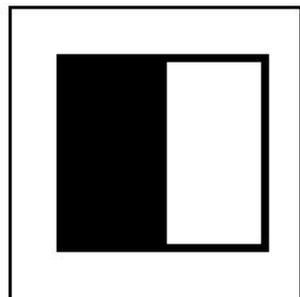
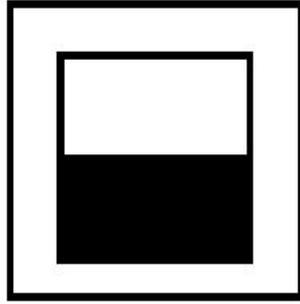
Present the VSR Test booklet to the learner, placing it in front of the learner. Open VSR Plate 1 in front of the learner. Say to the learner, "**Here are the exact same forms, but one is going in a different way...**" (whilst **pointing** to the responses) "**... look and find the one which is going in a different direction.**" If the learner identifies the correct response **continue** with the next plate of the VSR subtest **until the ceiling is reached**.

If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet. The learner may require prompting to make a choice if the learner takes more time than is considered reasonable (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation.

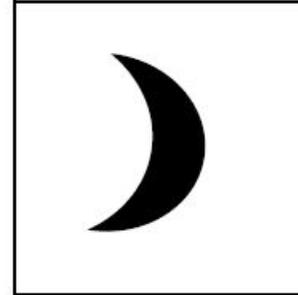
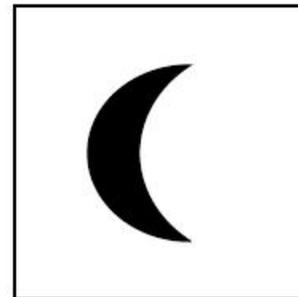
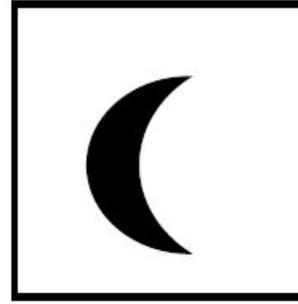
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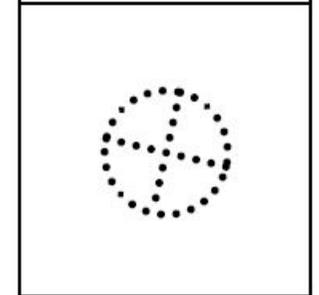
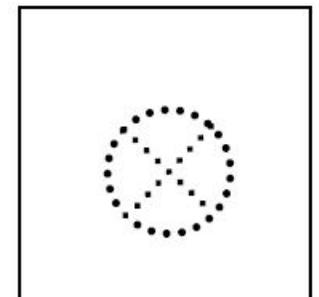
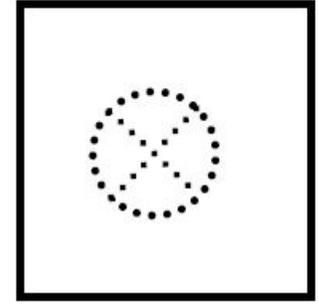
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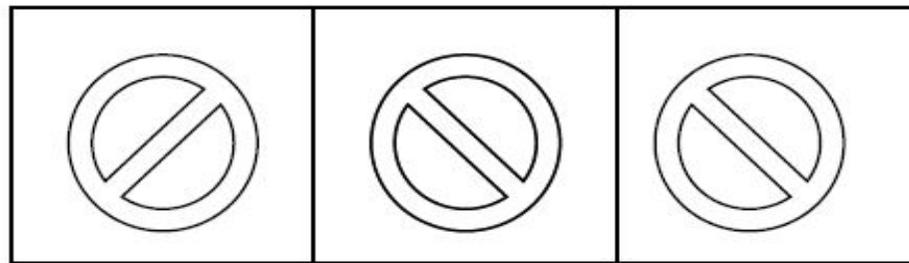
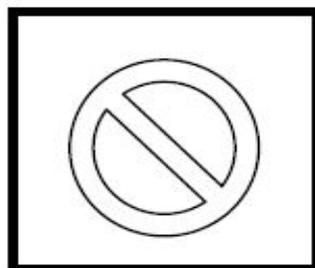
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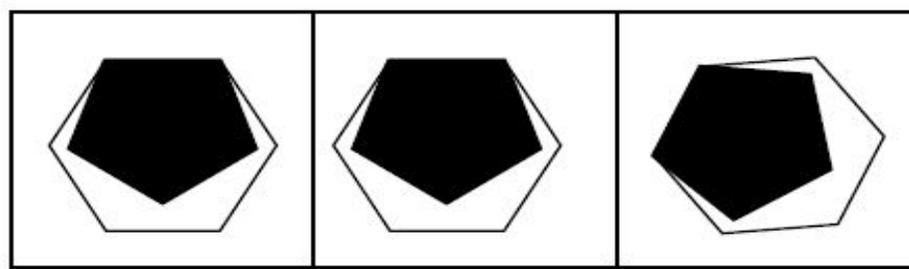
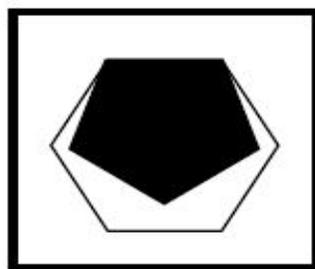
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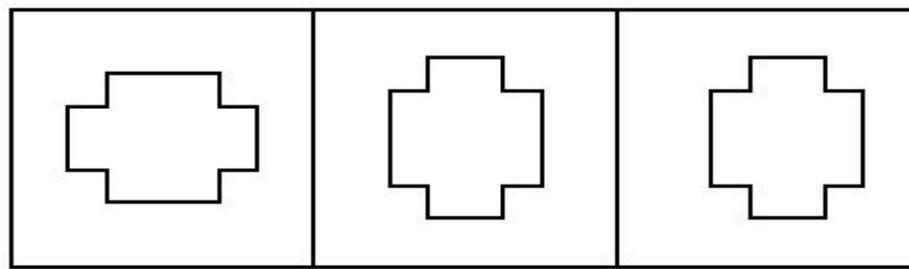
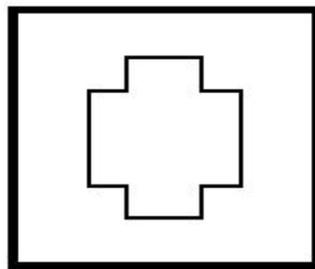
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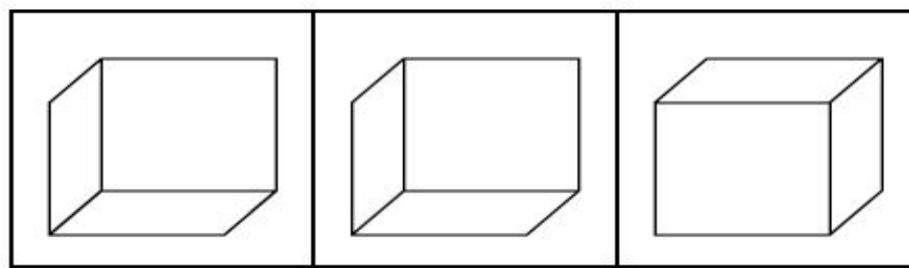
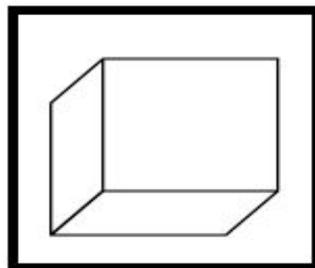
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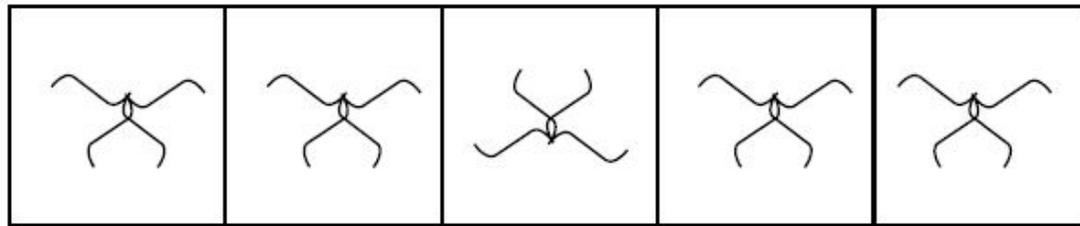
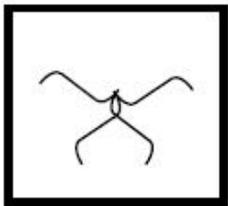
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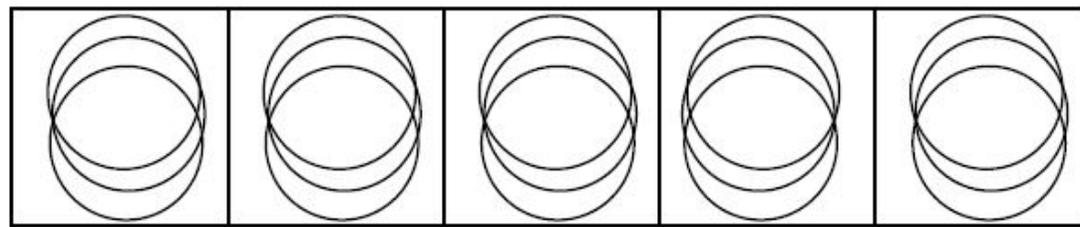
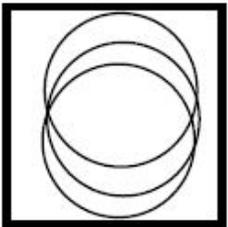
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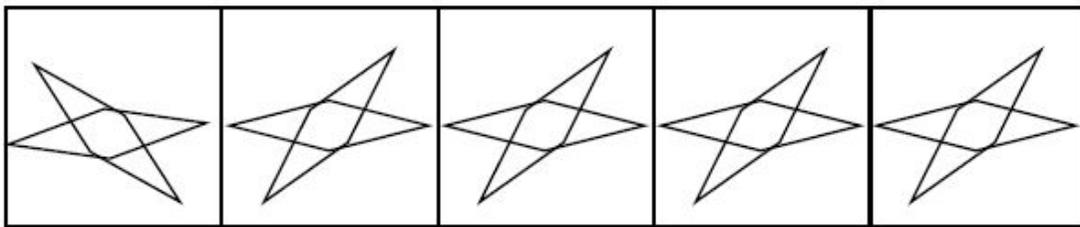
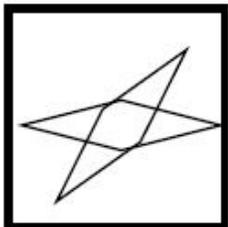
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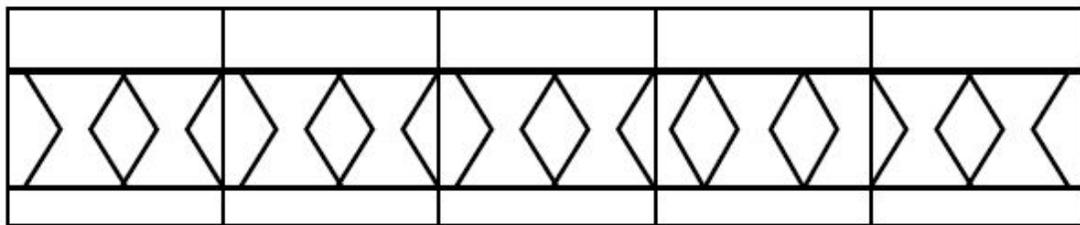
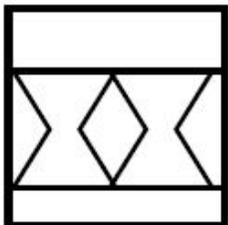
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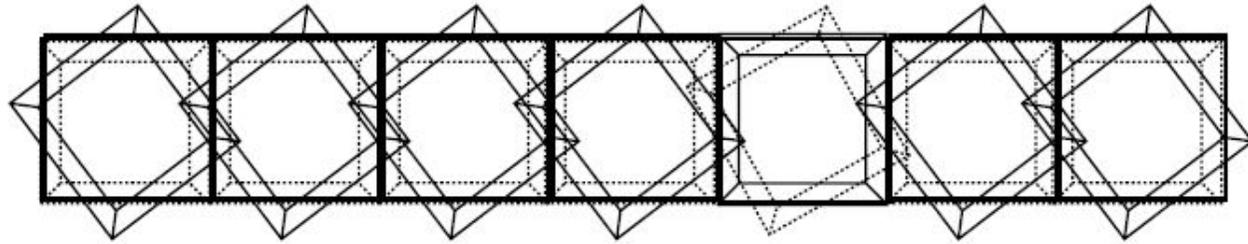
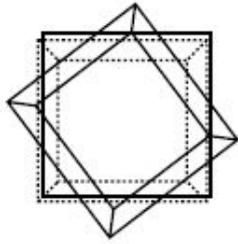
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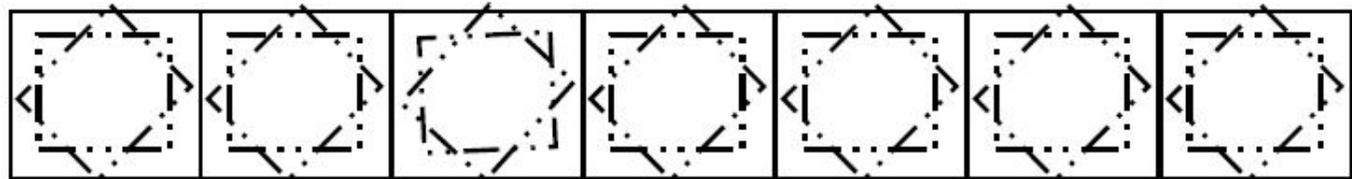
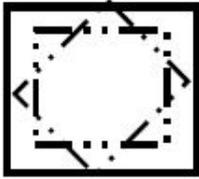
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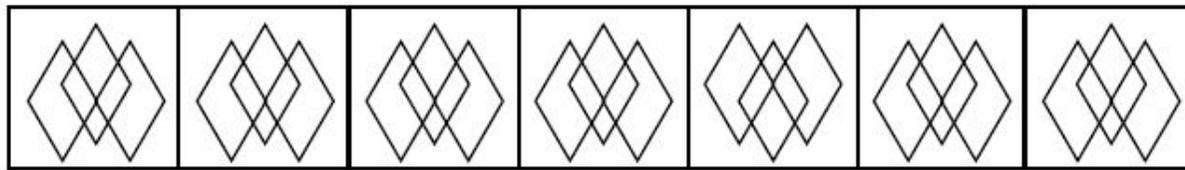
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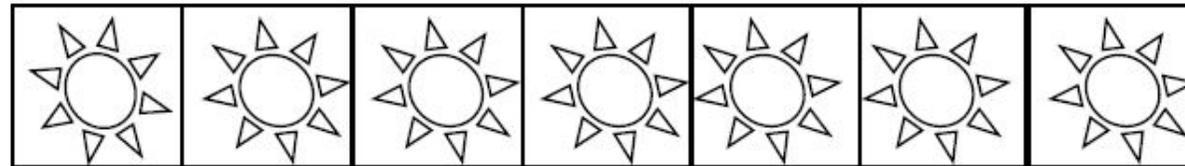
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16



