# DEVELOPMENT AND VALIDATION OF NONVERBAL ABILITY TEST FOR SCHOOL CHILDREN

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Transforming Education Transforming India

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# CERTIFICATE

This is to certify that the student namely, **Mr. Faheem Nabi** is a bonafide student of Department of Psychology and he has successfully completed his dissertation work entitled **"DEVELOPMENT AND VALIDATION OF NONVERBAL ABILITY TEST FOR SCHOOL CHILDREN"** at Lovely Professional University, Phagwara**.**

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# DECLARATION

I hereby declare that work entitled, **"DEVELOPMENT AND VALIDATION OF NONVERBAL ABILITY TEST FOR SCHOOL CHILDREN**" has been carried out by me under the supervision of Dr. Pardeep Kumar, Assistant Professor of Psychology, Department of Psychology, Lovely Professional University, Phagwara. No part of this dissertation has formed the basis for the award of any degree or fellowship previously.

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## DEDICATION

*Dedicated to the children of Syria, those who lost their lives and those who continue to suffer*

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## Abstract

Nonverbal ability test (NVAT), is a test which measures the cognitive abilities in a nonverbal fashion. The work describes the development and validation of NVAT. Intelligence being a hierarchically structured multifaceted construct has been described as the "ability to solve problems using memory and reasoning" by Jensen. The PASS model of intelligence also describes the importance of attention and planning while describing cognitive functioning. NVAT was developed using the two models for the assessment of the cognitive abilities. The tool has three subtests, Memory, Attention and Reasoning. Memory consisted of 20 items, while as Attention and Reasoning has 15 and 25 items respectively. Reasoning subtest is further divided into two parts i.e. Series and Matrices. The test shows a high correlation (0.86) with Culture fair test of R. B. Cattell which indicates a high construct validity for the test. of the test was measured by correlating the scores with Culture fair test of R.B Cattell. The test-retest validity was calculated on a sample of 30, and it was found to be 0.94, which indicates a high test-retest reliability.

# INTRODUCTION

Assessment of abilities have been an important part of the science of Psychology. Earlier different types of tests were developed both verbal, quantitative and nonverbal to meet the assessment criteria of diverse populations with different levels of education and proficiency in English language. To avoid "injustice by reason of relative unfamiliarity with English" (Yoakum & Yerkes, 1920, p. 19), army developed the series of beta tests which were nonverbal in nature to get the exact measure of everyone's abilities. Nonverbal assessment has been defined as the procedure to reduce the demand of language by the examiner or the examinee (Anastasi, 1988).

Tests developed earlier didn't draw any lines between verbal and nonverbal items (Performance based subtests). For Example, Wechsler was of the conviction that both verbal and nonverbal tests are equal measures of Intelligence and discarded the notion that nonverbal tests measure some special abilities (Boake, 2002). Wechsler stated that "the subtests are different measures of intelligence, not measures of different kinds of intelligence" (1958, p. 64) and he "viewed verbal and performance tests as equally valid measures of intelligence" (Wechsler & Naglieri, 2006). Naglieri argued that the term nonverbal doesn't refer to any ability but the content of the test which is measuring the general mental ability (Naglieri, 2008). As verbal tests possess a limitation of having verbal skills, people who lack such skills or children with neurological disabilities (language impairments) can't be assessed on such tests. Naglieri argued that autistic children or children with ADHD can more easily be assessed on a nonverbal test than a verbal one (Naglieri & Otero, 2011). Subjects with poor language skills or with lack of knowledge would perform poorly on verbal tests. Thus, while assessing different communities or children with such disabilities it becomes important to develop such tests that are free from the confounding variables like language and knowledge.

Like physical abilities, Mental abilities are vital for the existence of human beings. Mental abilities are the abilities of an individual to learn things, understand them and use them to solve problems. The most important term associated with mental abilities is intelligence. "Intelligence is the ability to think, analyse situations, solve problems and understand social values". There are two main forms of intelligence which include:

- **Verbal Intelligence** "it's the ability to understand and solve language based problems**"**
- **Nonverbal Intelligence** "can be described as the ability solve visual and spatial problems".

According to David Wechsler, Intelligence is the “global capacity of a person to act purposefully (in a situation), think rationally and to deal effectively in an environment”. For other scholar’s, it’s a “goal directed adaptive behaviour” (Sternberg RJ; Salter W, 1982). As Kline(1991a) demonstrated in his study that there have been numerous definitions of intelligence and hence there is no agreement. Thus, the term “Intelligence” and “abilities” are those traits which involve information processing and used to solve problems.

Intelligence is sometimes synonymously used as intelligence quotient (IQ), cognitive functioning, aptitude, intellectual ability, thinking skills and general mental ability.

“Intelligence testing is the measure of a person’s current intellectual functioning through a performance of various tasks that are designed to assess different types of reasoning.”

Non-verbal reasoning is thus “the ability to understand and analyse visual information and solve problems using visual reasoning, which includes identifying relationships between patters and things, similarities and differences between different patterns and shapes, recognition of visual sequences and relationships between objects, and remembering such information”. Nonverbal intelligence is thus the ability to analysing the information and solving problems using visual, or hands-on reasoning. Its thus solving problems and understanding without the necessary use of words to do so.

The terms used to characterize nonverbal assessment are somewhat confusing (e.g., "nonverbal assessment," "nonverbal intellectual assessment," "nonverbal scales," and "nonverbal testing"). Nonverbal assessment may be used to describe “a test administration process in which no receptive or expressive language demands are placed on either the examinee or the examiner (Bracken & McCallum, 1998)”. Similarly, the term "nonverbal intellectual assessment" may be used to describe the process of assessing the construct of intelligence in a nonverbal fashion. Although some test developers use this term to describe the assessment of a construct called "nonverbal intelligence," "nonverbal reasoning," or "nonverbal abilities" (Brown, Sherbenou, & Johnsen, 2001, 1990, 1997; Hammill, Pearson, &Wiederholt, 1997; Naglieri, 1985a, 1985b). However, Bracken and McCallum (2001) suggest that the central construct assessed by most "nonverbal intelligence tests" is in fact general intelligence.

## Types of Non-Verbal Reasoning

**Abstract thinking** "is the ability to think about objects, principles, and ideas that are not physically present. It is related to symbolic thinking, which uses the substitution of a symbol for an object or idea. It's also the ability to process ideas that involve complex visual or language-based ideas that are not easily associated with concrete ideas". Abstract ideas are often invisible, complex and subjective.

A variety of everyday behaviours constitute abstract thinking. These include: "Using metaphors and analogies; Understanding relationships between verbal and non-verbal ideas; Spatial reasoning and mentally manipulating and rotating objects; Complex reasoning, such as using critical thinking, the scientific method, and other approaches to reasoning through problems."

**Diagrammatic reasoning** "provides good measures of general intelligence. It involves evaluating processes represented via diagrams, understanding logical rules and process diagrams and identifying causes. Abstract reasoning is used where the ability to cope with complexity and deal with novelty is required rather than relying on previous experience."

**Spatial reasoning** predicts the ability to work with complex plans. "Spatial reasoning involves mentally rotating two dimensional representations of three dimensional shapes". It is needed in engineering settings, architecture and interior design.

## Memory

"Memory is the process of maintaining information over time." (Matlin, 2005). "It's the ability of an individual to encode, store, retain and subsequently recall information and past experiences". There are three types of memory which is sensory memory, short-term memory, and long-term memory.

Sensory memory is the shortest memory, which is the immediate and initial recording of sense organs. This memory retains for a short time (200-500 milliseconds) in its original form. It's based upon Iconic memory, which stores the visual information and lasts not more than 1)4$^{th}$ of a second. While as Echoic memory which is the auditory information and lasts for less than three seconds. Haptic memory stores the touch information.

Short term memory also known as "Active memory" which stores the information that we are currently aware about and which lasts for few

seconds to a minute before its either shifted to long term memory or lost. Short term memory can hold up to 7 items or less as found by George Miller while he was working at bell laboratories. Short term memories usually use acoustic code to retain information rather than a visual (Conrad, 1964).

Long term memory is the final step of information storage which can retain large amounts of information for longer durations of time. With its unlimited capacity and duration to store information, most of the information is retained in long term memory. It encodes information in semantic manner other than short term memory.

Recent findings on the assessment of memory in children with learning disabilities have produced different results (Cohen, 1982; Cermak, 1983; Liberman, Mann, Shankweiler, & Werfelman, Hagen, Barclay, & Schwethelm, 1982; 1982; Siegel & Linder, 1984). Some researchers have concluded that memory efficiencies are the reflections of difficulty in encoding memory and storing the information in the short-term memory (Liberman et al., 1982; Cohen, 1982; Swanson, 1981).

After world war, researchers found that brain damaged patients have had "consistently produced evidence of different memory systems for verbal and nonverbal material (Sperry, 1982)", and the use of nonverbal memory tasks helped the researchers to expatiate the nature of information processing disabilities in patients.

Wechsler in his memory test employed geometric drawings that he adopted from Binet's Intelligence Test (1906). But due to the complexity of the scoring procedures the inter scorer reliability coefficients for such tests are often low (Woloszyn et al., 1993). Rey Osterrieth developed his Complex Figure test (Rey, 1941, 1944) but like Wechsler's Memory scale these tests also have some limitations as subjects who lack grapho-motor skills or who are executive functioning are not able to perform well on such tests.

Jensen (1980) argued for a two-tiered hierarchical conceptualization of intelligence and included memory as one level (level I) out of the two levels. UNIT (Universal Nonverbal Ability Test developed by Bruce A. Bracken & R. Steve McCallum included Symbolic memory and Spatial memory as two of its subtests. Leiter International performance scale has added three memory subtests in order to asses' memory in terms of recognition, span and association. Thus, in most of the nonverbal ability tests, assessing memory was an important factor in order to find the total intelligence.

**Visual memory**

The ability to recall or remember information such as words, activities or pictures that have been viewed in the past visual memory is actually a type of

memory where some characteristics of our senses related to visual experiences are preserved. Visual memory describes the relationship between perceptual processing and the encoding, storage and retrieval of the resulting neural representations. Visual memory is actually an experience which we can say as the "mind's eye" through which a mental image of original places, objects, animals or people can be retrieved from our memory. As we know that we have several cognitive systems which are interconnected and combine to from the human memory, visual memory is one of the several cognitive systems the fact is that it takes a wide range of time spanning from eye movements to years for visual navigation of previously visited location.

**Attention** "is the process that enables an individual to focus on the relevant information in a stimulus array while also inhibiting further processing of nonrelevant information" (Rothbart, Posner, & Hershey, 1995). Attention helps us to take only a limited amount of the vast information present around us. Attention has been an important topic in cognitive psychology and continues to be so (Cowan, 2005). Attention has many types, like Divided attention where we pay attention to two or more messages simultaneously. In Selective attention, we pay attention to a particular information, while ignoring the other information (Fuster, 2003).

Attention involves a variety of processes which help us to process information. In a Selective Process, only some information coming from the environment is selected and processed. An Intense Process where this field is maximised and attention is varied. And Sustaining Process "whereby the receptivity to input information can be short- or long-term" (Thomas, Roa & Devi, 2016). Attention is not governed by a part of brain or the whole brain, but involves some anatomical areas that perform different cognitive functions.

One more term associated with attention is Attention Span. Attention span "is the amount of concentrated time spent on a task without distracting from it". Many tests have been developed to measure the attention span. Many tests have been developed to measure Attention span like Test of Attention in Infants (TAI) by DeGangi and Wechsler's Intelligence scale for Children- IV. After attention, a familiar concept to measure attention in currently used intelligence test is the distractibility. Many tests have been using this including Wechsler's scales.

Attention is a very important cognitive function and its impaired in many neurological and psychiatric disorders like ADHD, Autism and Bipolar Disorder ((Thomas, Roa & Devi, 2016). And thus, we need specific tests that will measure attention.

# Literature Review

The first person to assess nonverbal cognitive abilities was Jean Itard. He assessed the abilities of so called “Wild Boy of Aveyron” around 1830. Itard tried to determine whether the person has functional language skills and what’s his status on verbal and non-verbal capabilities (Carrey, 1995). After initial assessment Itard found that the boy couldn’t produce meaningful speech and thus he had to look for other options in order to assess his abilities and he shifted to nonverbal domain. Later in twentieth century scholars faced this problem of assessing the abilities of subjects with impaired speech and they tried to look for alternatives. In 1907, Seguin developed his unique nonverbal instrument named “Sequin Form Board”, a test based on inserting the geometric shapes in their befitting space, to assess the intellectual abilities of such children who couldn’t speak. During world war first such tests became very important because armies had to recruit foreign born soldiers who were not having English as their first language and needed to be assessed on nonverbal lines and in America “The Committee on the Psychological Examination of Recruits” was formed for assessment strategies (Thorndike & Lohman, 1990). These instruments that were designed by army included a variety of performance tasks in them, many of which were to appear later on the Wechsler Scales (for example puzzles, cube constructions, digit symbols, mazes, picture completions, picture arrangements).

Nonverbal assessment continued after the war. In 1924, Arthur developed the Arthur Point Scale of Performance Tests (Arthur, 1943, 1947). The Point Scale combined and modified a variety of existing performance tests, including a revision of the Knox Cube Test (Knox, 1914), Sequin Form Board, Arthur Stencil Design Test, Porteus Maze Test (Porteus, 1915), and an adaptation of the Healy Picture Completion Test (Healy, 1914, 1918, 1921) into a battery. This scale was made for examinees who were deaf or otherwise hard of hearing, and was designed by Arthur to provide a "multidimensional" IQ.

Nonverbal tests started getting more popularity and many new tests were developed for example Leiter International Performance Scale; Leiter, 1929; ‘Draw a Person’ developed by Dr. Dale B. Harris in 1926 and Columbia Mental Maturity Scale developed by Burgemeister, Blum, & Lorge(1972). After world war second came to an end, the popularity of these tests

decreased. During seventies, psychologists felt that the stimuli material, norms and procedures of these tests were outdated and many of them started using performance tasks from other standard batteries (for example WISC; Wechsler, 1949).

