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Influence of attention on drawing rotations in Bender test

Ewa Jarzębska

From: the Chair of Neurology, Medical University of Wrocław

The work proved influence of attention investigated with the use of digit span on the middle degree of drawings' rotations in the Bender test. Curvelinear dependence was expressed by the formula: ln Y = 3,26181 – 1,08144 ln X

Key words: rotations of the drawings, influence of attention

Introduction

Rotations in drawing tests are recognised as the symptom of the organic brain damage [1, 2, 3, 4, 5, 6]. They can also be found in drawings of mentally deteriorated patients, neurotics, schizophrenics and persons with personality disorders, alcohol abusing, susceptible to depression and in the drawings of healthy persons with a negative attitude or poor motivation towards the examination, and those that suppress the expression of emotions. Already the variability of the disorders with the occurrence of rotations suggests a complexity of conditioning mechanisms (or mechanism).

The most essential causes of rotations are:

1. Disorders of receptive visuo - spatial functions, among others the subjective visual value of vertical and plane, the difference of direction, length, distance, and shape of objects placed in the visual field [7]. The decrease of "picture reversing system's" performance (we see the reverse picture, and we perceive – after correction – the direct picture) belong here too. Memory and proprioception play an essential part here. Among others, the functional interrelation between the dominant and the subordinate hemisphere, and the corpus callosum are responsible for a correct interpretation of the reverse picture [8].
2. Disorders of sensations' synthesis. Attention and memory play an important part here. A picture is received not as a whole, but sequential. The appropriate field of attention is necessary, to contain both directional and figural factors in the process of the whole picture synthesis [9, 10]. These disorders are a cause of the difficulties in the production of the internal pattern's stimulus [11].
3. Physiological features of attention, mainly the tendency to focus it on topographi-

cal complex sites, and to omitting simple fragments in the visual image's analysis [12].

4. Disorders of intention: conscious (resulting from animosity towards the investigators or from a lack of motivation), unconscious and even purely reflexive, connected with the orientative reflex. This factor must be taken into account, because each function requires attention, also the orientative reflex has an intentional component [13, 14, 11].
5. Visual illusions subsequent to the pattern's property, e.g. parallel lines bisected at various angles by oblique lines may give the illusion of converged or diverged lines [15, 16].
6. The tendency to completion, simplification, or stabilisation of the shape (the square primarily based on the apex angle is based on the side)[1, 13].
7. The transformations and deformations of pictures in one's imagination or fantasy. In accordance with Kosslyn's model of imaginations, they appear in the so - called superficial representation that is located in short - term visual memory's domain, and which we consider as responsible for the formation of imaginations. The long--term human knowledge about the well known objects' structure is however stored in the so called depth representation and is not susceptible to deformations [17].
8. The motor or the perceptual - motor dysfunction. The so called perceptual motor dysfunction reported recently in parkinsonian patients consists of the inability to use sensory information for the planning of the movement, which in turn causes directional difficulties in drawings [11].
9. Personality factors projected on the drawings' mode: egocentric, negative attitude or tendencies for the abreaction of accumulated emotions in the drawing [4].

For the reason that the central part in distinguishing the shape from the background is played by attention (the shape is as that what is perceived) [14], the question arises, whether attention is also essential in the perception and reproduction of the object's position in space. Analysing the above mentioned possible reasons of rotations, attention may play a certain role in the mechanisms presented in points 1, 2, 3, 4, 5, 8, and 9.

The aim of the work was to see whether there is a dependence between drawings' rotation in the Bender test and attention and if so, what kind of dependence is it. It would appear to be a universal dependence in either brain damaged patients or healthy persons (therefore both these groups were included in this examination). The variable representing the rotations was the mean degree of rotations, and the attention level was specified by means of the Digit Span test, from the Wechsler Adult Intelligence Scale (part I - repeated directly). The last method was chosen to minimise the influence of the earlier executed attention test on Bender test results.

Material

The clinical material consisted of 40 persons selected from the 71 person initial group – the choice was made according to the requirements of the non-parametric Kruskall-Wallis tests [18]. By means of these tests it was planned to specify the dependence between the mean degree of rotations in the Bender test (dependent variable Y) and the results obtained in part I of the Digit Span tests (independent variable X).

