Abstract

This study addresses the preschool ages – 141 children from 4 to 6 ½ years – with the newly created Block Design test, applied in conjunction with three graphic tests, Draw a Man, Draw a House and Bender-Gestalt Standard tests. The main objective was to determine a few psychometric characteristics of the newly created instrument, to study its relationships with the other tests in the battery and its evolution in relation to age and gender. The results show robust psychometric properties of the Block Design, a highly discriminative capacity on the researched ages scale and an important contribution to defining the visuo-spatial-motor factor of intelligence. No gender differences were identified for the used tests.

Keywords: Block Design test; visuo-spatial-motor factor of intelligence; graphic intelligence.

1. INTRODUCTION

The Block Design, developed by Kohs in 1923, still has the reputation of being the best non-verbal intelligence test. The assumption of Kohs, according to whom this test can be considered a comprehensive measure of non-verbal intelligence, fully preserves its validity. The test especially measures visuo-spatial orientation, the subject having to build more and more complicated patterns out of separate blocks. As Zimmerman and Woo-Sam (1973) indicated, the ability to perceive meaningful spatial relationships, to analyze visually and to synthesize abstract geometric design provide strong clues for intelligence. Test scores, in which reasoning rather memory is involved, seems to be strongly correlated with early mathematical skills. In a study on 102 three-year-old children, Verdine, Golinkoff et al. (2014) indicate that spatial skill independently predicts a large amount of variability in current mathematical performance. Using a large, representative U.S. sample, Jirout and Newcombe (2014) find a positive correlation between parent-reported frequency of spatial play and Block Design scores. Another study on 504 4- and 5-year-olds, Möhring, Newcombe and Frick (2015), explains the close link between spatial skill and mathematical thinking through a mechanism of scaling involving proportional reasoning. In another study, on 364 4-year olds, Gustaffson and Wolff (2014) include the Block Design together with Raven Coloured Matrices, Recognition and Matrices from Wechsler’ WPPSI, in a battery destined to measure the visual component of fluid general intelligence at preschool age.

2. PURPOSES OF THE STUDY

Associating the Block Design test with the drawing tests in order to determine visuo-spatial fluid intelligence is one of the purposes concerning the present study. The main purpose was to research a few psychometric characteristics of the newly created Block Design (Clinciu, 2014) for preschool age. I was interested in determining if this test has a threshold which is low enough to allow the less gifted 4-year olds take the test. I also wanted to identify the discrimination power of this test for the successive ages of little, medium and big schooling in order to be able to create appropriate standards for every half year. Thirdly, I intended to investigate the relationships of this visuo-spatial-motor test with three graphic tests in order to identify its specific contribution to defining a mutual factor of fluid intelligence.

Secondarily, I wanted to investigate if the absence of gender differences at pubescent and adolescent ages for the Block Design test is found at preschool age as well. Depending on the answer to this question I am to calibrate the size of normative samples in order to generate unique or differentiated samples for the two genders norms. Among the purposes of this study, I can also mention the one of measuring the weight which the newly introduced way of scoring has in raising the overall variability of the Block Design test scores. The test scoring...
emphasizes both the integral execution of proposed patterns and also partial successes. If for one-colored blocks we give a point only for keeping the place, for the two-colored ones we give points for both place and also for the correct positions of blocks.

A major source of total scores variability results from giving unitary bonuses for the execution speed, namely one point for every 15 seconds, but only for totally done patterns. Having a total possible scores range of 180 points, it is expected that the new test should offer the possibility of some standards of fineness throughout all the ages of growth. It remains to be seen if this rise of raw scores is constant from one year to the other, planning to identify which major contributors to the total score join along with getting older. If at pubescent and adolescent ages the main element of total scores variability comes from the speed of execution (Clinciu, 2014), at preschool age it is expected that the bonuses for the relative position of blocks should fulfill the leading role.

It is important to mention that, building the present Block Design test, it was used a principle that is to be found as such at the homonym tests in the Wechsler intelligence batteries (Glaser and Zimmerman, 1967; Zimmerman, Woo-Sam, and Glasser, 1973). This principle proposes to solve three series of four patterns each which gradually get more difficult. The first series of two times two blocks is an introductory one consisting in very easy patterns, the task being much simplified by the existence of internal lines that delimits between two blocks, contour lines that allow a quick identification of the used face (full – white or red, or two-colored – white and red). The second series of patterns – also two times two blocks – has only the external contour lines, to identify the adequate face being the role of a careful visual analysis process of the pattern. The third series of patterns preserves only the lines of the external frame, but the analysis is more complex because the pattern to be solved is of three times three, namely nine blocks.