Other techniques were used to develop 'Nonverbal tests', by many other psychologists but they didn't get any positive feedback and were not popular among masses (for example Jean Piaget's 'tests of conservation' or Guilford's 'Processing tasks'). And thus, the new era of nonverbal ability tests started and during the early 1990s many psychologists have had already started such attempts and were successful also in creating the best nonverbal intelligence tests (see McCallum, Bracken, & Wasserman, 2001) and some of them are:

### The *Leiter International Performance Scale-Revised*

The Leiter International Performance Scale developed by Russell Leiter in 1929. It was developed to assess the intelligence of subjects with communication impairment. It's composed of individually administered subtests which are administered nonverbally. It can be administered on age groups from 2 years to 20 years, 11 months. A new scale derived from the Leiter-R known as Stoelting (Leiter) Brief Nonverbal Intelligence Test was published separately (Road and Miller, 1999). The Leiter International Performance Scale and its new form are used to operationalize nonverbal intelligence by measuring the fluid reasoning, visualization and nonverbal memory, mostly on Leiter-R (McGrew & Flanagan, 1998). There are four dimensions of general nonverbal ability on which the Leiter scale is based which are Memory, visualization, reasoning and attention. This battery was standardized in a large sample of 1,719 subjects and depicted a high reliability and validity in correlating with other popular intelligence tests. The original edition of Leiter International Performance Scale served as a useful test for assessing the intelligence of subjects who were deficits in learning, hearing, reading, autism, motor impairments or were with mutism or with attention deficit disorders. The battery consisted of wooden blocks that were to be placed into slots to match the sequence of pictures, that was present on wooden frame. And thus, this earlier version of Leiter was outdated and needed immediate revision and modernization, more over a well standardized scoring system and all of this was provided in the Leiter-R.

Leiter-R defined Nonverbal Intellectual abilities as those "cognitive and mental skills and aptitudes which involve a plurality of nonlanguage functions such as visual attention, figural reasoning, picture memory and

spatial visualization (Brouwer, van Zomeran, 1992). The instructions for the test are given as gestures by the administer of the test.

There are two grouping of subtests in Leiter-R scale which include (A) 'the Visualization and Reasoning Battery(VR)', which has further 10 subtests mainly related to spatial ability, visualization and reasoning. The other subtest is based upon (B) 'Attention and Memory(AM)' battery with further 10 subtests of memory function and nonverbal attention. The testing duration for subsets is 45-50 mins each. There are four multidimensional behavioural observation scales also which are to be filled by Parent, Teacher, Examiner and Self, which cover areas like sociability, emotions, anxiety, impulse control, mood and attention (0-3-point rating scale for parents, teachers and self and 4 points rating scale for the examiner).

**Reliability and Validity:** The battery was standardized on a stratified sample of 1719 normative cases (51.1% males and 49.9% females) and the internal consistency reliability of Leiter-R were ranging from 0.91 to 0.93 for full scale IQ. The test-retest reliabilities were ranging from 0.90 to 0.96. The internal consistency reliabilities of rating scales ranged from 0.73 to 0.99. The Leiter-R full scale showed a correlation of 0.86 with the WISC-III and 0.85 with Performance IQ(PIQ) with a sample of 122(n=122).

The strengths of Leiter-R lie in its 'Child and Examiner' friendly form. Also, it's the only scale which measured nonverbal memory and attention measures along IQ assessment. It's also popular for its fairness of assessment across ethnic groups. While as some weakness came from the users who claimed it's difficult to learn Leiter-R tests and users found it difficult to give nonverbal instructions and some people even claimed that they miss the blocks.

## Naglieri Nonverbal Ability Tests: *NNAT* and *MAT-EF*

The Naglieri nonverbal ability test, which is a 38-item test developed by Jack A. Naglieri in 1997(NNAT; Naglieri, 1997). He developed a 72-item individual form for it after revision which is called "Naglieri Nonverbal Ability Test-Individual Form (NNAT-I; Naglieri, 2003)". The Naglieri Nonverbal ability test is a revised form of the Matrix Analogies Test Short Form (MAT-SF; Naglieri, 1985b), which was a group administered test for

assessing the General mental ability, mainly comprised of nonverbal items. Naglieri revised the NNAT in 2003 and developed an individually administered NNAT-I.

Both of these scales are comprised of items that in order to be solved require that the colourful designs which are formed by organised shapes which are to be understood to determine which shapes complete the pattern and thus the answer. The items of the scales are colour blind friendly, mostly printed in white, blue and yellow colours (Naglieri, 1985). The items are grouped under subtests which include Serial reasoning, Pattern completion, Spatial visualization and Reasoning by analogy. The time duration for 38 items is 30 minutes, and extra 10 minutes are given to fill the demographic data, while as for NNAT-I its 20-25 minutes.

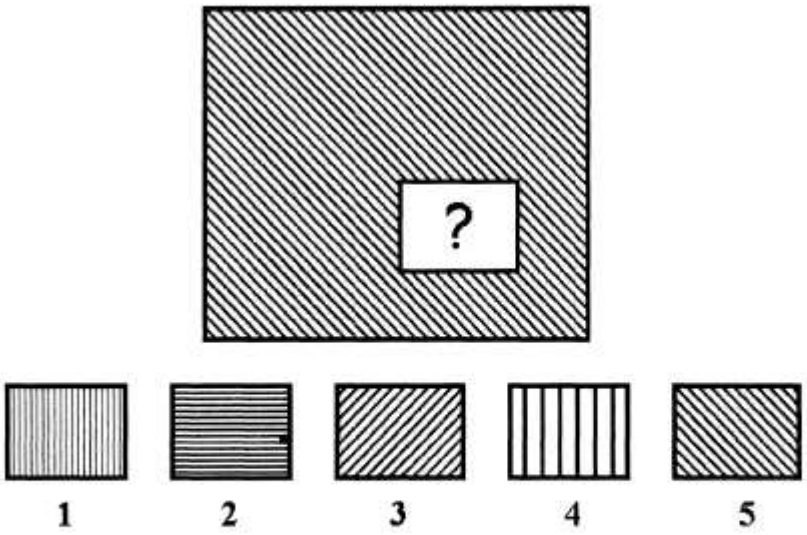



**Figure 9.1** Pattern Completion Item Type. image source : https://www.testingmom.com

Figure 9.1 describes Pattern Recognition. In Pattern Recognition, subject needs to look into the box and find the appropriate pattern that would fit into the box and complete the pattern.

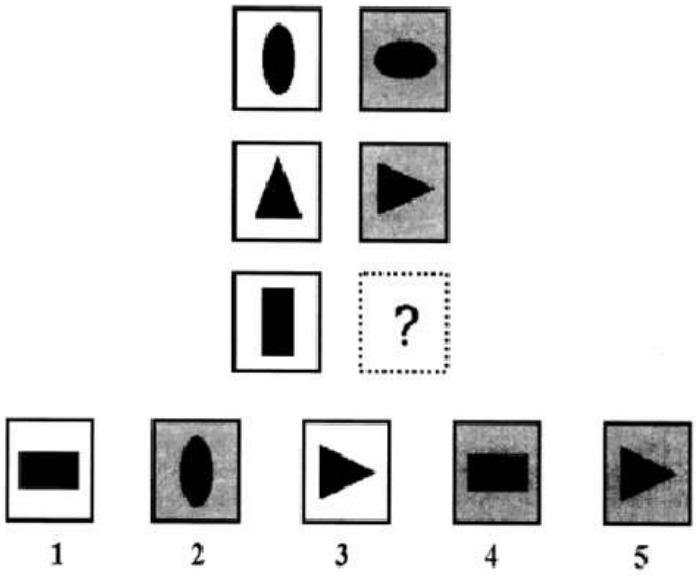



Figure 9.2 Reasoning by Analogy Item Type.

Image source https://www.testingmom.com

Figure 9.2 describes reasoning by analogy, which involved determining the logical relationship between different geometric shapes.

**Reliability**

The KR-20 Internal reliability coefficients for NNAT were found to be 0.83 to 0.93 with average of 0.86 on all the samples (n= 76,661), which is considered to be very high and is one of the strengths of the test. The Cronbach alpha coefficients of the NNAT-I were found out to be 0.88 to 0.95 across different ages on a sample of 1585 (n=1585).

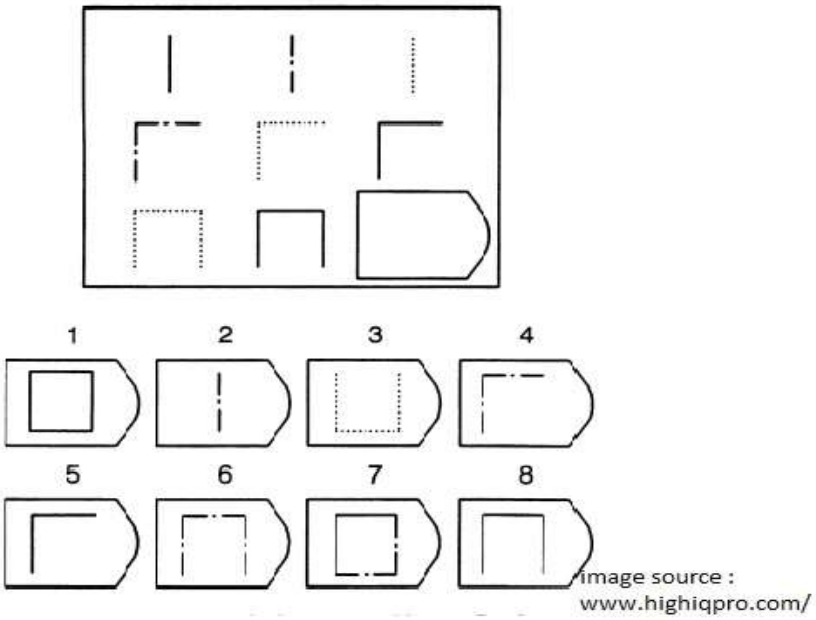
**Strengths and Weakness**

NNAT is a briefly administered test and its strength lies in its administration on a large sample. It also provides machine scorable answer sheets which further add to the ease of the test administrator. It's a cultural-fair test and has demonstrated very less difference between the white and other ethnic minorities (in US). The weakness of the test is less research on the validity of the test (Maller and Mowery, 2000).

**The Raven Progressive Matrices**

The Ravens Progressive Matrices(RPM) tests developed by J.C Raven is a nonverbal group test, used to measure "General Cognitive Ability" (Raven,

Raven, & court, 1998a, 2000). Standard Progressive Matrices or SPM is the basic version of the test, comprised of five sets of items. There are total 60 items in the test and they are in increased difficulty order and each item in the set becomes progressively difficult. The test was developed as a part of a study which was examining the genetic and environmental origins of the mental deficiency. J. C Raven developed the SPM for Lionel Penrose, who was conducting this study.




Test items of SPM

**Reliability and Validity**

The internal consistency of the test was found out to be 0.90 (Court & Raven, 1995). The test-retest reliability was found out to be 0.85 and above. The Raven Progressive Matrices was correlated with other intelligence tests such as Binet and Wechsler's scales and was found out to be ranging from 0.54 to 0.86.

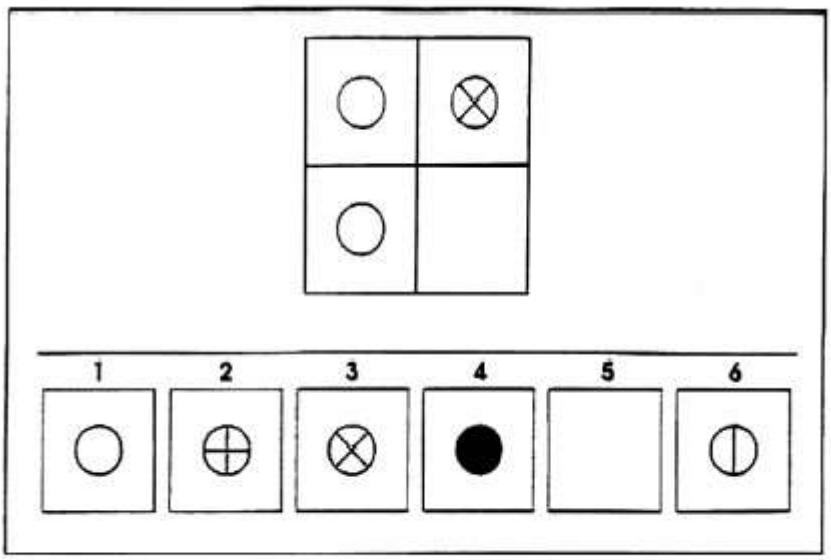
**Strengths and Weaknesses**

Ravens scale is the most researched scale among all the cognitive tests with nonverbal items. The test is easy to administer and provides a lot of details to the administer.

**The *Test of Nonverbal Intelligence***

The test of Nonverbal Intelligence (TONI; Brown, Sherbenou, & Johnsen, 1982, 1990, 1997, 2010) is an individually administered, nonverbal test used to assess the theoretical constructs of general and fluid intelligence (Horn & Cattell, 1966; Spearman, 1904). The authors of the test Brown, Sherbenou, and Johnsen argued that TONI-4, can be used in a variety of settings which include assessment of intellectual functioning and impairment, aptitude and in research fields.

The original test consisted of 307 items, but the TONI-3 is comprised of 90 items only by taking into consideration the various psychometric principles. The age group for this test is 6 to 89 years, 11 months. The latest version of the test doesn't have any subtests. First 19 items of the test are for age group 6 to 9 and the rest of the 41 items are for subjects above the age of 9. The time duration for the test is 15 minutes. Each item consists of an abstract figure and a missing figure in the sequence. And each sequence is distinguished from others in terms of 'rotation, position, shape, contiguity, size or movement' in the order of increasing difficulty. Each right answer is awarded one point and zero for each incorrect answer.

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http://xazahint.jimdo.com/

Test item of TONI

**Reliability & Validity**

The test was standardised on a sample of 2,272 subjects. The internal consistency (Alpha coefficients) were found out to be 0.96. The test-retest reliability was obtained on a sample of 63 participants and was found out to be 0.88 and 0.93 for Form A and Form B respectively. The construct validity was demonstrated by correlating the test with other two nonverbal tests of

intelligence which are Comprehensive Test of Nonverbal Intelligence (CTONI-2 Hammill, Pearson, & Wiederholt, 2009) and the TONI-3 (Brown, Sherbenou, & Johnsen, 1997). It was administered on 72 participants. With CTONI-2 it was found out to be 0.79 and with TONI-3 it was found to be 0.74 (n= 56). It was also found that TONI-4 has high predictive validity.