SUBTEST: POSITION-IN-SPACE (P-S)

VISUAL SPATIAL PROCESSING ASPECTS

(Similar Tests: SSAIS-R: pattern completion (subtest); Gardiner's TVPS: visual spatial relationship subtest)

Task:	To locate a 2- or 3D view of a form which presents itself in the same directional position as the target form
Purpose:	To evaluate the learner's ability to be aware of the spatial orientation of objects, first to self then to other objects
Over and above:	Requires visual attention, visual scanning, laterality, reasoning and comprehension
Ceiling:	Three consecutive unsuccessful responses
Time Allocation:	2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
Material:	<ul style="list-style-type: none">✓ 3D Shapes: four rectangles✓ Test Booklet containing 16 Position-in-Space Plates

Procedure:

❖ Concrete Example: four plastic 3-dimensional rectangle shapes

Instructions:

The tester places a row of rectangles in front of the learner in an array of different directional positions (i.e. –| — |). Say to the learner, “**See these forms are the same shape...**” (whilst **pointing to a rectangle**). Then say, “**...but look how they can change the way that they point**” (whilst **pointing** to the remaining rectangles on the table and **remarking** on their directional position). **Which one is pointing in the same direction as you are?**”

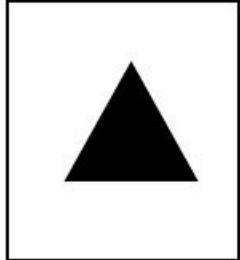
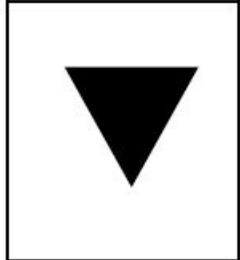
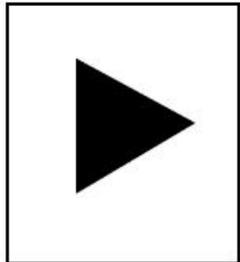
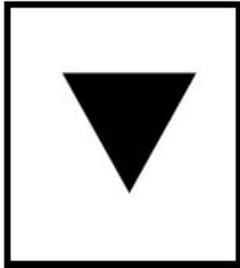
❖ Test Booklet: 16 P-S Plates – 2- or 3D represented views of black stimuli on blue paper

Instructions:

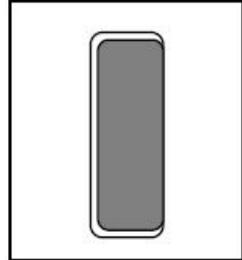
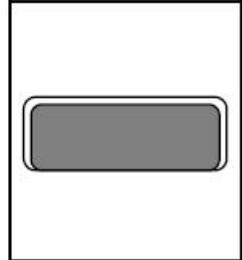
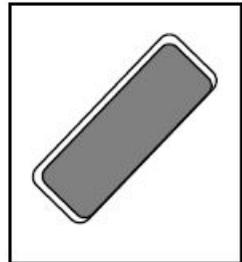
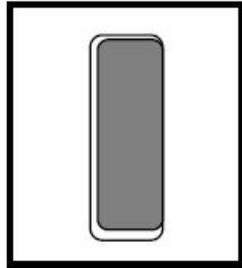
Present the P-S Test booklet to the learner, placing it in front of the learner. Open P-S Plate 1 in front of the learner. Say to the learner, “**Here are the exact same forms, but only one is going in the same way...**” (whilst **pointing** to the responses then to the target block) “**... as the one in this target block, look and find the one which is going in a same direction.**” If the learner identifies the correct response **continue** with the next plate of the VSR subtest **until the ceiling is reached**.

If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation.