In the first stage I examined, by means of both tests 71 persons chosen at random from the patients treated in the Chair of Neurology Medical University of Wrocław (42 organic brain damaged patients, and 29 non brain damaged persons). The patients were able to perform the featured tests (walking, without disorientation, aphasia, visual disorders or significant hearing weakness). Most of the examined patients (67 persons) in the 1st part Digit Span test achieved results from 4 to 7 points, i.e. they have repeated from 4 to 7 digits, therefore in the 2nd part of the work I took these as independent variable levels. Distribution of the result's on these levels is presented in table 1.

From those examined, who have achieved 4 points (16 persons) and 5 points (31 persons), ten persons were randomly chosen, so that the final group consisted of four

Table 1

Distribution of Digit Span test results (part I – directly repeated) on the levels from 4 to 7 points

Tests result	Number of persons
4	16
5	31
6	10
7	10

10 person subgroups. In this way an even distribution on particular levels of the independent variable was obtained:

with the result of 4 points – 10 persons
with the result of 5 points – 10 persons
with the result of 6 points – 10 persons
with the result of 7 points – 10 persons

In this group 16 persons were without organic brain damage and 24 persons had organic brain damage. Since in the presented study the dependence of rotations' degree from the type of organic brain damage was not evaluated, I do not describe the character of the particular brain damage.

Methods

I. Description of administrated tests.

1. The Digit Span test is part of the Wechsler Adult Intelligence Scale (WAIS), but it was well known long before the WAIS construction [19]. The test's first consists of directly repeated, each time longer series of digits. In the test's second part, the series are repeated in reverse. According to Wechsler, this test is very useful in evaluating immediate memory (in this paper, writing on attention I have also considered immedi-

ate memory). Disorders of attention detected by these tests can have different grounds (organic brain damage, anxiety, failure of motivation to be examinated, etc.). Wechsler considered the test's results to be poorly correlated with the so called global intelligence factor g. However, a result of less than 5 points in the directly repeated series of digits and below 3 points in the reverse repeated series meant a lowered intelligence level related to mental deficiency or organic brain disorders. According to the author, the administration of both parts of tests together (directly repeated and reverse repeated), is intended to minimise the influence of the Digit Span test on the global result obtained by the patient in the Wechsler Adult Intelligence Scale (reverse repeatition usually comparatively diminishes the cumulative results of both subtests). The author of the scale considered the Digit Span test to be poorly distinctive and not matching the whole scale, but he did not exclude it due to its' large sensitivity in detecting organic brain damage. He considered as purposeful the usage of the Digit Span test as a separate diagnostic method as well as using both parts of the test separately [19].

The examination of attention by means of the Digit Span test repeated directly was performed once, directly according to the WAIS instruction [20], immediately before applying the Bender test. The question was, whether there is relation between the drawings' rotation's degree and a level of attention in the moment of the examination and not the change neither in the situation or the state of the examined persons in the interval between the administration of the two tests. The aim of the work was not to find a given relation between rotation's degree and the certain level of attention as characteristic for some given person. It is difficult to rely on such a criterion due to the dynamic quality of attention and its' susceptibility to disturbing factors [21]. The tests' second part (reverse repeated) was not used because it also involved the visuo - spatial functions [22], and in order to avoid the tiredness of the examined person.

The application of the Digit Span test together with organic drawings tests together, already postulated by Benton [2], can be found in contemporary concepts which recommend using tests involved in a variety of modalities as a means of applying a way of essential test's material (repeated digits - auditive modality, Bender test - visual modality), in order to avoid interference of the tests on each other [23].

2. Analysis of rotations in Bender test. The Bender test and methods of its' application are commonly known [1, 5]. This test was performed using the method of copying drawings. The essential element in the course of the examination was the fixation of the presented paper and that on which the patient drew. It is the condition to recognise the rotation as real [3]. The rotation's angle each with 9 tests figures was measured according to the method described in the instruction of the Minnesota Percepto-Diagnostic Test – the famous method of organic brain damage estimation by the analysis of drawings rotation's degree. Here three lines were used: a base line, a line perpendicular to the base line which allows the judge to be oriented in the true axis of the figure, and a line along the actual axis of the figure. The change of the actual axis line from the perpendicular line constitutes the degrees of rotation [3]. The final result (mean degree of rotation) was the calculation of the mean rotation angles obtained from 9 drawings. The results were arranged in ordered rank series (according to the Kruskall Wallis test). The rank series are presented in table 2.