## The Comprehensive Test of Nonverbal Intelligence

"The Comprehensive Test of Nonverbal Intelligence (CTONI; Hammill. Pearson. & Wiederholt. 1997)" is a nonverbal test which assess the problem solving and reasoning abilities of subjects. The test is a nonverbal test which purports to measure Sequential reasoning, Analogical thinking and Categorical formulation using geometric designs and pictorial objects. The test can be administered on an age group of 6 to 89 years. The time duration for the test is 40 to 60 minutes. Hammill, D. D., Pearson, N. A., & Weiderholt, J. L, suggest that the test is the best measure of Spearman's "g" (1923).

## Reliability and Validity

The test was standardized on a sample of 2,827. The internal consistency was measured by using alpha coefficient and was found out to be 0.80. The test-retest reliability was computed on a sample of 63 students, and was found out to be 0.88. The interrater agreement was also measured and was found out to be 0.95.

Construct validity was measured by correlating the scores of CTONI and CTONI-2 ranged from 0.60 to 0.90. CTONI was also correlated with TONI-3 and it was found to be 0.79(n=72). Criterion Prediction validity was also found to be high.

## Strengths and Weakness

CTONI-2 is a good attempt to measure Intelligence, with its clear instructions and simple scoring system, it can be administered on subjects with linguistic, motor and auditory impairments. Some weaknesses of the test are that the test can't be administered on individuals with visual difficulties.

## The *Universal Nonverbal Intelligence Test* (UNIT)

The Universal Nonverbal Intelligence Test (UNIT; Bracken & McCallum, 1998) is a nonverbal test used to assess intelligence. UNIT, provides a unique measure of cognitive organization (symbolic and non-symbolic content) and function (memory and reasoning) and is a strong measure of *g*. There are six subtests in UNIT, which include Object memory (OM), Spatial memory (Spa M), Symbolic memory (Sym M), Cube design (CD), Mazes (M) and Analogic Reasoning (AR). The battery takes around 30 minutes' time for completion.

UNIT measures the nonsymbolic performance and the subconstruct of memory (Wechsler, 1939; Jensen, 1980). UNIT also conceptualizes the Gf-Gc model of fluid intelligence as described by Cattell (1963), Horn (1968) and Woodcock (1990). UNIT subtests assess a number of factors of the Gf-Gc stratum (McGrew and Flannagan, 1998). The psychometric qualities of the UNIT were found to be "acceptable" by many experts (Settler, 2001; Kamphaus, 2001). UNIT is a user friendly, multidimensional, nonverbal intelligence test with full nonverbal administration.

## Reliability and Validity

The test was standardized on a sample of 2100 children and additional 1765 children and adolescents also participated in the validity and fairness studies. The internal consistency reliability was found to be 0.83. The test-retest reliability was administered on 197 participants, and was found out to be 0.88. The UNIT was correlated with other nonverbal tests of Intelligence and was found to be 0.81 to 0.84 with WISC-III and with Woodcock-Johnsons-Revised (WJ-R; Woodcock & Johnson, 1989/1990) was found to be 0.82. With TONI, it was 0.68 and with MAT (Matrix Analogies Test, 1985) it was 0.79.

## RESEARCH METHODOLOGY

Research methodology is a set of procedures which is conducted to systematically solve the research problem. It can be defined as the process which is used to collect data and information for the purpose of making certain conclusions and decisions. It also provides tools and techniques with which the research is dealt with. The methodology usually includes the sampling, tools and statistical analysis.

## SCOPE OF THE STUDY

In recent years, a lot of nonverbal tests have been developed overseas to assess the intelligence and other cognitive abilities. India being a multilinguistic and multi cultured country, whose beauty lies in its diversity, where we find a new language or culture after every few miles, verbal tests of intelligence don't find any relevancy. Nonverbal intelligence tests are the need of the hour as there are n number of students in India with learning, motor and linguistic or Neurodevelopmental disorders, who can't be directly assessed with verbal tests of intelligence and need to be assessed with nonverbal methods. The available nonverbal tests either lack the psychometric qualities or don't find any relevancy in Indian context. The aim of this study is to develop a tool which will assess the intelligence and other cognitive constructs in a nonverbal fashion. The tool will be useful in both school and clinical settings and will be useful across the different cultures and diversities of India. The tool can be used across different cultures and in almost all the states of India without any problems in its administration and use.

## OBJECTIVES

The objectives of the study are:

I) Development of Nonverbal Ability Test for School Children
II) Validation of Nonverbal ability test

## HYPOTHESIS

1. As there were no hypothesis for the study. The test was developed and validity and reliability was calculated. The test shows a high correlation (0.86) with Culture fair test of R. B Cattell which indicates a high construct validity for the test. of the test was measured by correlating the scores with Culture fair test of R.B Cattell. The test-retest validity was calculated on a sample of 30, and it was found to be 0.94, which indicates a high test-retest reliability.

**Research Title**

Development and validation of Nonverbal Ability Test for School Children

**Sample**

The test was standardised on a sample of 100 subjects. The subjects were selected from Saffron Public School, Phagwara. The sample was collected from class $5^{th}$ students and subjects were randomly selected. Total sample consisted of 50 Male and 50 female subjects.

**Tools**

1. **Culture Fair Intelligence Test:** Culture fair test was developed by R. B Cattell and A. K. S Cattell. The test consists of three scales. Scale 2 has been standardised on a age group of 8-14. It consists of two forms, Form A and Form B. There are four subtests each comprising of 12, 14, 12 and 8 questions. The subtests include series, classifications, matrices and conditions. Time limit for the test is 12.5 minutes for scale 2. The reliability of the scale 2 is 0.87. Scale 2, form A was used in the study.
2. **Self-developed Tool** was used to collect data. The test assesses memory, attention and reasoning. There are 20 items in memory sub-test, 25 in reasoning and 15 in attention.

**Statistical Analysis**

Suitable and required statistical techniques such as Pearson Product Moment will be used in the current study.

# Results and Discussion

## Underlying theory of NVAT

NVAT didn't use a single model for its development but multiple models were under consideration during the development of NVAT. Intelligence being a hierarchically structured multifaceted construct (Jensen, 1980; Carroll, 1993). The Jensen's Model of Intelligence defined intelligence "as the ability to solve problems using memory and reasoning". Jensen further described the mental abilities "g" into two levels. Level one consists of capacity of short-term memory and rote learning, while as, Level two of mental abilities consist of Problems solving and reasoning skills (Jensen, 1980). Carroll in 1993, proposed that the "general intelligence "g" forms the peak of the construct followed fluid intelligence and other narrow abilities such as deductive reasoning" (Carroll, 1993).

PASS model proposed by Das, Kirby and Jarman in 1975, with its later proponents like Naglieri and Parrilla is based on the work of A. R Luria (1996). It has three basic units, which includes the functional unit which acts as the first unit and is responsible for regulation of cortical tone and maintenance of attention. Das et al. (1994) argued that attention is being controlled by the cortex particularly the frontal lobe of the brain and is a higher order functioning without which no other cognitive function can be maintained. The second unit receives, processes and stores information using simultaneous and successive processing. Simultaneous processing is a mental process whereby the persons integrates separate stimuli into a single perceptual or conceptual whole and nonverbal processing comes under this (Naglieri & Das, 1997). Whereas, Successive processing helps a person to work with a stimulus in a specific serial order (Naglieri, 2003). And third programs, directs and regulates the mental activities (Das et al. 1994). This unit is responsible for the programming, regulation and verification of activities (Luria, 1973). The researchers concluded that in order to function effectively, all the three functioning units should work in unison. During the development of NVAT, PASS model of intelligence was utilised for the development of attention and Reasoning subtests.

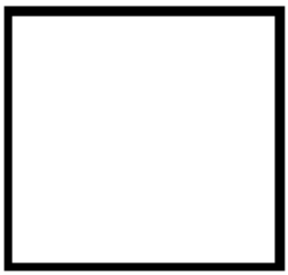
Sustained Attention, which is vital for completing tasks which are demanding and it comprises of focussed attention, vigilance, Spatial and selective attention (Zomeren & Brouwer, 1994). Many studies have found a positive relationship between sustained attention and intelligence (Schweizer et al., 2000; Stankov, 1988b; Stankov, Roberts, & Spilsbury, 1994; Crawford, 1991; Schweizer & Moosbrugger, 1999, 2004). The researchers also argue that high levels of sustained attention can provide the basis for better performance on intelligence

tests. Since, intelligence is a high demanding task, it can be assumed that an efficient supervisory attentional system is closely associated with memory.

The test was divided into three subtests which included "**Memory, Attention and Reasoning."** Reasoning subtest was further divided into two parts i.e. Series and Matrices. Although the test is standardised on age 11 subjects, but it can be used for age groups 8-14.

1. **Memory**

Initially 100 items were developed for assessing memory. After taking expert opinion only 20 items were selected. The subtest is a power test and difficulty increases with the order of items. Items were designed in a way that recognisable patterns would be eliminated. After giving clear instructions to the subject's items were presented. The items were shown serial wise on a card. Card was exposed for 5 Seconds and then subject was asked to draw it on a sheet. For drawing, 1 minute time was given for the first 10 cards and 2 minutes for the cards from 11 to 20. The standard time for memory subtest is 30 minutes. Time duration was strictly measured and no delay was allowed. For every right answer one marks was awarded. Drawings that didn't match the exact figure on the card were not accepted and zero marks were awarded for them. The item order begins this way:

| ITEMS OF MEMORY (POWER TEST) | |
|---|---|
| **ITEM NO. 1** |  |
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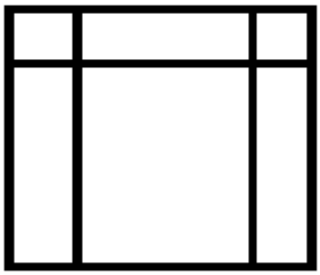
| **ITEM NO. 3** |  |

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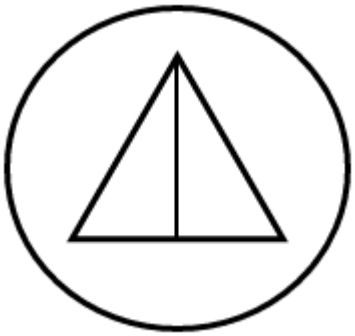
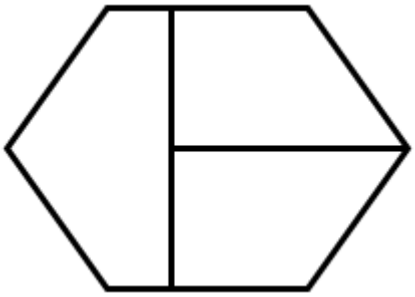
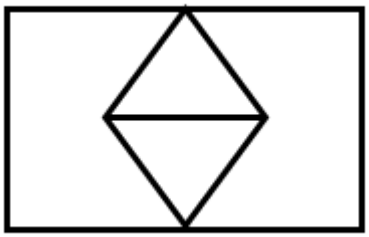
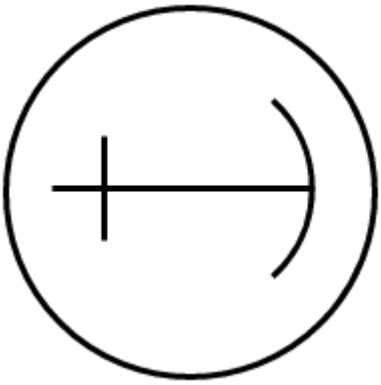
| **ITEM NO. 4** |  |
| **ITEM NO. 5** |  |
| **ITEM NO. 6** |  |
| **ITEM NO. 7** |  |

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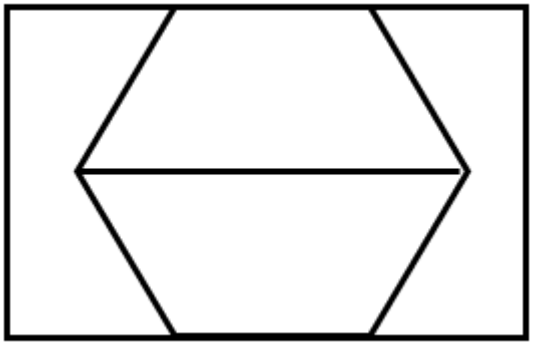
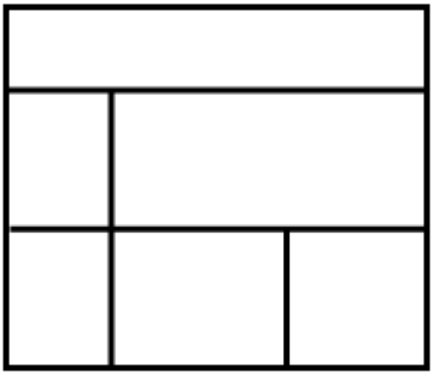
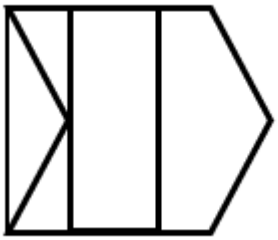
| **ITEM NO. 8** |  |
| **ITEM NO. 9** |  |
| **ITEM NO. 10** |  |