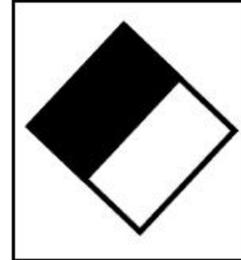
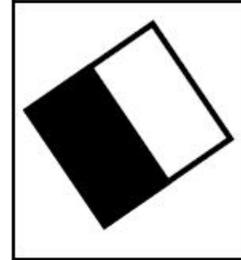
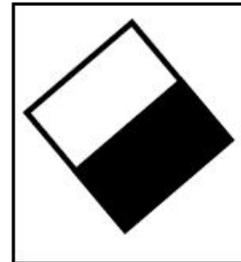
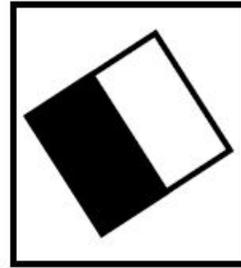
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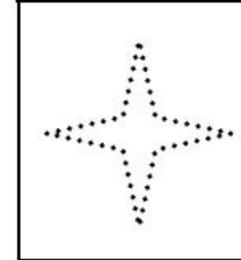
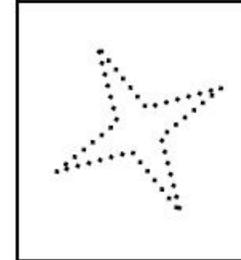
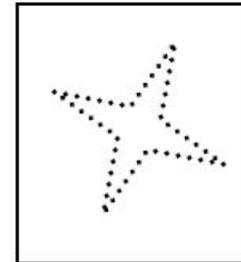
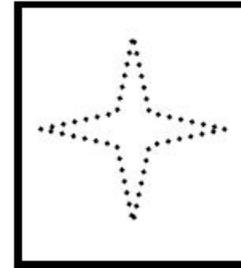
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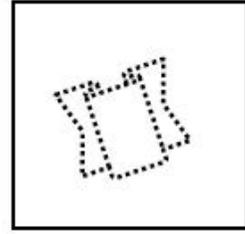
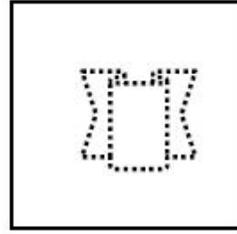
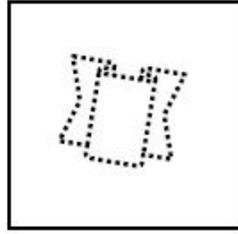
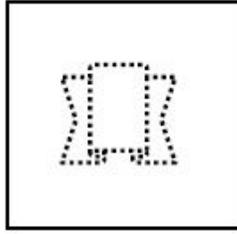
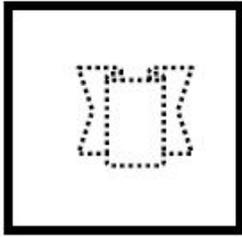
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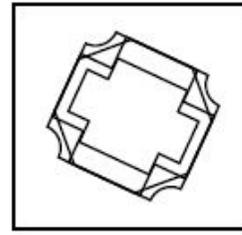
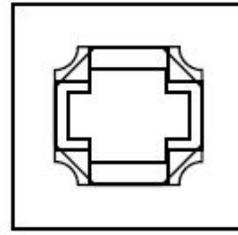
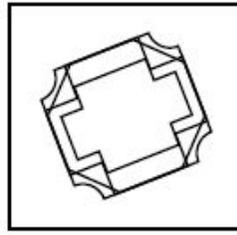
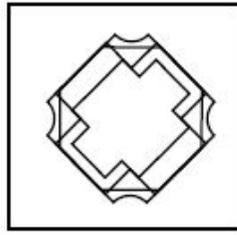
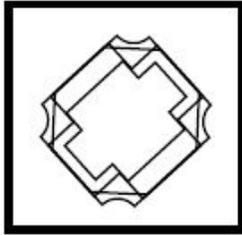
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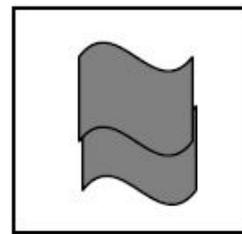
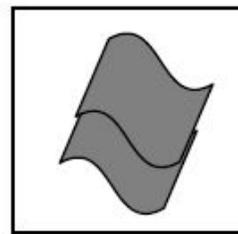
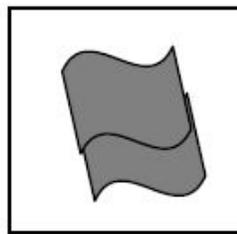
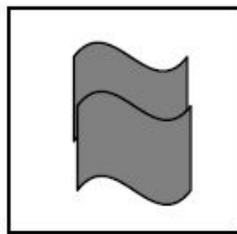
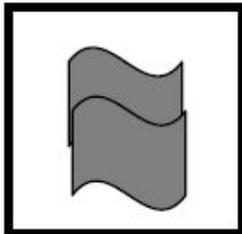
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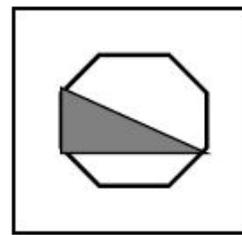
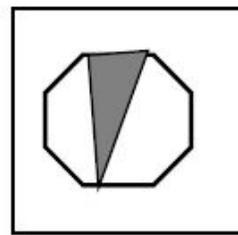
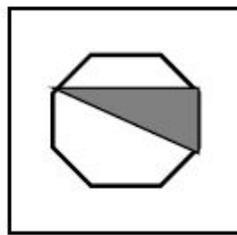
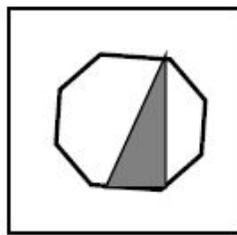
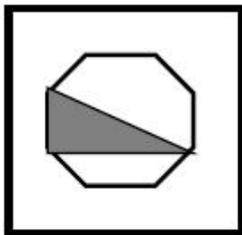
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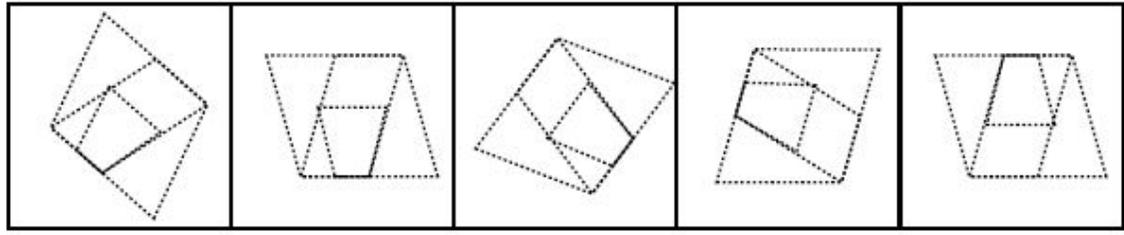
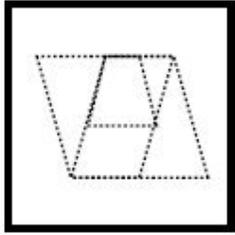
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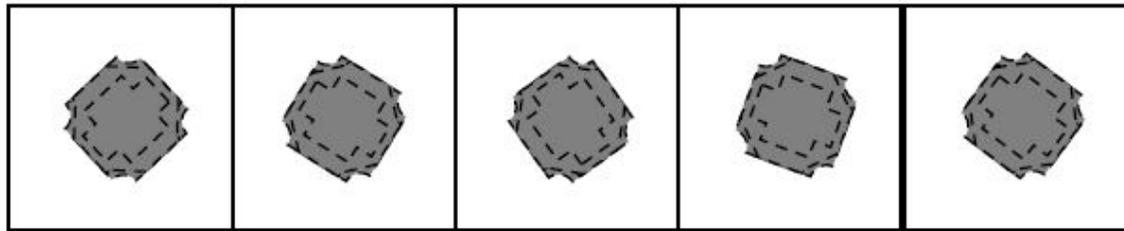
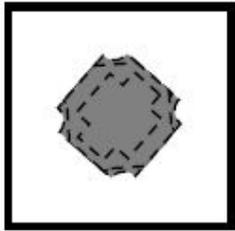
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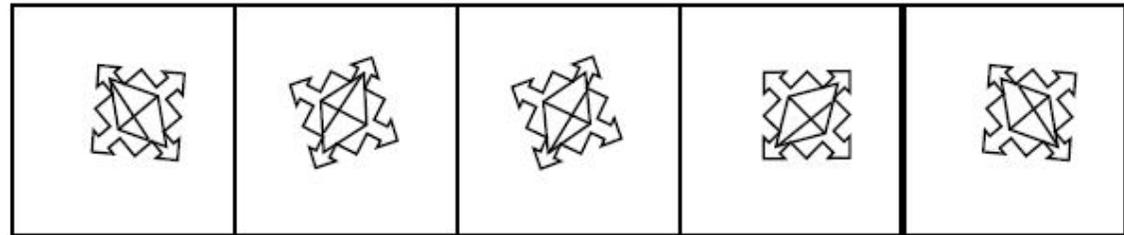
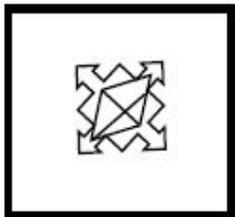
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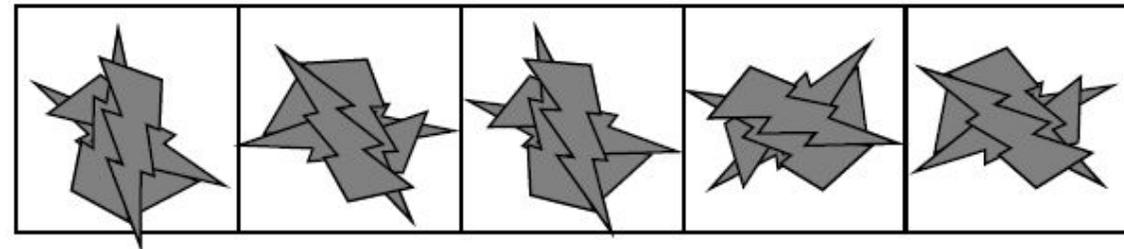
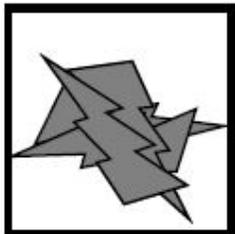
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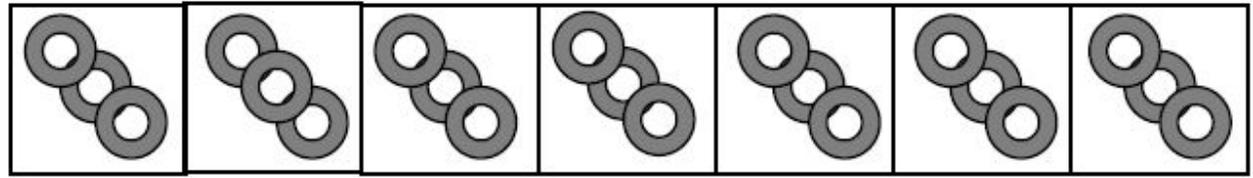
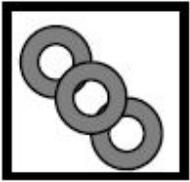
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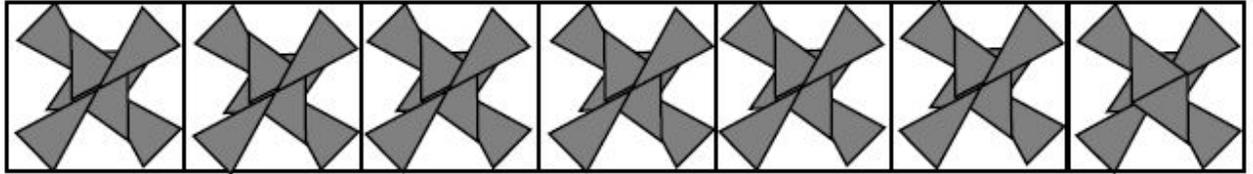
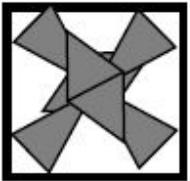
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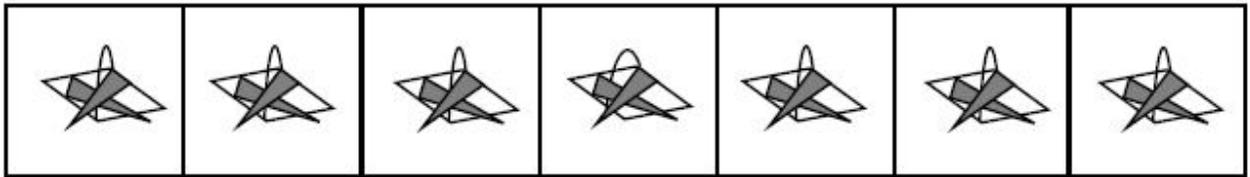
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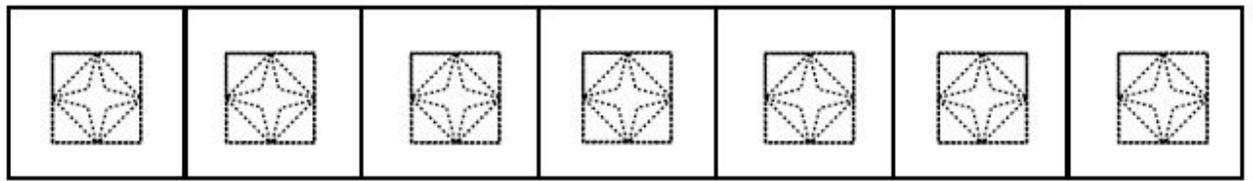
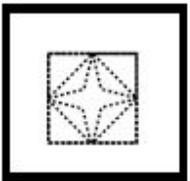
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16