The specific element of this new test consists in the ingenious way of operationalizing the gradual rising of task difficulty through the progressive elimination of one-colored faces in favor of the two-colored one and through the selection of patterns with perceptive gestalts that are by far more complex, thus requiring a bigger and bigger discrimination power. A special purpose of this research was to determine if the theoretical way of operationalizing the task difficulty is to be found in the structure of the scores that result at the preschool age.

3. METHOD

The participants were 141 kindergarten children, out of which 67 boys and 74 girls from two kindergartens in Brașov, with ages between 3 ½ and 6 ½ years. For the age of 4 years there were tested 40, for 5 years 51 and for 6 years 50 children. Participation was voluntarily, based on parental consent, approval of the school inspectorate and of the kindergarten manager. The parents were informed about the nature and purpose of the study and were assured about the result confidentiality. No child withdrew from the research, though this possibility had been stated from the very beginning. The administration of the three graphic tests: Goodenough & Harris’ (1963) Draw a Man Test, Ribault’ (1965) Draw a House and Bender-Gestalt Standard (Clinciu, 2014) was made collectively. There were subsequently determined the raw and standard scores by relating them to the area samples that had been previously designed (Clinciu, 2003). The Block Design Test was performed individually by each pupil in the school guidance room. The working time was between 4 and 10 minutes, with an average value of 6 minutes. The Block Design Test was accepted with great interest and pleasure by all the children due to its intrinsic feature of intelligent game.

4. RESULTS

The below Figure 1 shows that for the age of 4 years the main contributors to the final score are the first three patterns –with five points each on average, followed by the patterns 4, 5 and 6 – with three points each on average. The other half of the test contributes very low or not at all to the final score. At the age of 5 years there can be identified a six-item package with an average contribution of 5 points, followed by a second package consisting from the 7-11 items with minor contributions (from two to zero points for a score). The structure of the 5 years is kept at the age of 6, but the average of the first package of 6 items rises to 6 points, of the items 7, 8, 9 at 3 points and of the last items at one point.
As we can notice in the first diagram of Figure 2, the total scores of the Block Design Test have an extremely quick dynamics, they getting double from 4 to 6 years olds. The rise rate is about 12 points on average from one year to the other, namely about one point per month. To verify the preservation of this rising rate is necessary to approach the age groups that are consecutive to that of 6 years.
In order to answer more specifically the objective of identifying the role of execution speed and the relative position in the structure of total score, I shall analyze the second diagram in the above Figure 2. If at the age of 4 the main contribution to the total score is that of the blocks with one-colored faces, displayed in the proper place, towards the age of 6 years the most substantial contribution is that of the two-colored faces which respect the place and correct position simultaneously. The rise of this type of bonus is almost four times bigger at 6 years compared to 4 years old. Though time bonuses double from 4 to 6 years, they come to get a dominant weight in the total score, later on maybe towards puberty. The age of 5 has an intermediate position being closer to the structure of the final score of the age of 6.

To verify the inner structure of the 12 items of the Block Design test, I have developed an exploratory factorial analysis. The conditions of this type of analysis are satisfied as the determinant is positive, Kaiser-Meyer-Olkin Measure of Sampling Adequacy has the value of .87, and Bartlett's Test of Sphericity is extremely significant statistical (p < .001). The result of factorial analysis is summarized in the below Table 1, in which saturations which are .40 less were eliminated for more clarity.