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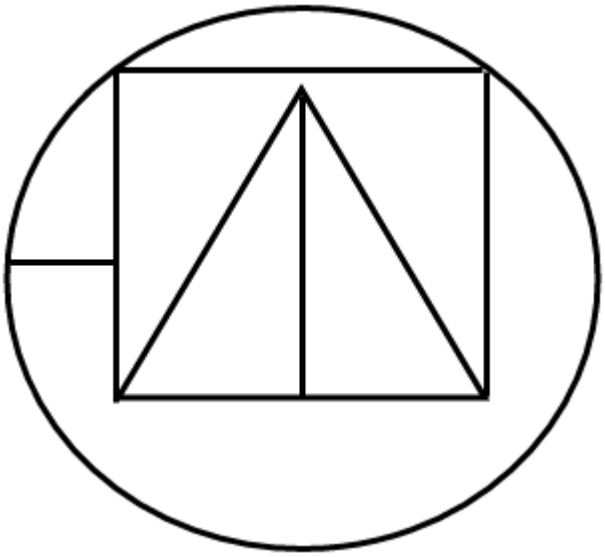
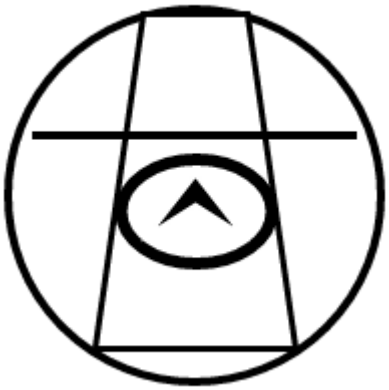
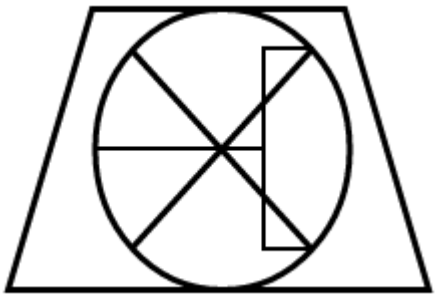
| **ITEM NO. 11** |  |
| **ITEM NO. 12** |  |
| **ITEM NO. 13** |  |

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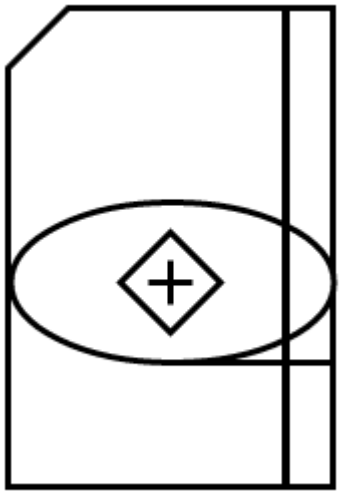
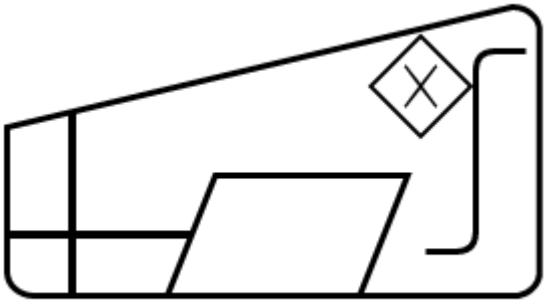
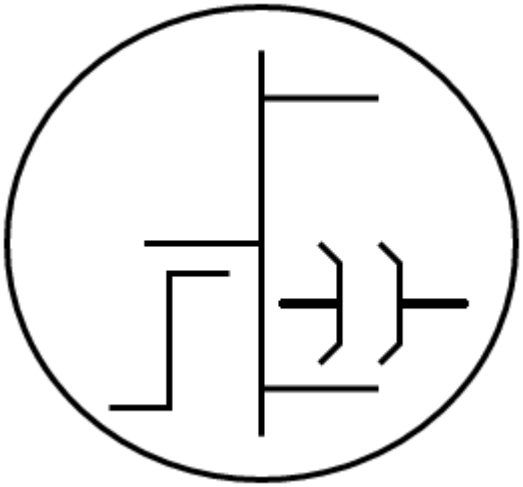
| **ITEM NO. 14** |  |
| **ITEM NO. 15** |  |
| **ITEM NO. 16** |  |

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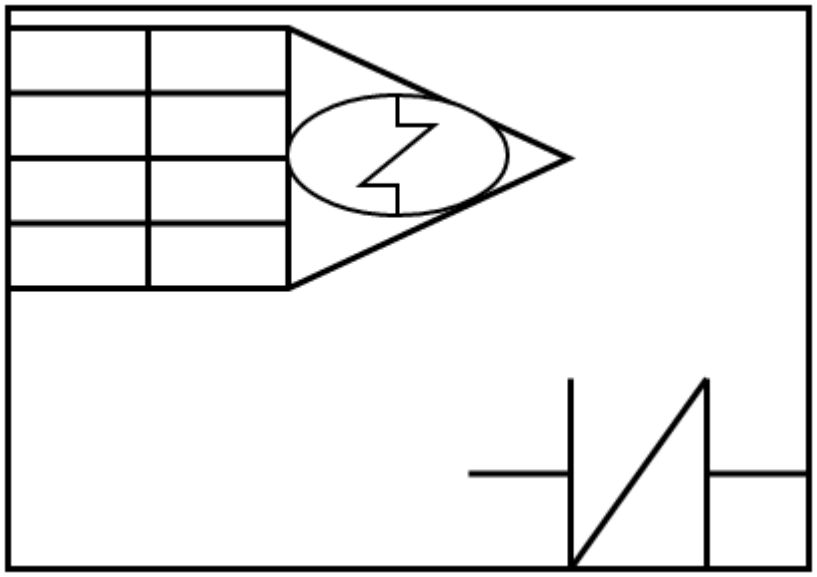
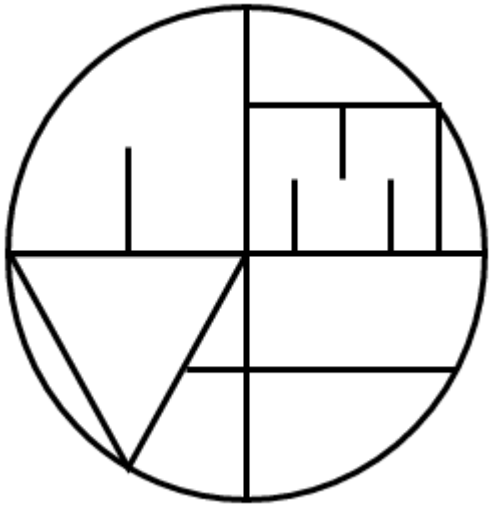
| **ITEM NO. 17** |  |
| **ITEM NO. 18** |  |

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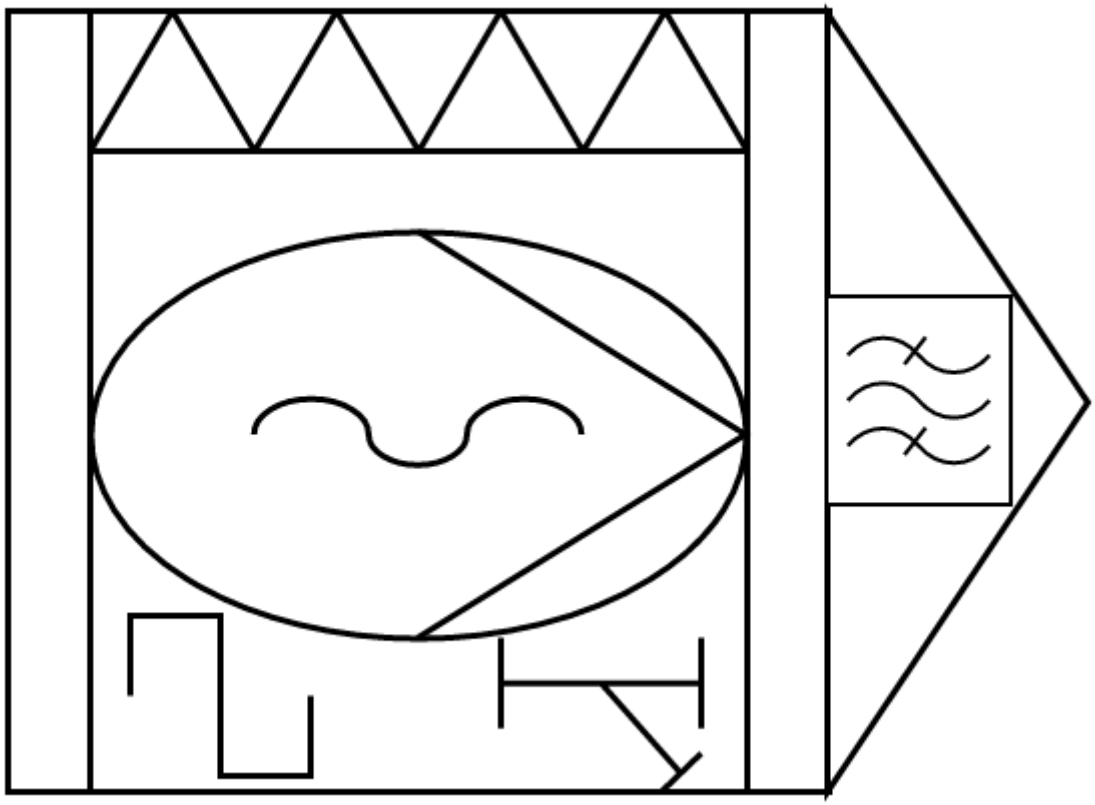
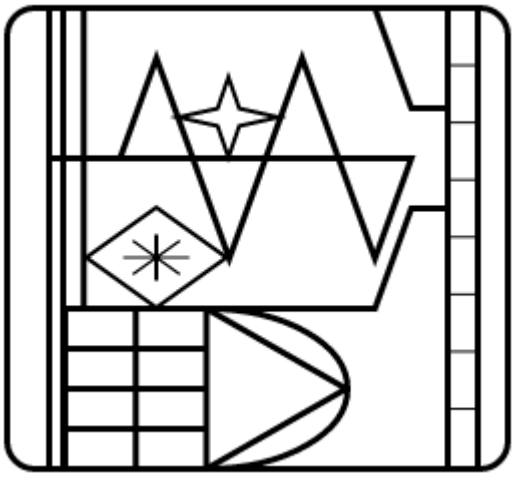
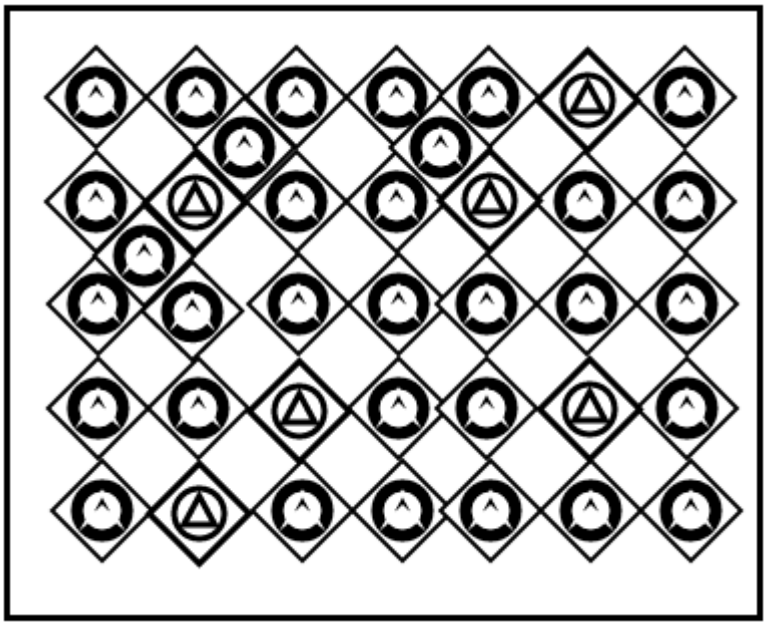
| **ITEM NO. 19** |  |
| **ITEM NO. 20** |  |

## 2. Attention

For assessing the attention, 40 items were developed. After taking experts opinions, only 15 items were developed. The test begins with the example, followed by other 15 items in an order of increasing difficulty level. Items are designed in a way that will instigate distractibility and subjects have to find the odd items from the list. The stimulus was presented for 10 seconds and subjects have to report the number of odd items in the group. The total time allotted for this activity is 1 minute and 50 seconds. Next to the item a separate space was provided were respondents would write their score. For every right answer one marks was awarded and for every wrong answer 0 marks were awarded. Marks were awarded only if the number of odd items was correct. In case the subject is completely illiterate and doesn't know how to mark the responses he can point out the odd items by ticking on them or encircling them. The attention subtest is comprised of the following items:

**ITEMS OF ATTENTION: Finding the odd items**

**EXAMPLE**



Finding the No. of odd items

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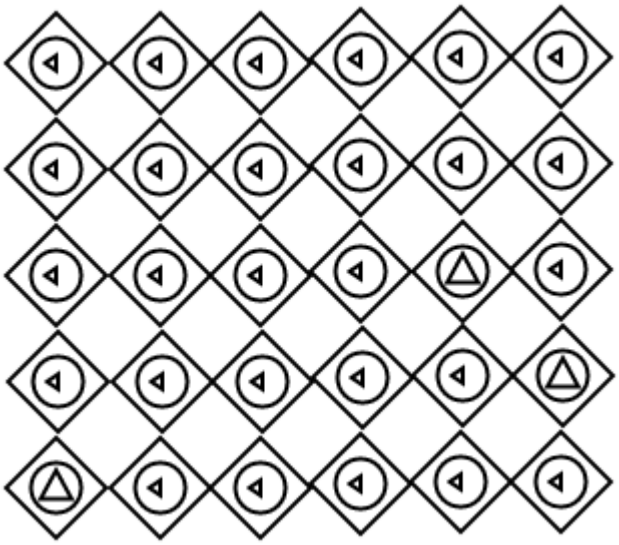
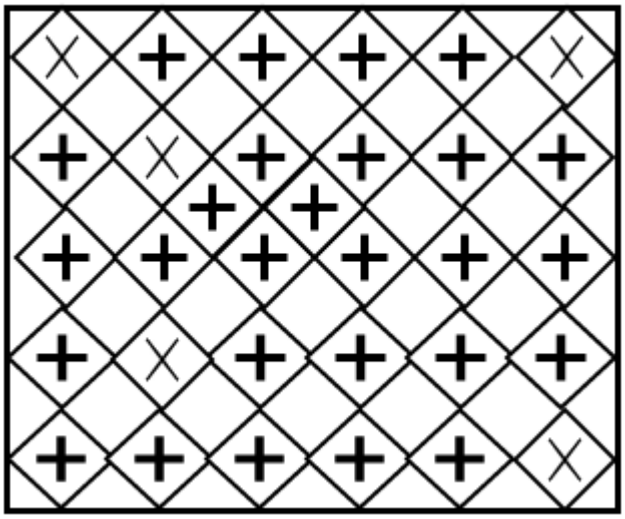
| **ITEM NO. 1** |  | |
| **ITEM NO. 2** |  | |