SUBTEST: VISUAL FIGURE-GROUND (VF-G)

VISUAL PERCEPTUAL ANALYTICAL ASPECTS

(Similar Tests: Gardiner's TVPS- Subtest: Figure-Ground; DVPT - Figure-Ground - subtest 4)

Task:	To locate the same 2- or 3D form view even though it has been placed in a background
Purpose:	To attend to a specific form whilst maintaining an awareness of the relationship of this form/feature to the background information
Over and above:	Requires visual attention, visual scanning, reasoning and comprehending
Ceiling:	Three consecutive unsuccessful attempts
Time allocation:	2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
Material:	<ul style="list-style-type: none">✓ 3D Shapes: The entire array of shapes✓ Test Booklet containing 16 Visual Figure-Ground Plates

Procedure:

❖ Concrete Example: all plastic 3-dimensional shapes

Instructions:

The tester places all the shapes on the table in front of the learner. Say to the learner, "**Can you find the blue star...**" (whilst **pointing to** the array of shapes on the table). Then say to the learner, "**...look and find it amongst these shapes**".

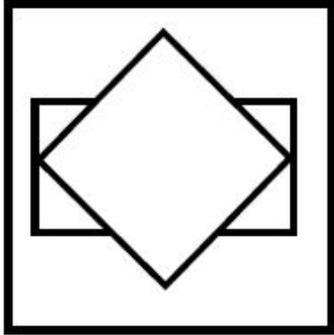
❖ Test Booklet: 16 VF-G Plates - 2D black stimuli on blue paper

Instructions:

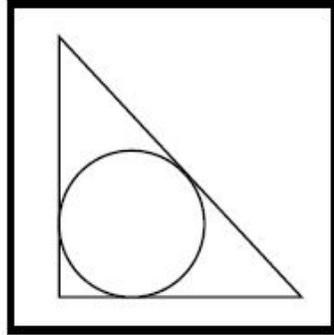
Present the VF-G Test booklet to the learner, placing it in front of the learner. Open VF-G Plate 1 in front of the learner. Say to the learner, "**See this form in this block...**" (whilst **pointing to the target block** containing the single form). Then say to the learner, "**Look and find it amongst these forms.**" (pointing now to **the blocks** containing the choices for the response). Once more emphasis to the learner the target form is hiding and close attention is required) "**Look very carefully ... remember it is hiding and may have change its size, direction or colour**".

If the learner identifies the correct response continue with the next plate of the VF-G subtest until the ceiling is reached. If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation and to delineate the areas required for remediation.