Table 1. Factorial structure for the 12 items of the Block Design test and items correlations with Block Design’ total score and with IQ

<table>
<thead>
<tr>
<th>Item</th>
<th>Communali-ties</th>
<th>Component</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>BD total score</th>
<th>IQ correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>.359</td>
<td>.845</td>
<td>.598</td>
<td>.337</td>
<td>.326**</td>
<td></td>
</tr>
<tr>
<td>Item 2</td>
<td>.377</td>
<td>.844</td>
<td>.611</td>
<td>.409</td>
<td>.327**</td>
<td></td>
</tr>
<tr>
<td>Item 3</td>
<td>.588</td>
<td>.806</td>
<td>.763</td>
<td>.530</td>
<td>.507**</td>
<td></td>
</tr>
<tr>
<td>Item 4</td>
<td>.568</td>
<td>.799</td>
<td>.729</td>
<td>.585</td>
<td>.611**</td>
<td></td>
</tr>
<tr>
<td>Item 5</td>
<td>.681</td>
<td>.770</td>
<td>.769</td>
<td>.698</td>
<td>.566**</td>
<td></td>
</tr>
<tr>
<td>Item 6</td>
<td>.723</td>
<td>.738</td>
<td>.787</td>
<td>.730</td>
<td>.525**</td>
<td></td>
</tr>
<tr>
<td>Item 7</td>
<td>.714</td>
<td>.669</td>
<td>.631</td>
<td>.563</td>
<td>.800</td>
<td>.552**</td>
</tr>
<tr>
<td>Item 8</td>
<td>.713</td>
<td>.656</td>
<td>.637</td>
<td>.554</td>
<td>.801</td>
<td>.546**</td>
</tr>
<tr>
<td>Item 9</td>
<td>.760</td>
<td>.615</td>
<td>.786</td>
<td>.760</td>
<td>.493**</td>
<td></td>
</tr>
<tr>
<td>Item 10</td>
<td>.807</td>
<td>.491</td>
<td>.875</td>
<td>.670</td>
<td>.338**</td>
<td></td>
</tr>
<tr>
<td>Item 11</td>
<td>.756</td>
<td>.511</td>
<td>.863</td>
<td>.594</td>
<td>.324**</td>
<td></td>
</tr>
<tr>
<td>Item 12</td>
<td>.684</td>
<td>.416</td>
<td>.825</td>
<td>.445</td>
<td>.222**</td>
<td></td>
</tr>
</tbody>
</table>

As we notice in Table 1, excepting the first two items of test entrance, the level of communalities is high, showing that the found solution in two factors covers most of each pattern variance. The method of main components emphasizes the existence of a single mutual factor that covers almost half of the entire variance (48.21%). Varimax rotator method proposes sharing again this variance on two factors with close weights, covering 33.82% and respectively 30.59% out of the total variance of scores. Factor 1 condenses the variance of the first eight items, which are the main contributors to the total score, factor 2 the last four items, which are the most difficult (patterns of nine blocks). The factorial structure is similar to the expected one but the factorial solution that was found here must be verified on a representative sample which is more numerically extensive because two of the 12 test items (patterns 7 and 8) have high saturations in two factors each.

Internal consistency of the Block Design test is very good for the looked upon ages. Items correlation with the total score at this test is average for the first four items of scale, to become big and very big for the following seven items. Alpha Cronbach coefficient of .90 for the entire scale is an extremely high one, the internal consistency being bigger for the last six items (alpha = .89), than for the first six items (alpha = .80). Spearman-Brown correlation coefficient of the two halves is also high (.77). The last column of Table 1 shows that, though all are very significantly statistic, the items correlations of the Block Design test with the IQ provided by mini-
battery of the visual-motor-graphic intelligence tests are very good for the patterns from 3 to 9, which means that these are the items with the best metrical qualities for the area of preschool age. Indeed, the first two items have the role of helping the test entrance, being very easy, while the last three are too difficult for preschool age, their diagnostic power is to impose during the following ages.

The presence of graphic tests in the mini-battery of preschool cognitive development tests is justified by trying to identify discriminative tests for the age of 4-5 years. On the other side, these were a criterion of external validation of the Block Design test, as both categories of tests give expression to the same visuo-spatial-motor factor. The difference between this test and graphic tests is that the latter give expression to a mental construct, making actual through drawing a scheme which enriches once with the graphic experience accumulations that were brought by rising and exercising. By comparison, the Block Design test establishes the perceptive correspondence between the executed model and the present one in the perceptive field. We can state that, beyond the obvious similes, the two compared categories present the difference existing between reproduction and recognition. The correlations of the Block Design test with Bender-Gestalt Standard are of .60, with the Draw a Man Test of .62, and with the Draw a House Test of .58. Submitted to an exploratory factorial analysis, the four tests give expression to a mutual factor, the visuo-spatial-motor one, which covers 77.58% of their total variance.

5. REFERENCES