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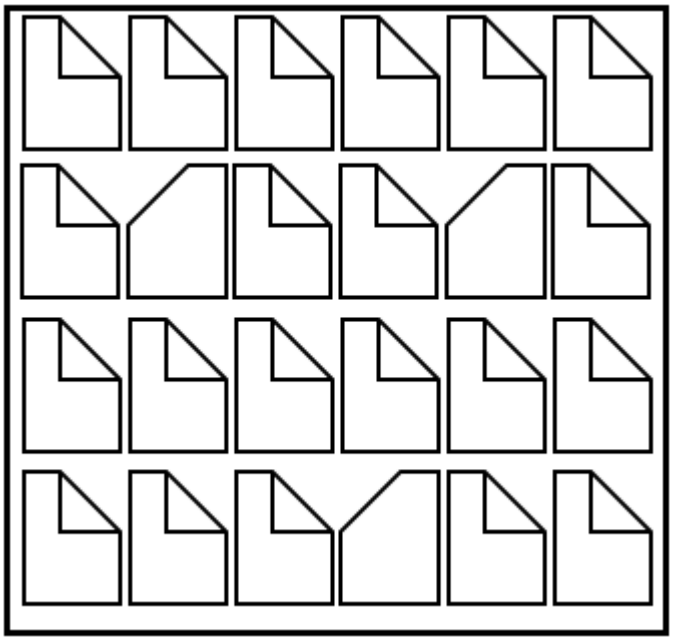
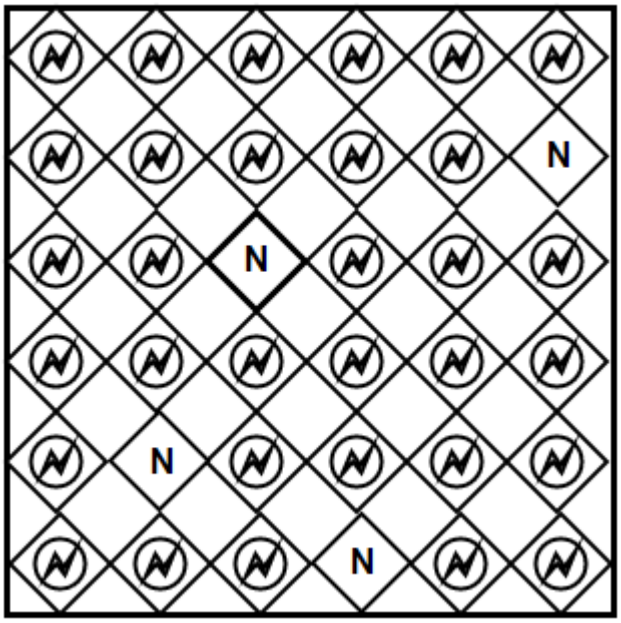
| **ITEM NO. 3** |  | |
| **ITEM NO. 4** |  | |

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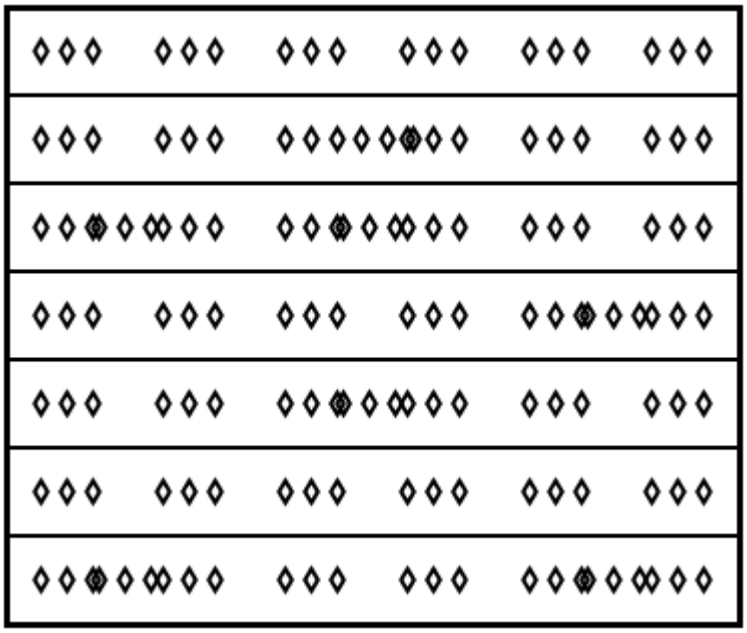
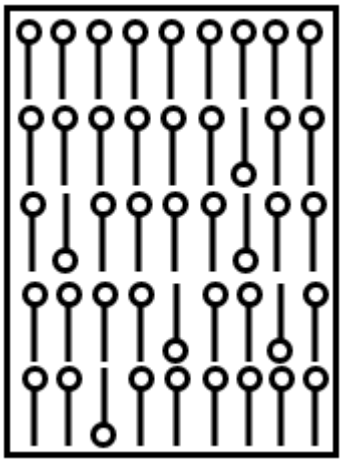
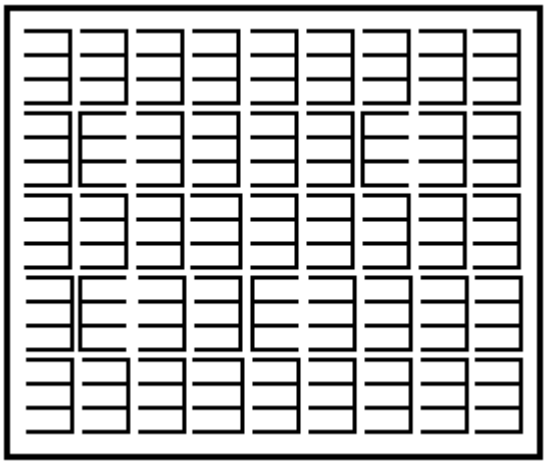
| **ITEM NO. 5** |  | ☐ |
| **ITEM NO. 6** |  | ☐ |
| **ITEM NO. 7** |  | ☐ |

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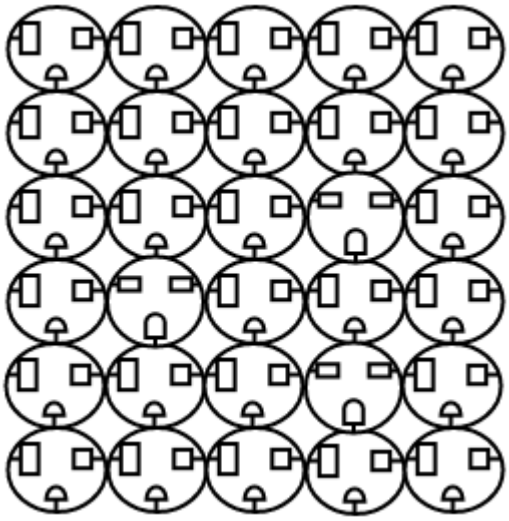
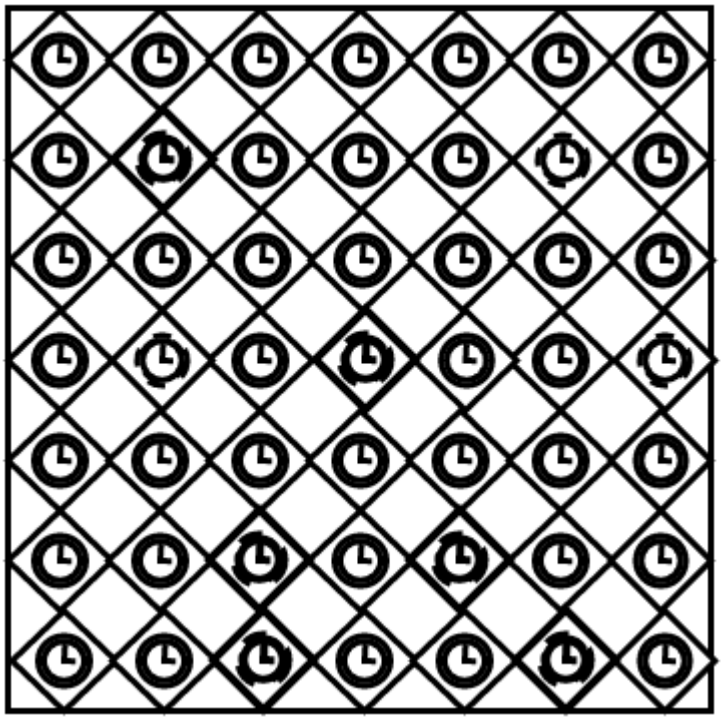
| **ITEM NO. 8** |  | ☐ |
| **ITEM NO. 9** |  | ☐ |

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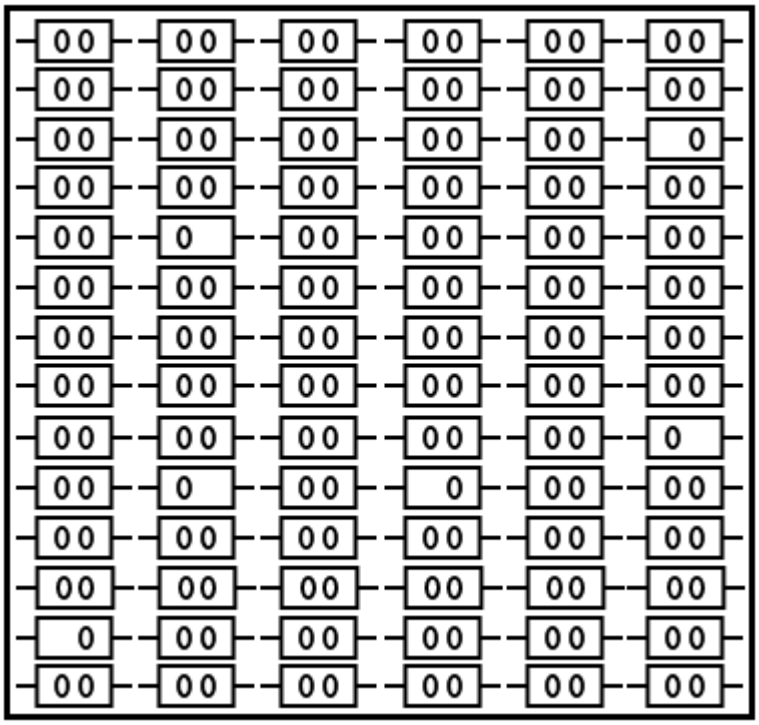
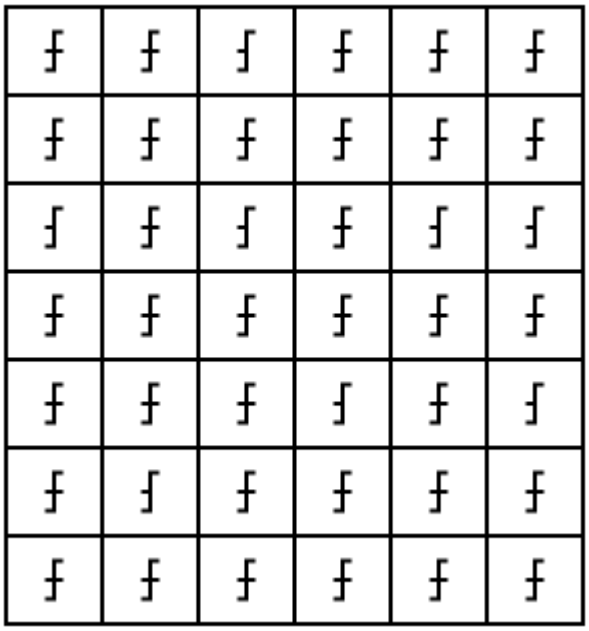
| **ITEM NO. 10** |  | |
| **ITEM NO. 11** |  | |

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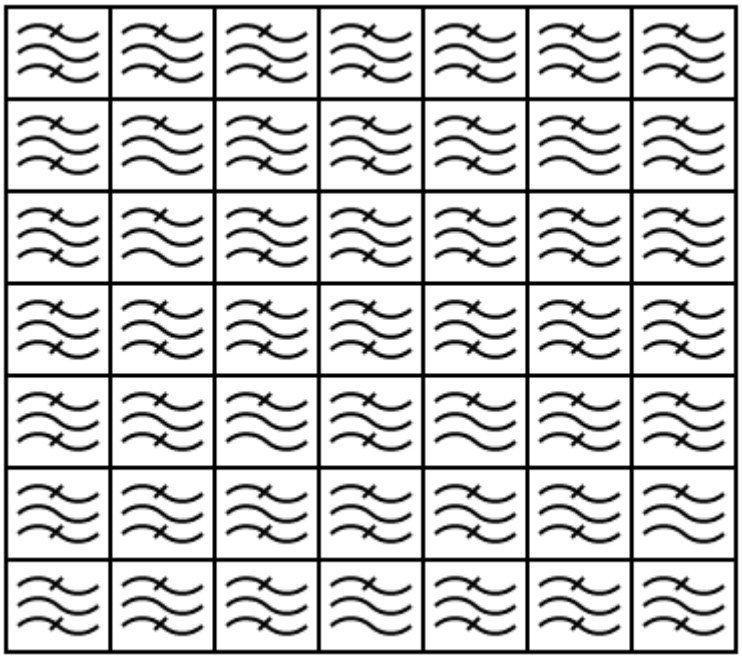
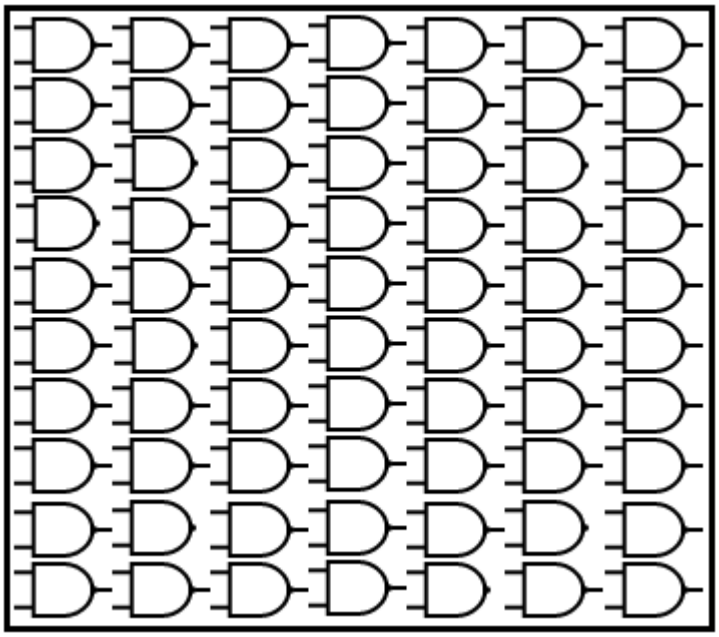
| **ITEM NO. 12** |  | |
| **ITEM NO. 13** |  | |