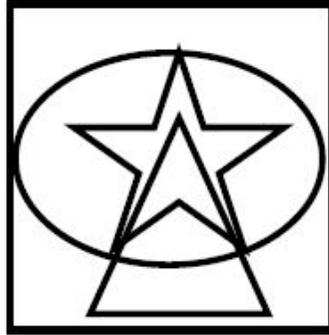
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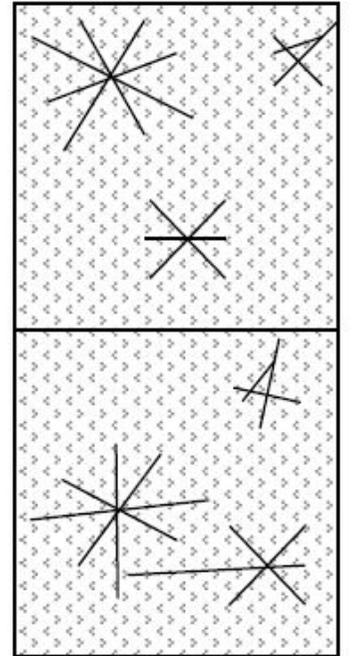
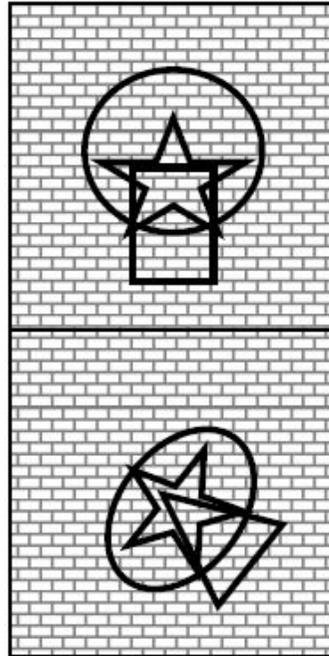
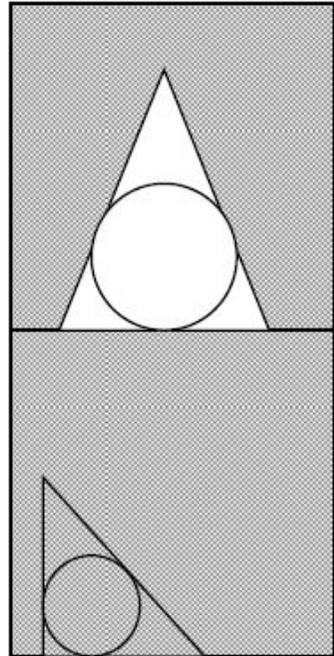
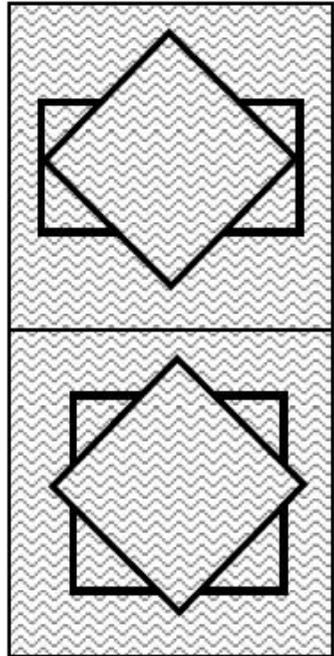
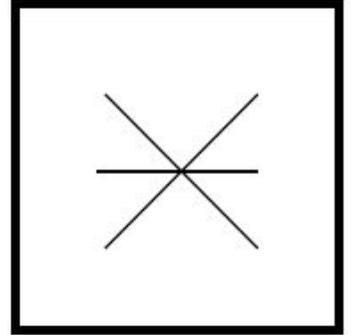
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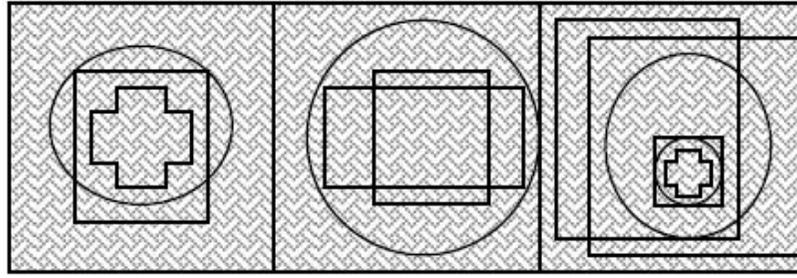
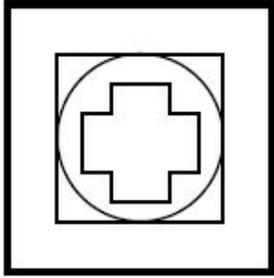
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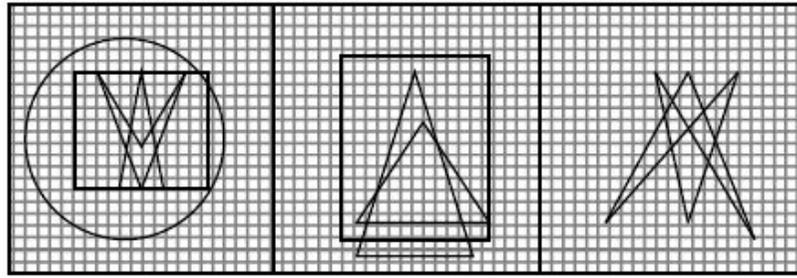
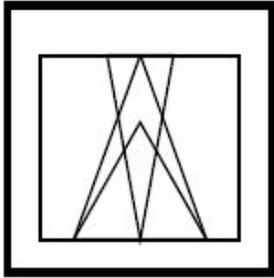
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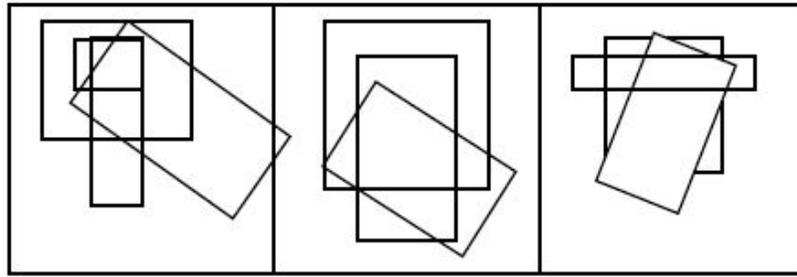
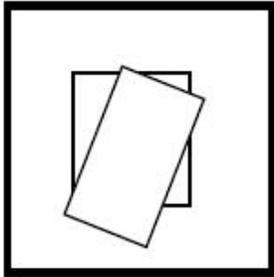
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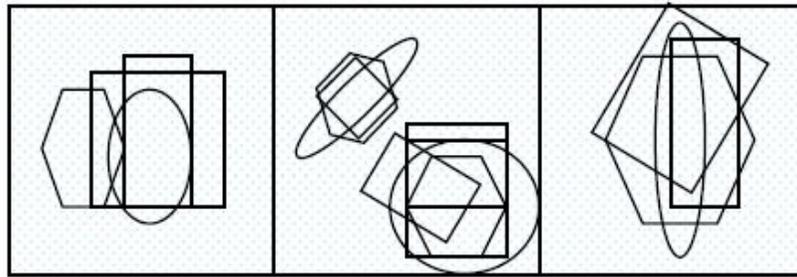
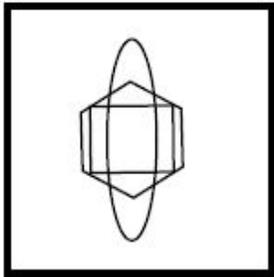
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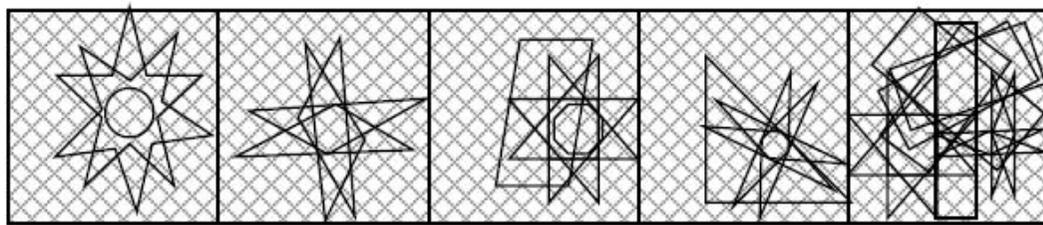
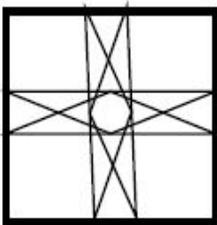
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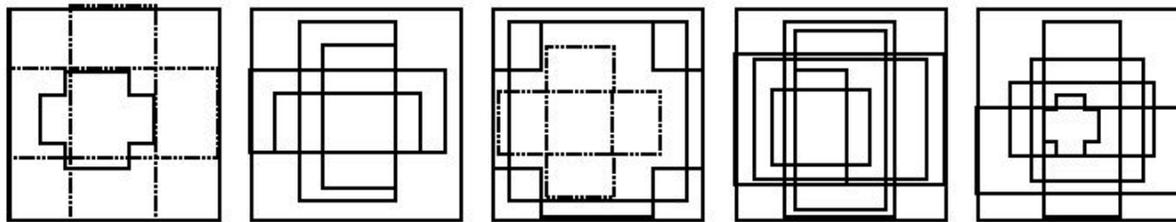
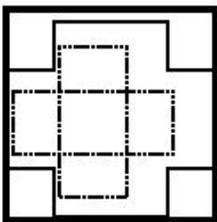
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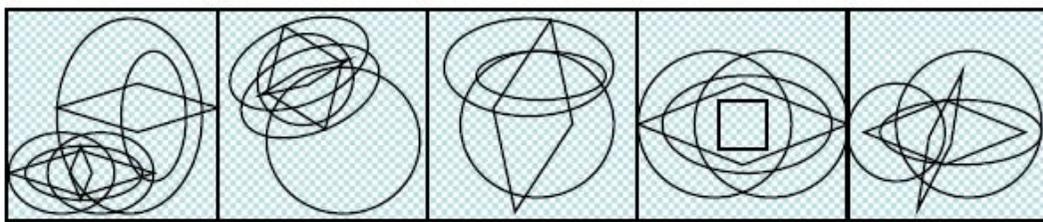
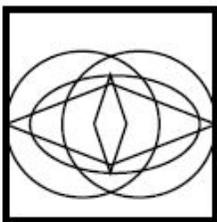
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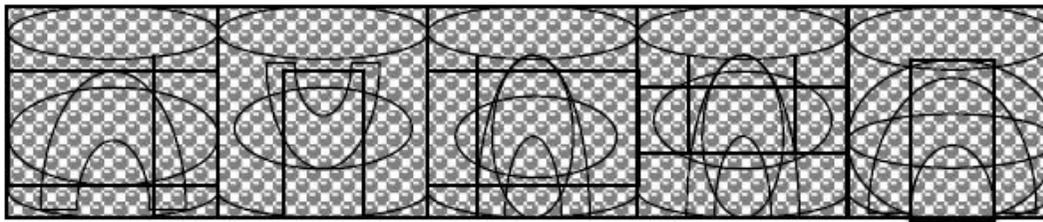
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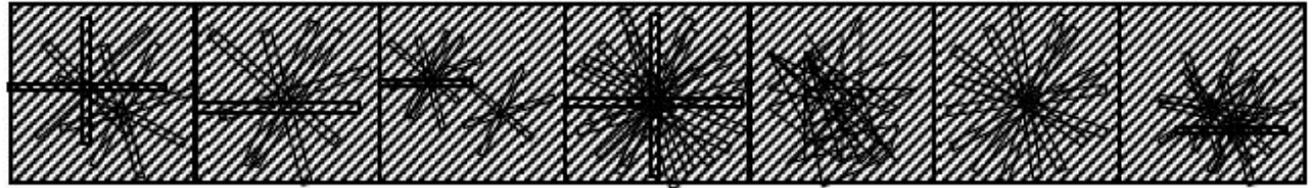
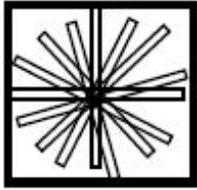
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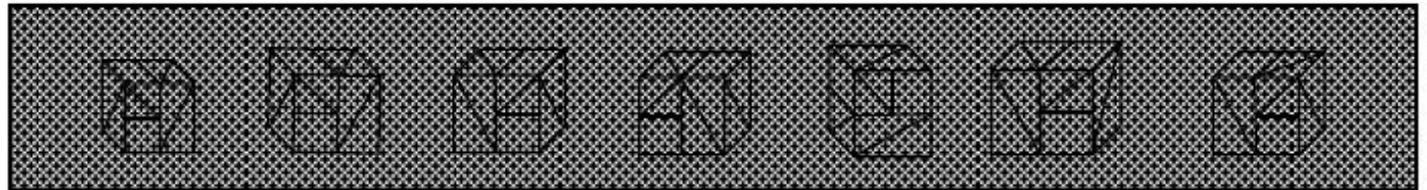
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16



SUBTEST: VISUAL CLOSURE (VC)

VISUAL PERCEPTUAL ANALYTICAL ASPECTS

(Similar Tests: SSAIS-R: pattern completion (items 1), Gardiner's TVPS - visual closure subtest; DVPT's visual closure: subtest 6; ITPA – Subtest: Visual Closure)

Task:	To locate the identified form, even though it is incomplete in presentation.
Purpose:	To evaluate the learner's ability to identify and be aware of clues to a complete form from an incomplete visual representation.
Over and above:	Requires visual attention, visual memory, reasoning and comprehending
Ceiling:	Three consecutive unsuccessful attempts
Time allocation:	2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
Material:	<ul style="list-style-type: none">✓ A 3D Shape, pencil, paper and eraser✓ Test Booklet containing 16 Visual Closure Plates

Procedure:

❖ **Concrete Example: a plastic 3-dimensional shape, pencil, paper and an eraser.**

Instructions:

The tester places the shape on a piece of paper and traces the outline onto the paper. Say to the learner, "**See this shape...**" (whilst **pointing to the shape**). Then say to the learner, "**...look if I erase a piece here, here and here can you still tell what the shape is**" (using the eraser erase pieces of the shape forming an incomplete shape).