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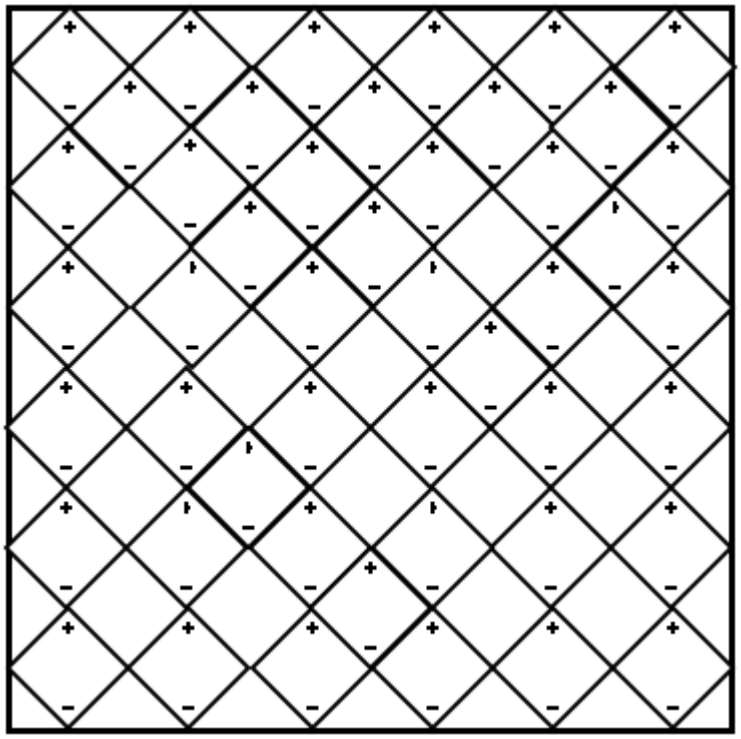
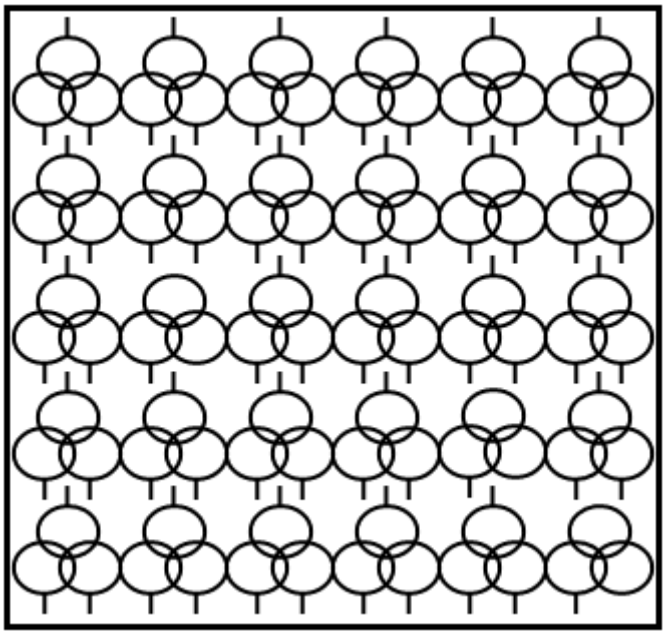
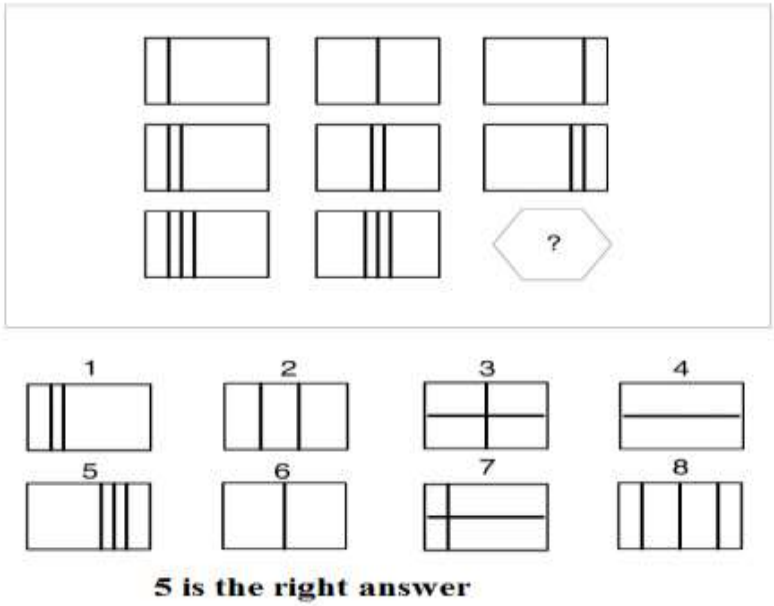
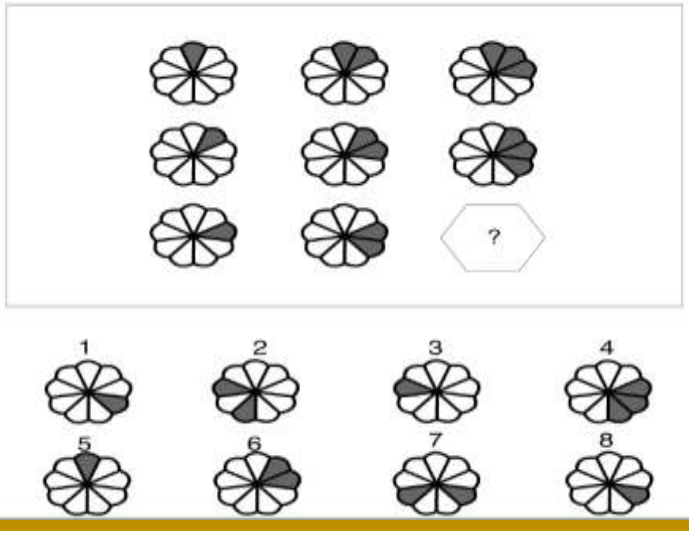
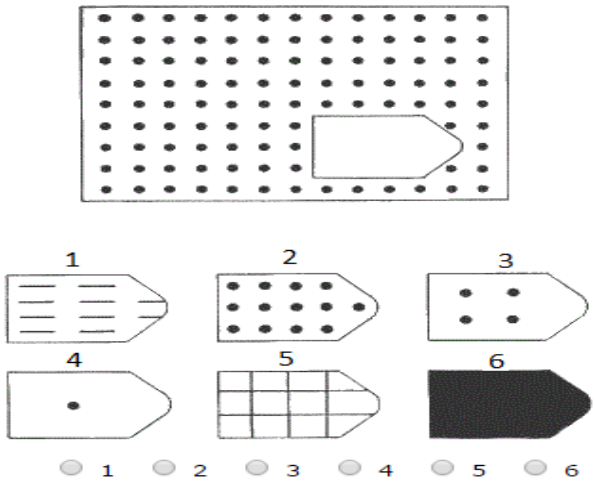
| **ITEM NO. 14** |  | |
| **ITEM NO. 15** |  | |

### 3. Reasoning

Reasoning subtests consists of two parts, one is the *Series part* and another is the *Matrices part*. After taking expert opinion 27 items were selected from the list of 40 items and were arranged into two groups. In *series part*, subject has to complete the incomplete matrices by selecting the best option which completes the series from the answers given. There is one practice item followed by 10 test items in increasing difficulty order. The standard time for completing this subtest is 2 minutes and 30 seconds. *Matrices part* consists of 17 items with one practice item. The total time assigned for this task is 3 minutes. After giving the instructions subjects were asked to start the test and mark their responses in the box provided. One marks was awarded for each right answer and zero for every wrong answer in both Series and Matrices. The items are arranged with increasing difficulty, starting from the least difficult item. In case the subject doesn't know how to mark the response, he can point out the right answer by ticking the right option or encircling it's option number. The reasoning sub-test consisted of the following items:

| ITEMS OF REASONING: SERIES | |
|---|---|
| **EXAMPLE** |  **5 is the right answer** |

| | | |
|---|---|---|
| **ITEM NO. 1** |  | |
| **ITEM NO. 2** |  | |

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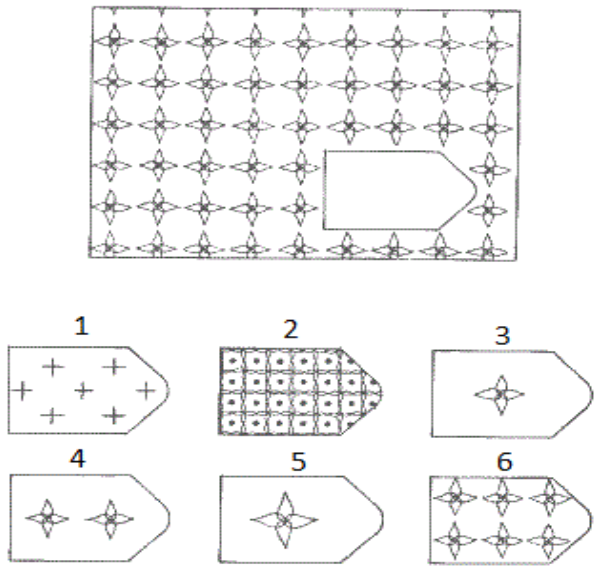
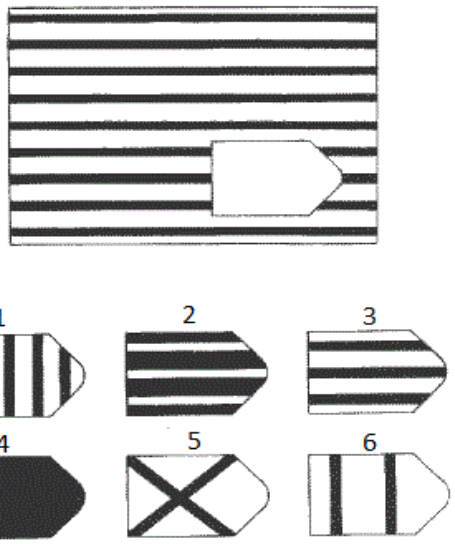
| **ITEM NO. 3** |  |
| **ITEM NO. 4** |  |

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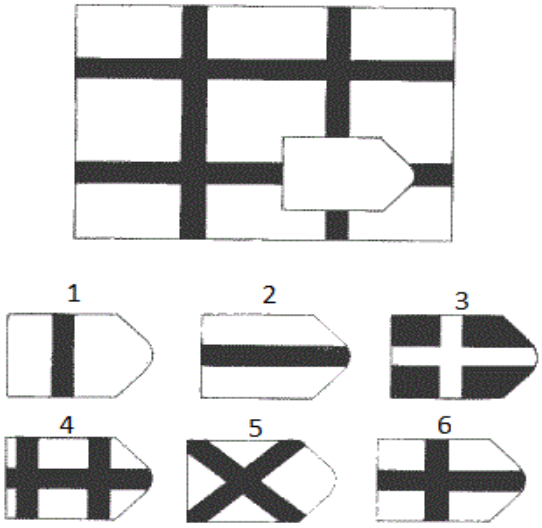
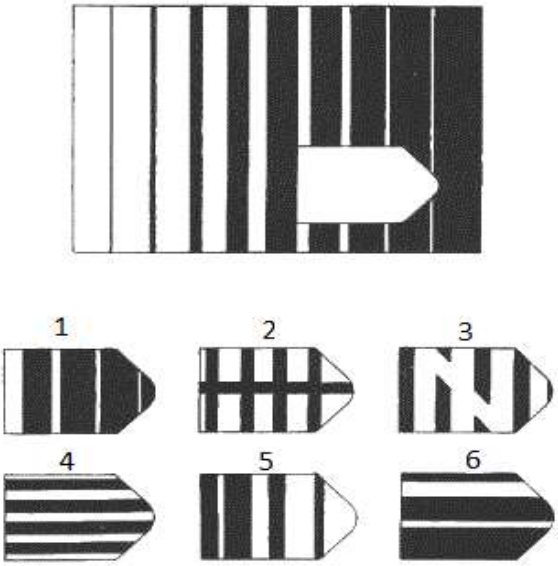
| **ITEM NO. 5** |  | |
| **ITEM NO. 6** |  | |