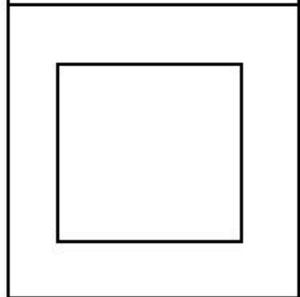
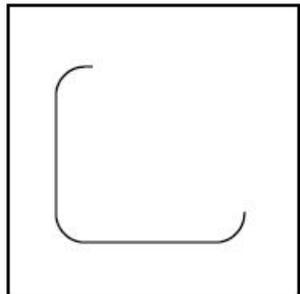
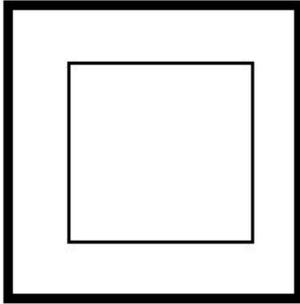
❖ **Test Booklet: 16 VC Plates - 2D black stimuli on blue paper**

Instructions:

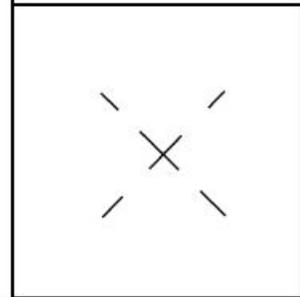
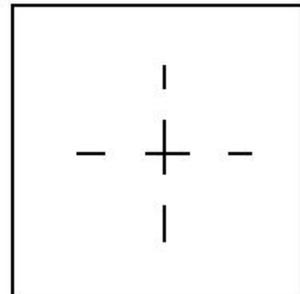
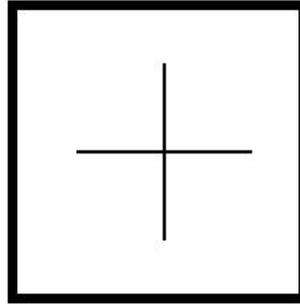
Present the VC Test booklet to the learner, placing it in front of the learner. Open VC Plate 1 in front of the learner. Say to the learner, "**See this form in this block...**" (whilst **pointing to the target block** containing the single form). Then say to the learner, "**... look at these forms...**" (**pointing now to the blocks below** containing the choices for the response). "**... which is the same form that is incomplete?**" If the learner identifies the correct response **continue** with the next plate of the VC subtest **until the ceiling is reached**.

If the learner is unable to allocate the correct response, once more demonstrate the Concrete and Plate 1 Examples. Record this unsuccessful attempt on the score sheet. The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation and to delineate the areas required for remediation.

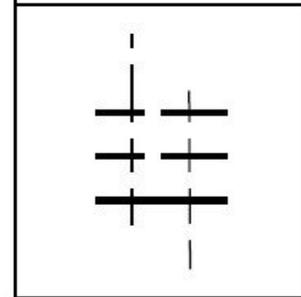
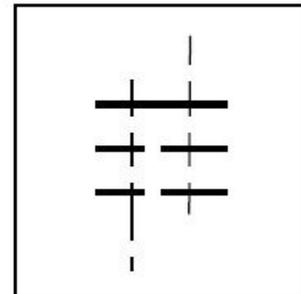
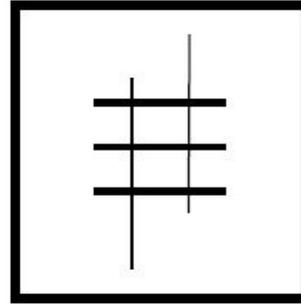
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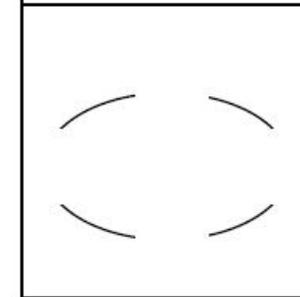
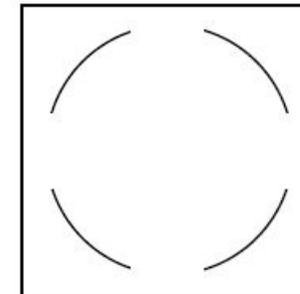
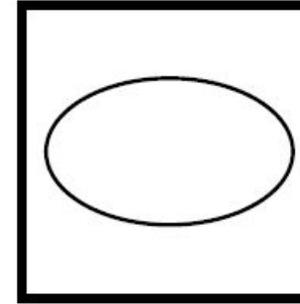
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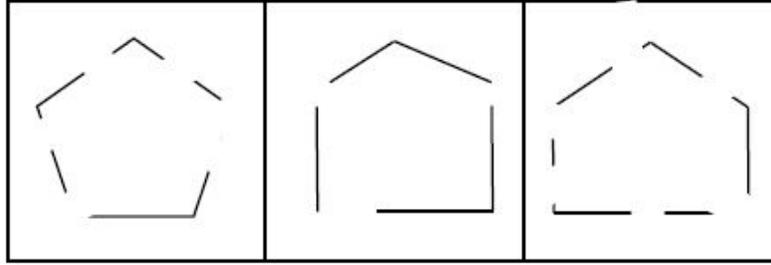
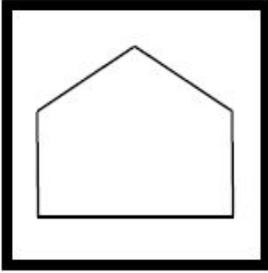
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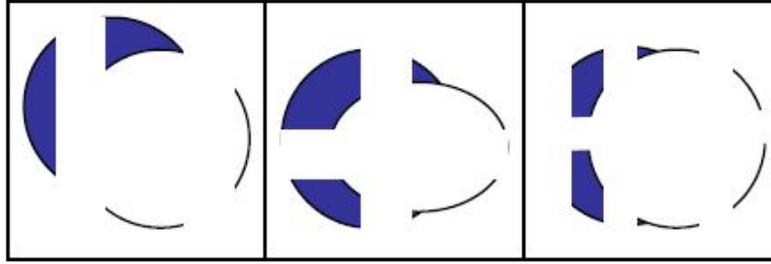
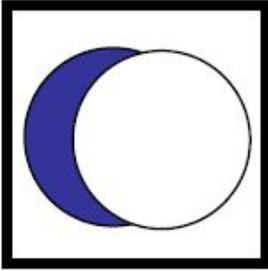
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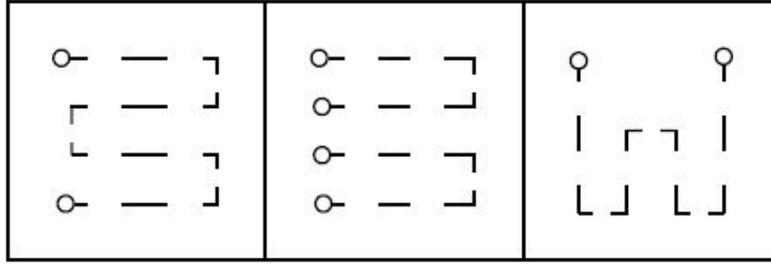
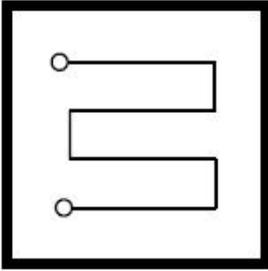
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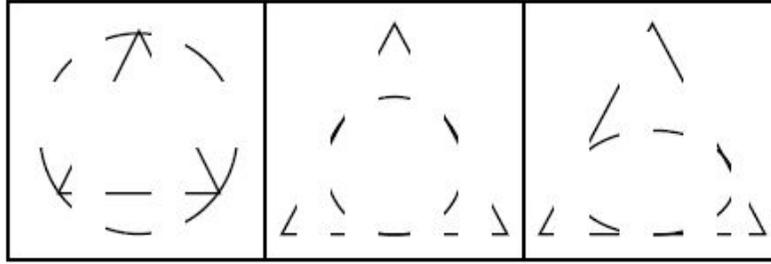
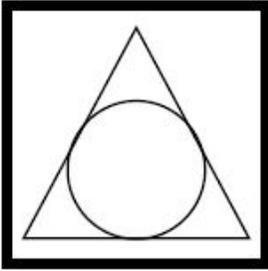
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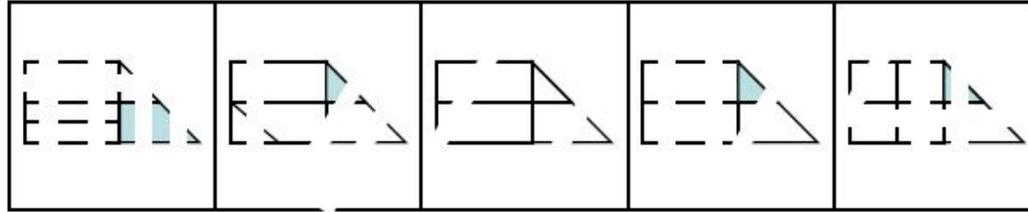
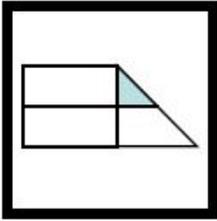
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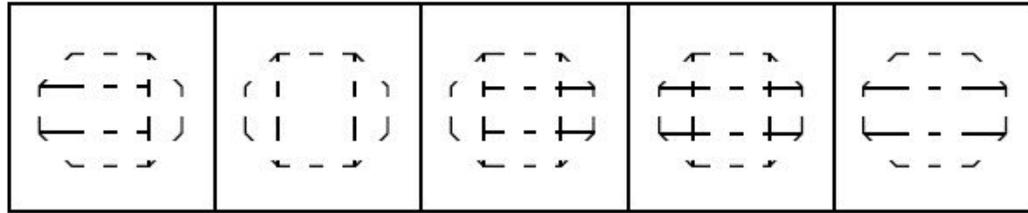
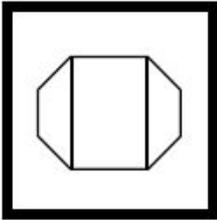
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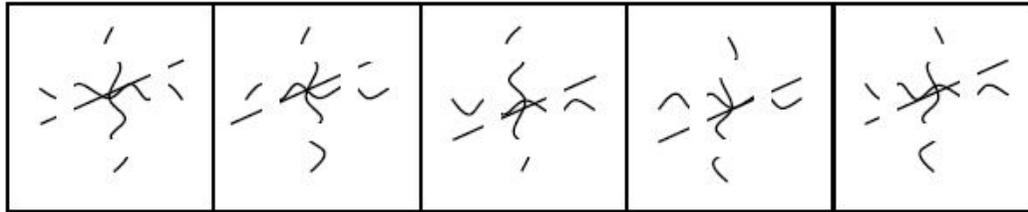
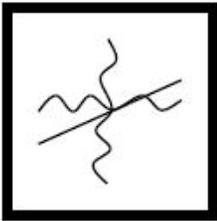
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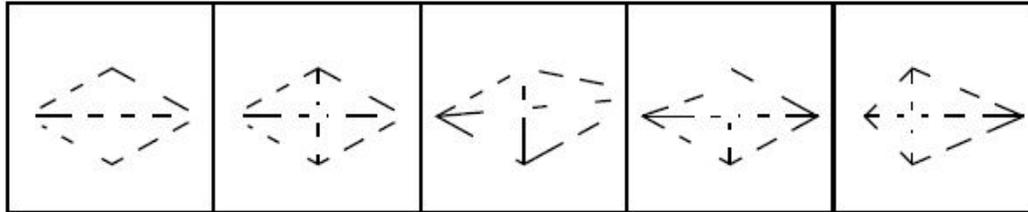
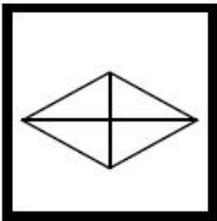
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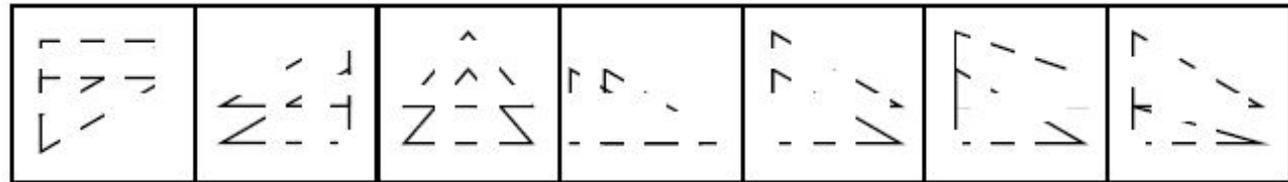
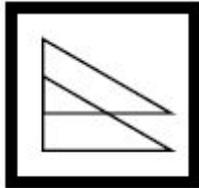
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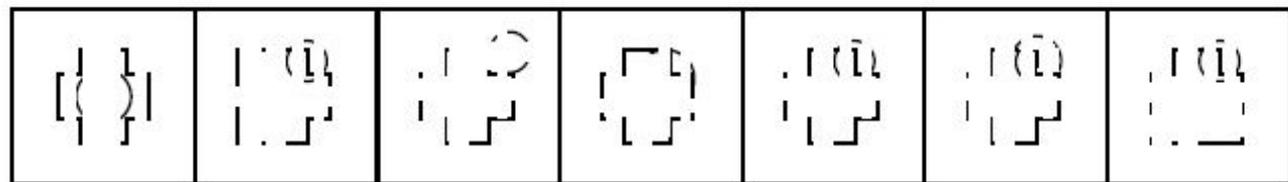
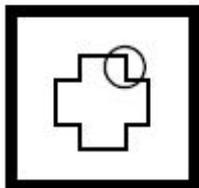
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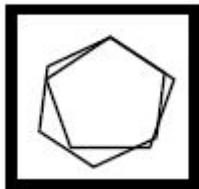
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SUBTEST: VISUAL ANALYSIS AND SYNTHESIS (VA/S)