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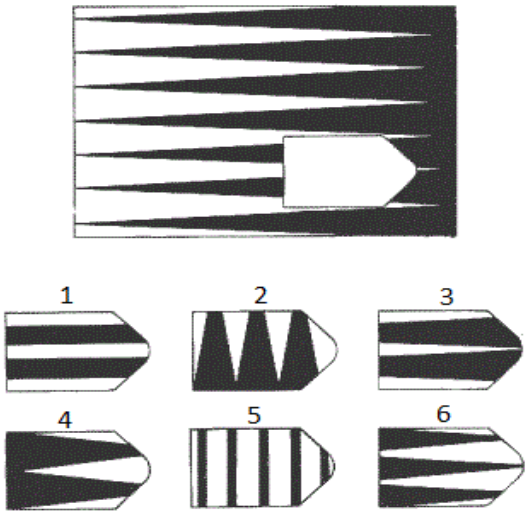
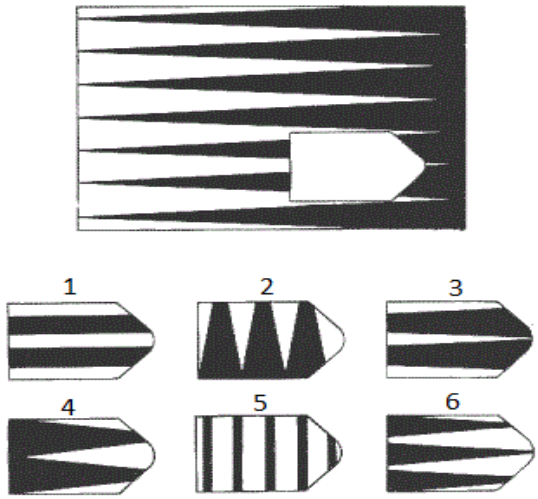
|---|---|---|
| **ITEM NO. 7** |  | ☐ |
| **ITEM NO. 8** |  | ☐ |

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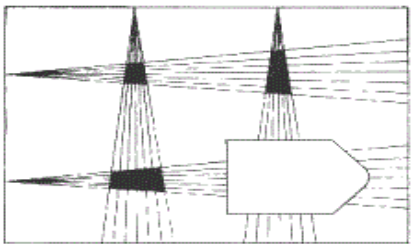
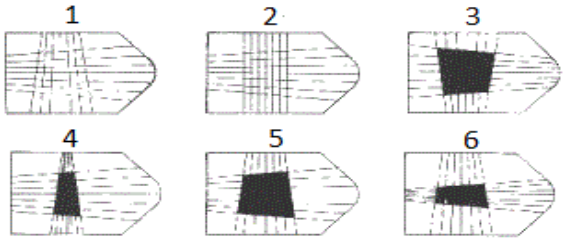
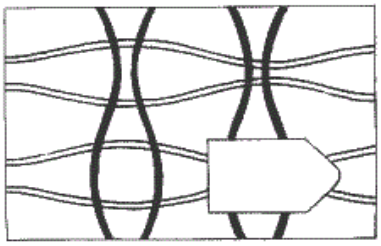
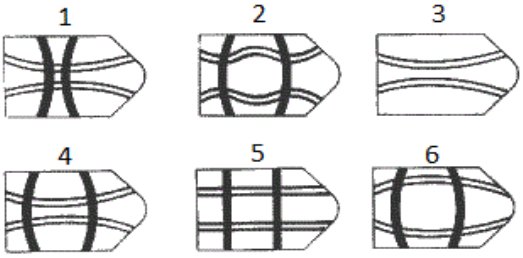
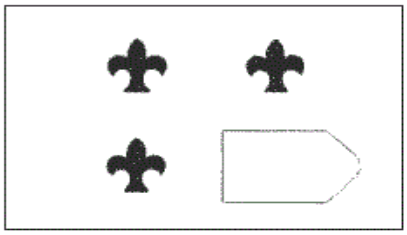
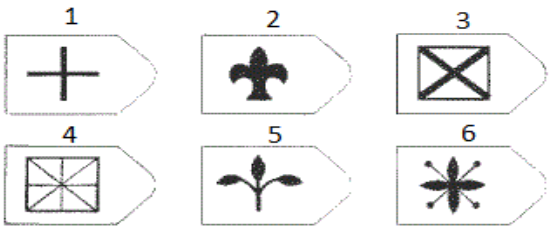
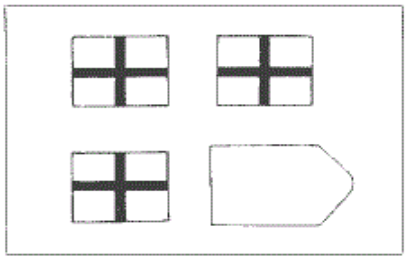
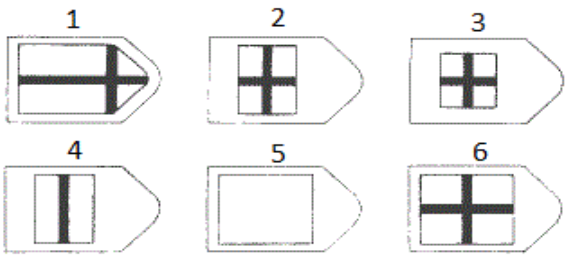
|---|---|
| **ITEM NO. 9** |  <br>  <br> |
| **Item No. 10** |  <br>  <br> |

## Part two: Matrices

| | |
|---|---|
| **Example** |  <br>  <br>**2 is the right answer** |
| **Item 1** |  <br>  |

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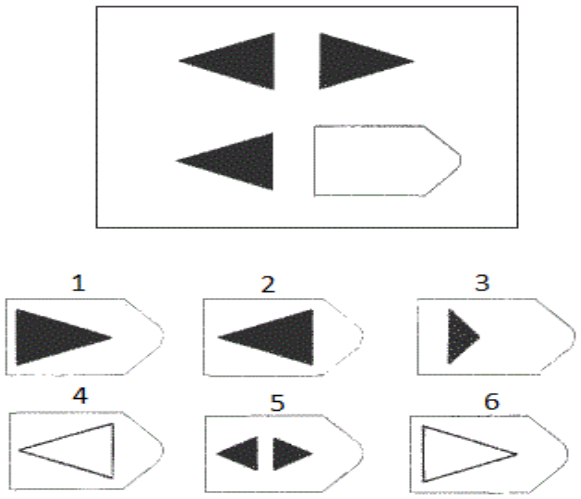
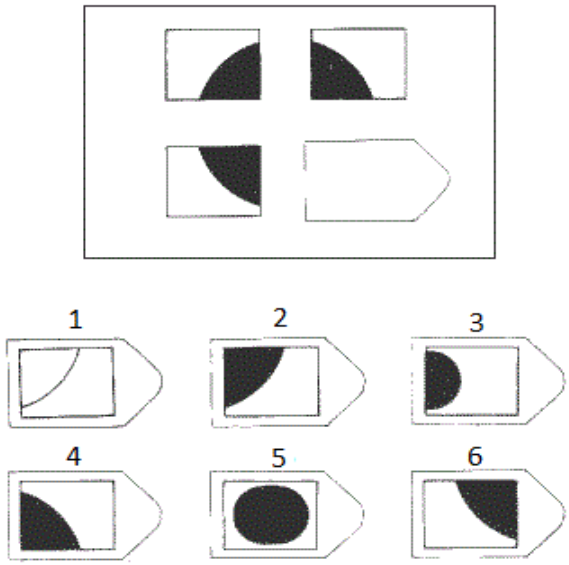
|---|---|---|
| **Item 2** |  | |
| **Item 3** |  | |

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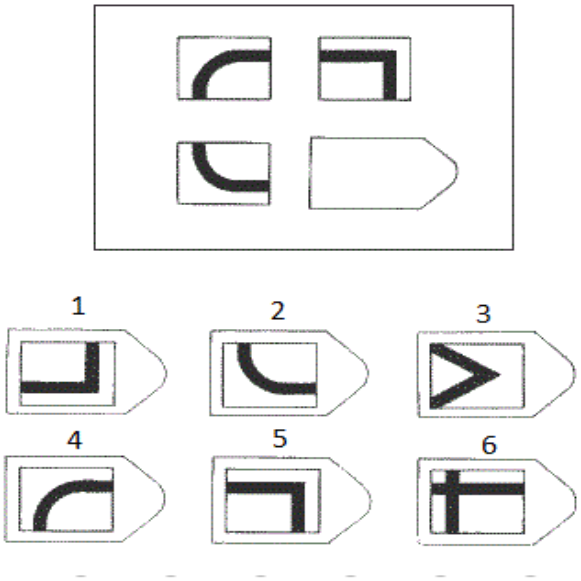
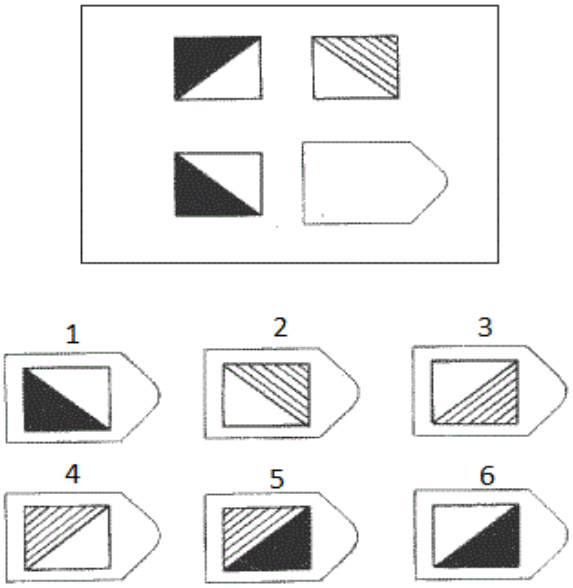
|---|---|
| **Item 4** |  |
| **Item 5** |  |

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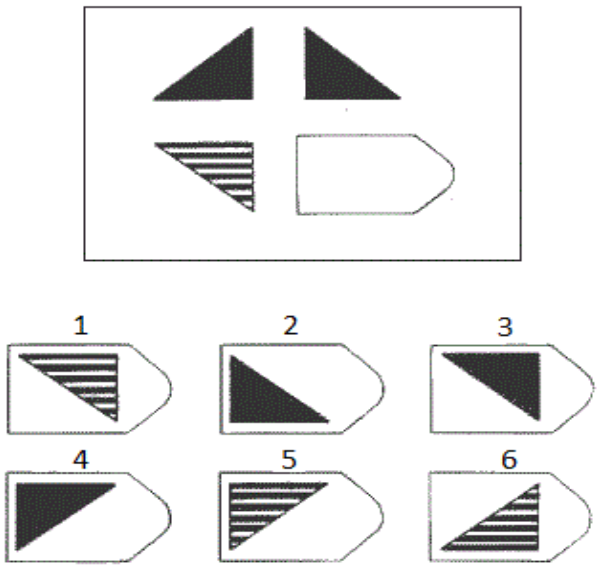
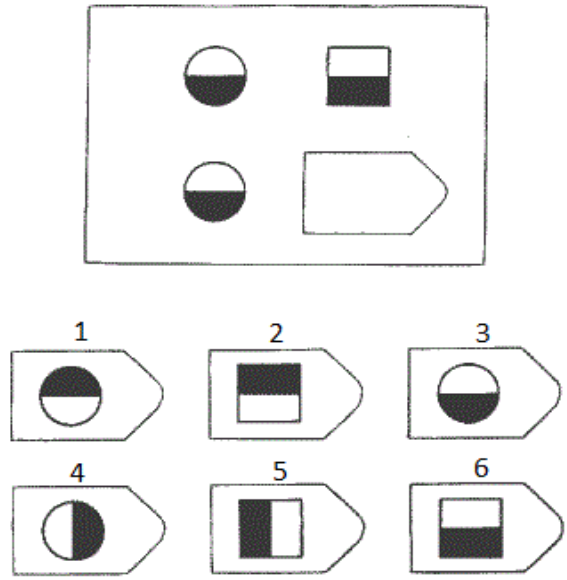
|---|---|
| **Item 6** |  |
| **Item 7** |  |

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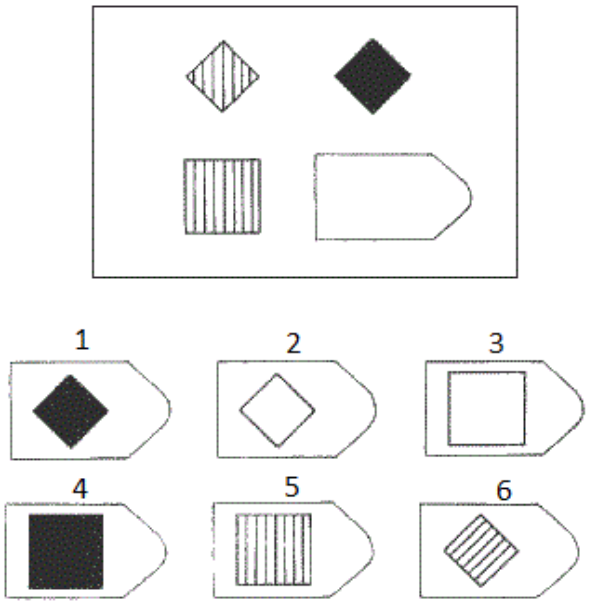
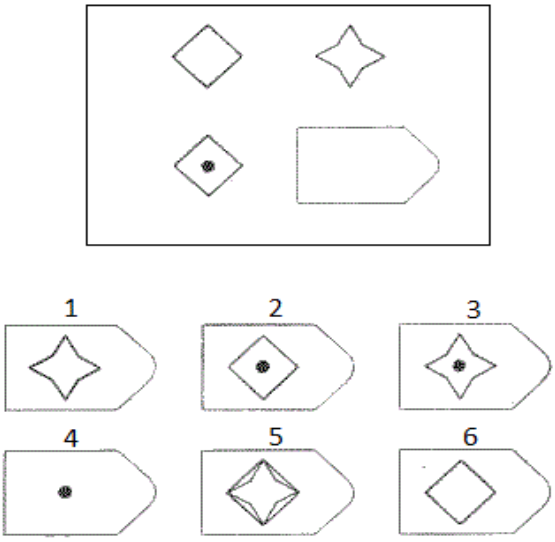
|---|---|
| **Item 8** |  |
| **Item 9** |  |