VISUAL PERCEPTUAL ANALYTICAL ASPECTS

(Similar Test: JSAIS & SSAIS-R : Block design and Form Board Subtests)

Task:	To analyse (break up) a represented form or to assemble a form view presented
Purpose:	To evaluate the learner's capacity to analyse, as well as to assemble 2- or 3D form views presented on paper
Over and above:	Requires visual attention, visual scanning, reasoning, comprehending and planning
Ceiling:	Three consecutive unsuccessful attempts
Time allocation:	2 to 9 seconds (taking into account the learner's age and the item's level of difficulty)
Material:	<ul style="list-style-type: none">✓ 3D Shapes: diamond and two triangles✓ Test Booklet containing 16 Visual Form Constancy Plates

Procedure:

❖ **Concrete Example: plastic 3-dimensional shapes (a diamond and two triangles)**

Instructions:

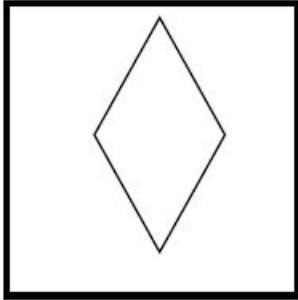
The tester places the diamond in front of the learner. Say to the learner, "**See this shape...**" (whilst **pointing to the diamond**). Then say to the learner, "**...can these shapes be used to build it... or these**" (whilst **pointing to the remaining shapes** [two triangles] on the table).

❖ **Test Booklet: 16 VA/S Plates - 2D black stimuli on blue paper**

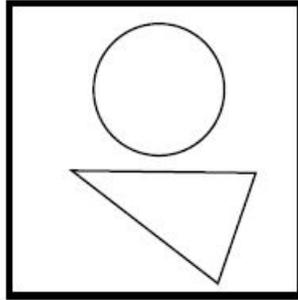
Instructions:

Present the VA/S Test booklet to the learner, placing it in front of the learner. Open VA/S Plate 1 in front of the learner. Say to the learner, "**See this form in this block...**" (whilst **pointing to the target block** containing the single form). Then say to the learner, "**what can be used to build it?**" (**pointing now to the blocks below** containing the choices for the response). If the learner identifies the correct response **continue** with the next plate. Open VA/S Plate 2 in front of the learner. Say to the learner, "**See these shapes what can you build with it...**" (whilst **pointing to the target block** containing the single form). Then say to the learner, "**what can be used to build it?**" (**pointing now to the blocks below** containing the choices for the response). If the learner identifies the correct response **continue** with the next plate of the VA/S subtest **until the ceiling is reached**. If the learner is unable to allocate the correct response, once more demonstrate the concrete and Plate 1 examples. Record this unsuccessful attempt on the score sheet (see score sheet example). The learner may require prompting to make a choice if more time than is considered reasonable is taken (see time allocation). Record all responses on the score sheet by either circling or crossing through the learner's elected response to later assist with a possible diagnostic evaluation and to delineate the areas required for remediation.

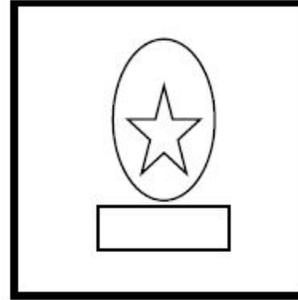
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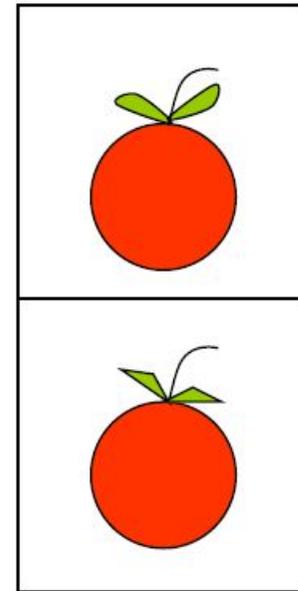
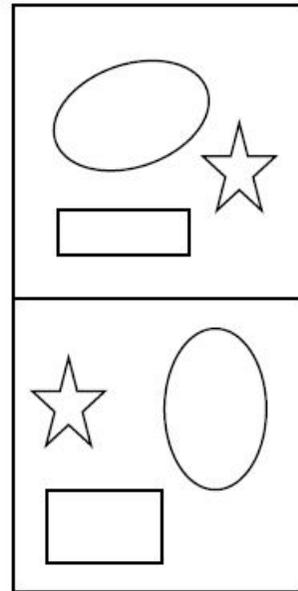
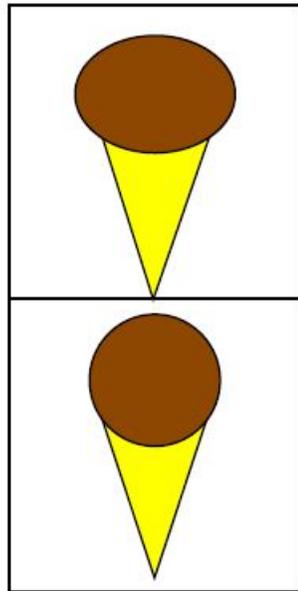
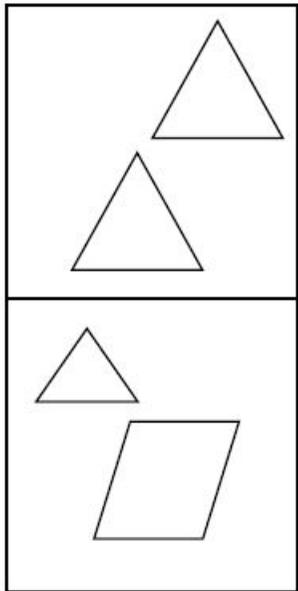
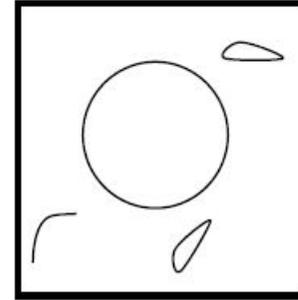
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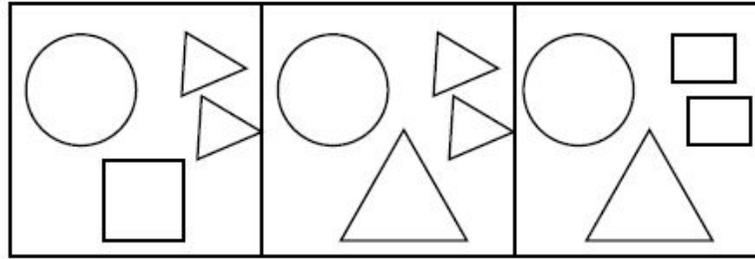
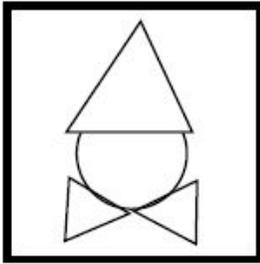
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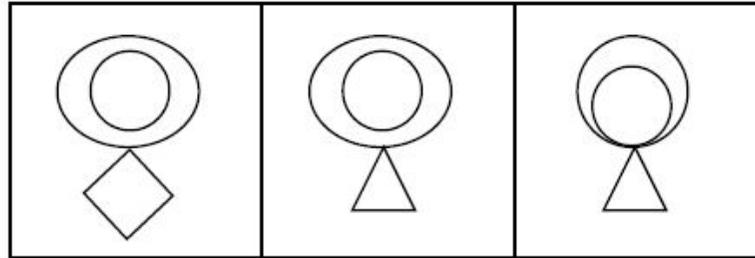
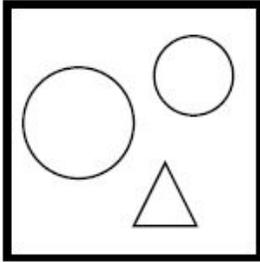
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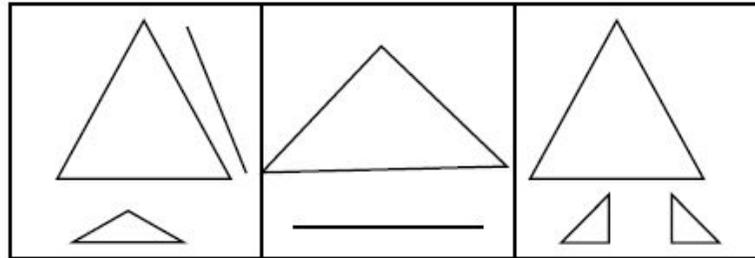
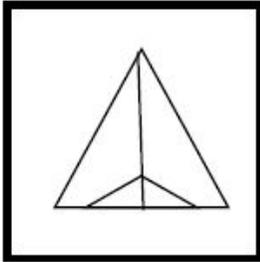
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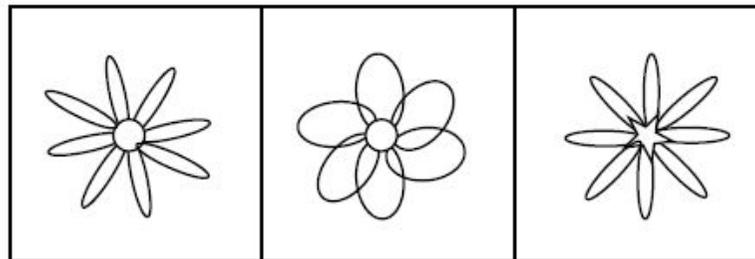
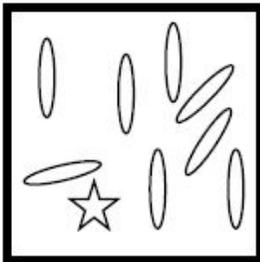
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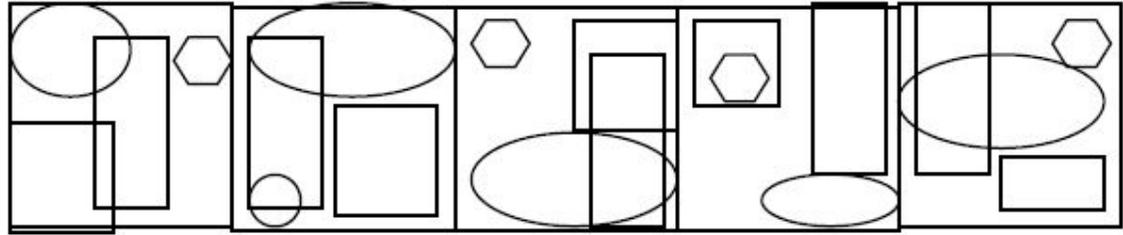
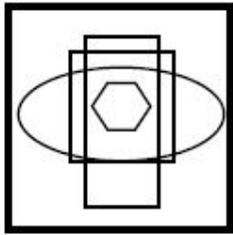
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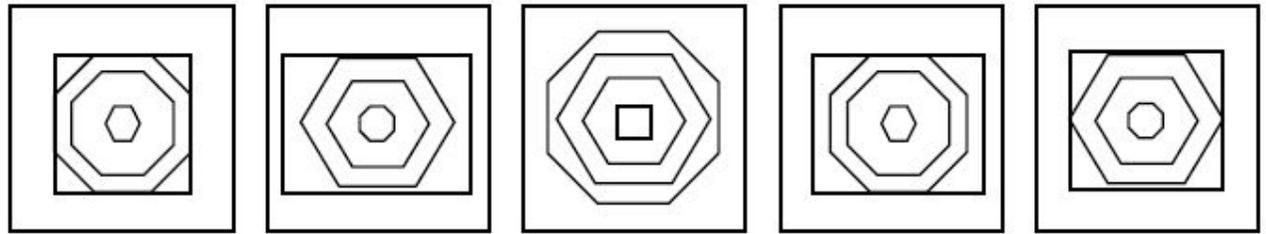
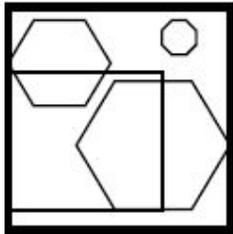
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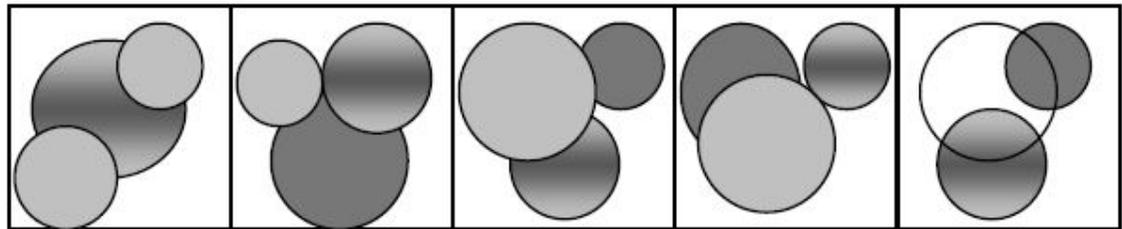
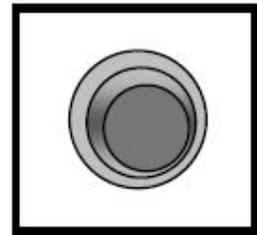
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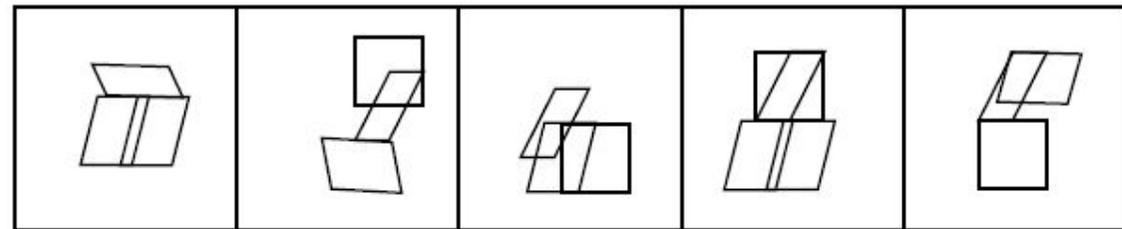
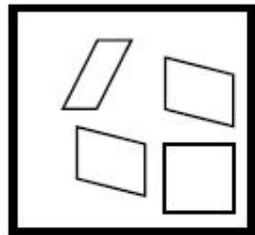
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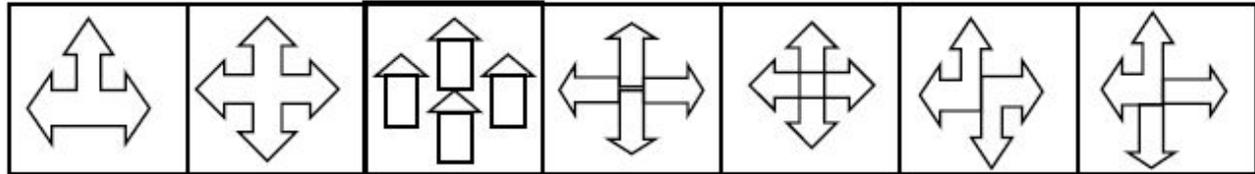
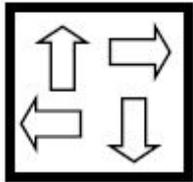
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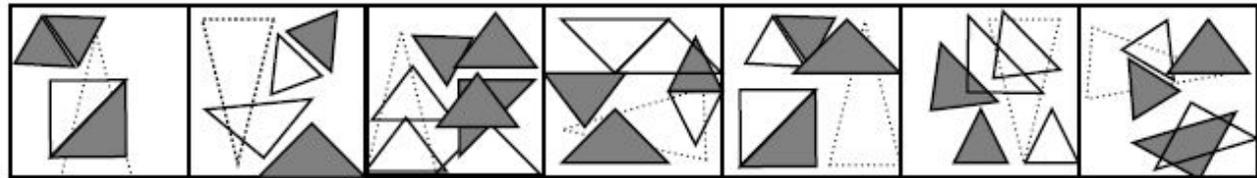
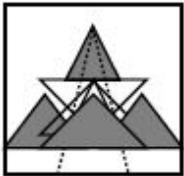
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