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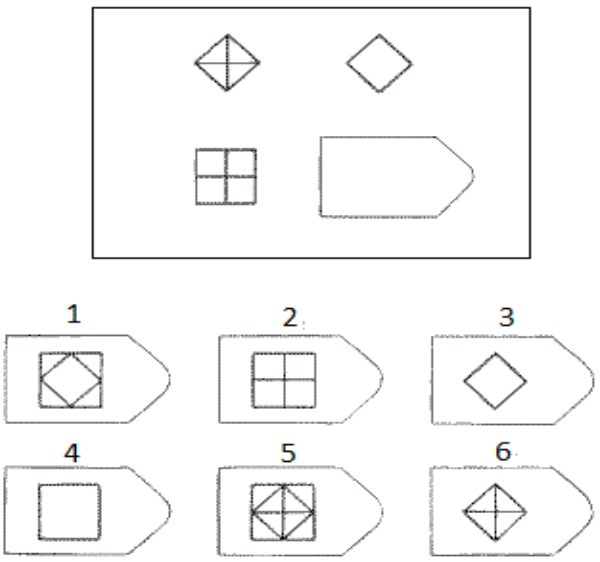
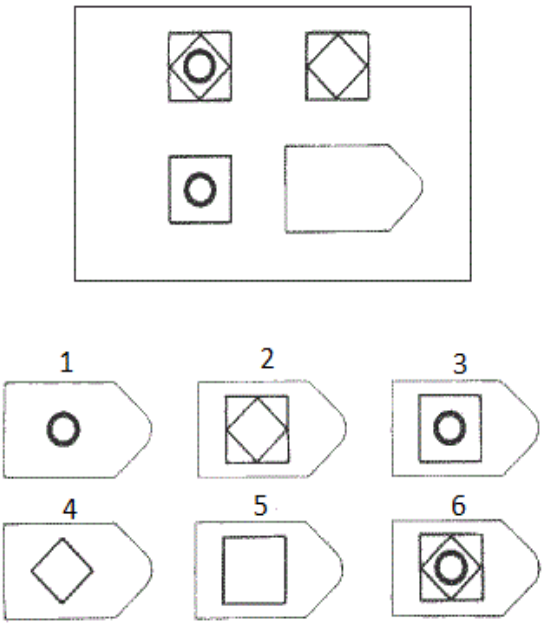
|---|---|
| **Item 10** |  |
| **ITEM 11** |  |

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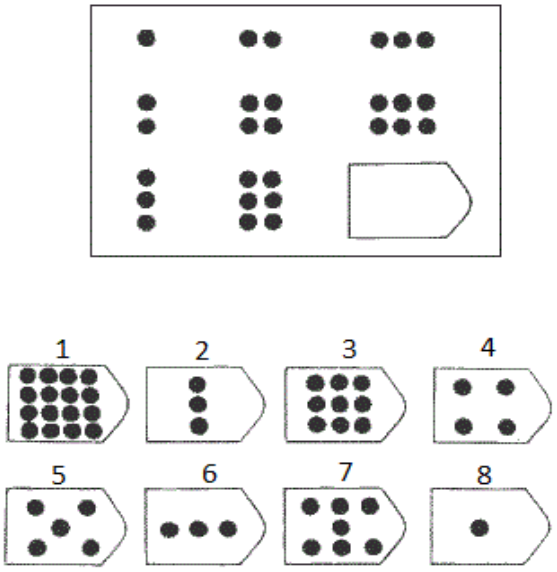


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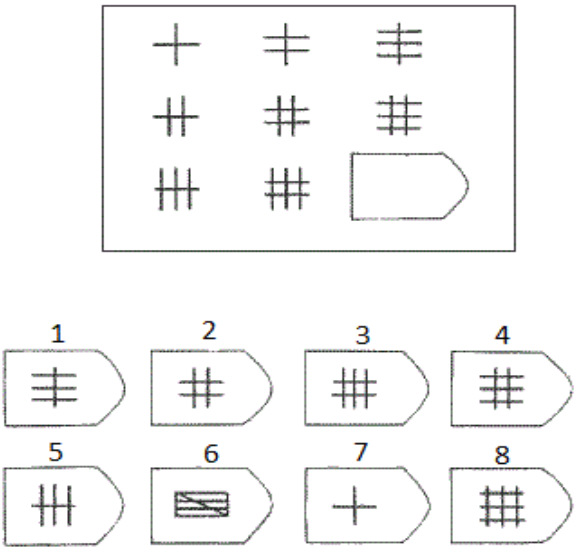
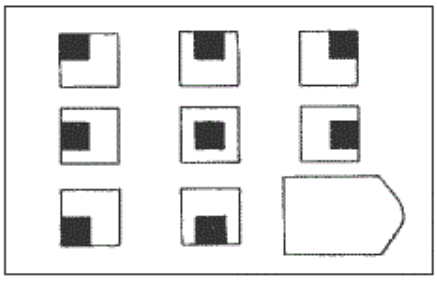
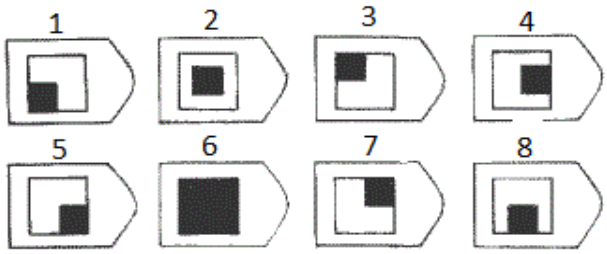
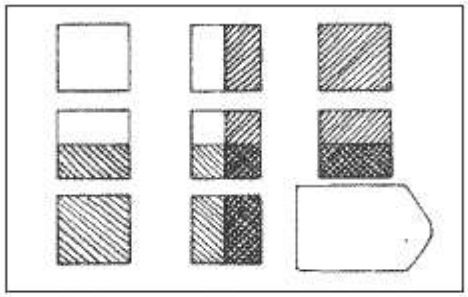
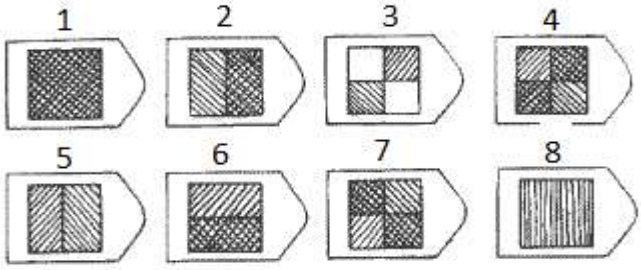


| | |
|---|---|
| **ITEM 14** |  <br>  <br> |
| **ITEM 15** |  <br>  <br> |

## Psychometric Properties of the test

### Mean and Percentile

| Table 1 NVAT Mean and Variance | |
|---|---|
| **N** | 100 |
| **Mean** | 42.30 |
| **Median** | 42 |
| **Mode** | 41 |
| **Std. Deviation** | 6.31 |
| **Variance** | 39.82 |

Table 1 shows the mean of the scores which is 42.30. The Standard Deviation is 6.31.

**Validity** of the test can be described as the psychometric property of the test by which it measures what it intends to measure. The concept was put forth by Kelly in 1927. For validating NVAT, the following methods were used

### Face Validity

Experts were asked to rate the items from the pool. The items that were rated high by experts were selected for the tool.

### Construct Validity

Table 1, shows the Pearson's product moment correlation values of the test constructs with Culture fair test. The test was correlated with Culture fair test, prepared by R. B Cattell and A.K.S Cattell scale 2. The test was standardised on a sample of 100 students who were from class $5^{th}$ (mean age = 11). NVAT showed a very high relation with Culture fair test and the correlation value was found to be 0.86 which is statistically significant ($P<0.01$). NVAT also showed a very high relation with academic scores of the participants and the value was found to be 0.79 which is statistically significant ($P<0.01$).

| TABLE 2: Pearson's Product Moment Correlation | | | | | | |
|---|---|---|---|---|---|---|
| **VARIABLES** | **NVAT** | **MEMORY** | **ATTENTION** | **REASONING** | **ACADEMIC SCORES** | **Culture Fair** |
| **Culture Fair Test** | **0.86*** | **0.83*** | **0.72*** | **0.78*** | **0.63**** | **1** |
| **NVAT** | **1** | **0.92*** | **0.88*** | **0.93*** | **0.79*** | **0.86*** |
| **Memory** | **0.92*** | **1** | **0.68*** | **0.79*** | **0.68*** | **0.83*** |
| **Attention** | **0.88*** | **0.68*** | **1** | **0.76*** | **0.70*** | **0.72*** |
| **Reasoning** | **0.93*** | **0.79*** | **0.76*** | **1** | **0.79*** | **0.78*** |
| **Academic Sc.** | **0.79*** | **0.68*** | **0.70*** | **0.79*** | **1** | **0.63*** |
| **N=100** | | | | | | |
| ***SIGNIFICANT AT 0.01 LEVEL** | | | | | | |

## Reliability

Table 2, shows the test-retest reliability of the NVAT. The test-retest validity of the test was calculated on a sample of 30. The test retest reliability was found to be 0.94 which is statistically significant ($P<0.01$). Test-retest reliability for the three subtests was also calculated and it was found to be very high. Memory subtest showed a test-retest reliability of 0.91 ($P<0.01$). Test-retest reliability for attention was found to be 0.91 ($P<0.01$). The Reasoning subtest showed a good test-retest reliability of 0.83 ($P<0.01$).

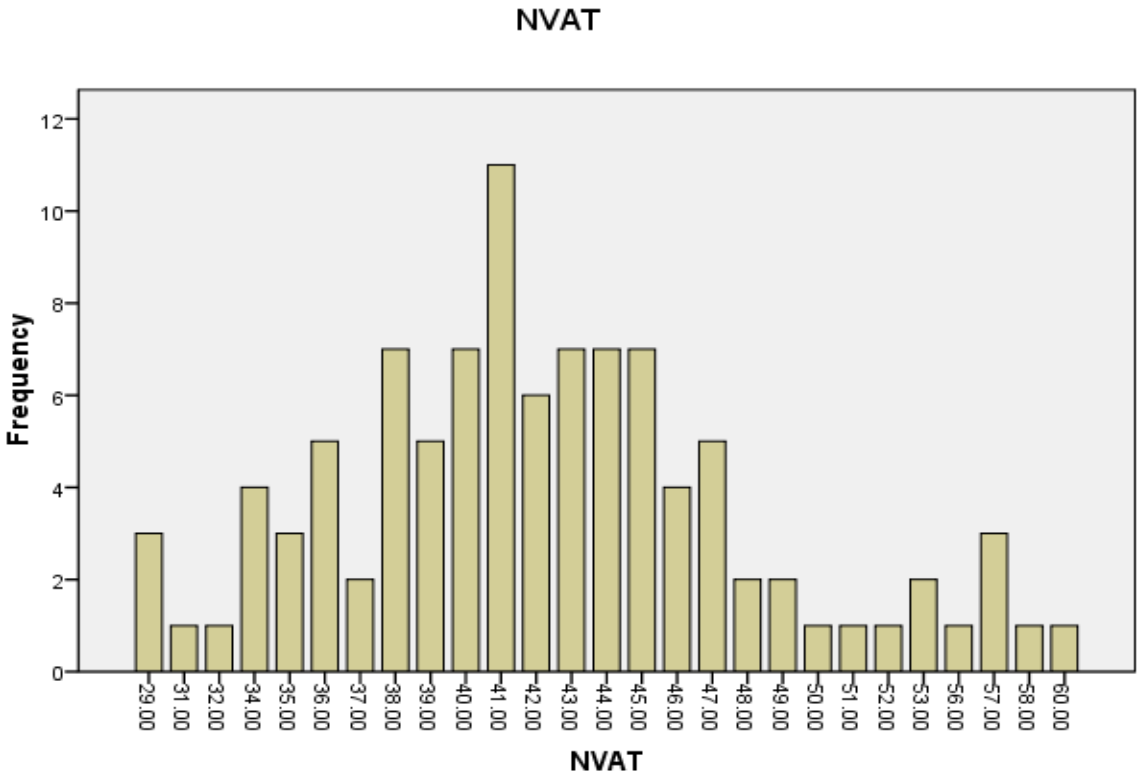
**TABLE 3: TEST-RETEST RELIABILITY OF NVAT**

| | PEARSON'S PRODUCT MOMENT | TEST | RETEST |
|---|---|---|---|
| NVAT TEST | SIGNICANCE (2-tailed) | | 0.94** |
| MEMORY | | | 0.91** |
| ATTENTION | | | 0.91** |
| REASONING | | | 0.83** |
| N | 30 | | |
| **Significant at 0.01 | | | |

**NORMS**

Table 4, shows the classification of T Norms for NVAT.

| Table 4: NVAT T NORMS CLASSIFICATION | |
|---|---|
| **Mean** | 42.30 |
| **Below Average** | 29.68 |
| **Average Intelligence** | 35.99-48.61 |
| **Above Average Intelligence** | 48.61-54.92 |
| **Superior Intelligence** | 54.92-61.23 |




The distribution of NVAT scores on Histogram.

## Conclusion

Assessment of cognitive abilities is a major issue in psychology. The field of psychometrics is involved in developing the test that measure the desired constructs. The major challenge faced by psychologists is the language and the cultural differences which reduces the applicability of the test. In order to counter this problem, psychologists switched to other ways to make the assessment. The development of nonverbal ability tests was suggested as one such option to effectively deal this problem. NVAT is one more step into the development of such tests. NVAT, is a nonverbal ability test which measures cognitive abilities in a nonverbal fashion. The test comprises of three subtests. Memory is the first subtest and it comprises of 20 items. Attention is another subtest which is comprised of 15 items. For assessing the reasoning and planning abilities, the third subtest was divided into two parts i.e. series and matrices. NVAT was validated by comparing the scores with the culture fair test of R. B. Cattell. The construct validity was found to be very high (0.86). The test-retest validity was also computed on a sample of 30 subjects and it was found to be 0.94 which is very high. The future perspective of the test will be finding better marks of validity and reliability by validating the tool on a large population base. Furthermore, the scoring procedure will be simplified for reducing the time of scoring.

## Weakness of the tool and future perspectives

No tool is complete without its weaknesses. NVAT also has its weaknesses that the test developer faced during the development of test. The tool was validated on a small population of 100 subjects which increases the chances of error. Due to lack of resources, the test item base was kept small and other constructs of mental abilities were not added. One weakness of NVAT is that it relies heavily on the memory and reasoning constructs as the measures of a large construct "intelligence" which is more than the just memory and reasoning. Memory was assessed using a single pattern of items which measured the Symbolic memory while as ignoring other measures of memory like spatial and object memory. The future revision of the test will try to include these constructs also, for a better assessment of memory. The tool will be validated by correlating it with other nonverbal ability tests for getting a better measure of its construct validity.

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