II. Statistical procedures

1. To measure the influence of the level of attention on the mean degree in the Bender test drawing rotations, I have maintained the non - parametric Kruskal-Wallis

Table 2

Raw results and ranks obtained by patients in four examined groups

Group I - 4 points			Group II - 5 points		
Number of the examined person	Raw result	Rank	Number of the examined person	Raw result	Rank
6	3,7(7)	20	4	1,9(4)	5
15	10,1(1)	36	5	5,5	27
17	13,5(5)	37	8	2,6(1)	11
18	6,4(4)	32	24	2,6(6)	12
19	6,0(5)	28	28	0,9(4)	1
25	17,2(2)	38	34	3,3(3)	16
33	3,2(2)	15	41	2,1(1)	6
39	3,8(8)	22	45	1,8(3)	4
54	5,3(3)	25	51	32,3(8)	40
55	6,3(8)	31	60	5,3(8)	26
Group III - 6 points			**Group IV - 7 points**		
Number of the examined person	Raw result	Rank	Number of the examined person	Raw result	Rank
1	6,2(2)	30	7	3,6(6)	19
3	6,6(6)	33	22	1,1(6)	2
13	8,5(5)	35	30	3,8(3)	21
23	4	23	40	6,1(6)	29
35	24,5	39	43	2,2(2)	9
48	2,1(6)	7	46	3,5(5)	17
53	8,0(5)	34	62	2,9(4)	14
64	3,6(1)	18	67	2,2	8
68	2,6875	13	69	2,3(8)	10
70	1,6(1)	3	71	4,1(6)	24

test appropriated to ranks [18].

2. To appoint the shape of dependence, I have planned:

a) An analysis of trend for nondependent data by the means of Marasquilo and Mc-Sweeney method, using the ortogonal multinomial coefficient presented in tables

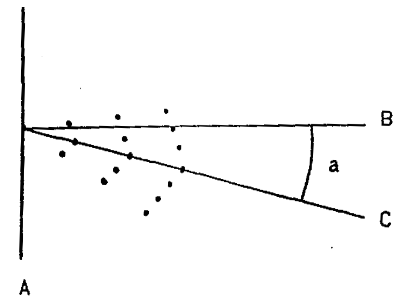

Fig. 1 **Principle of measurement of the rotations' angle**

[18],

b) If this method did not give the univocal result, the data was to be referred to the quantitative analysis of dependence on the ground of the the simple regression by a method of smallest squares calculated by the means of a statistical package Statgraphics [24, 25, 26].

An analysis conducted in this way would give the possibility to establish some general dependence between attention level in Digit Span test's part I and drawing rotation degree in Bender test. This dependence might be, in my opinion, at least a partial explanation of the occurrence of even great rotations degree in the Bender test performed by healthy persons. I have also attempted to compare the mean rotation degrees between the group of persons with organic brain damage and the group of persons without such a damage. By the means of a One - Way Analysis of Variance I evaluated, whether there is a dependence between the number of rotations done by the patient and the level of their attention. I have also estimated the significance of the mean rotation degree between the groups with a different level of attention (4 groups).

Results

1. The statistic Kruskal - Wallis test H = 9,57964. Critical value chi^2 for a = 0,025 and df = 3 amount to 9,34. Because H > chi^2 0,025; 3, we can reject the null hypothesis and approve, that the mean drawing rotations degree in the Bender test is dependent from the level of attention level measured by the means of Digit Span test - simple repeated.
2. By means of Marasquilo and McSweeney's method we were not able to define the type of dependence.
3. Evaluation of the type of dependence shape by means of the simple regression analysis gave the following results:

A. The value F for the regression line was 1,945708, what conforms to a probability a = 0,17115. Thus, the null hypothesis about a lack of linear dependence between the examined variables could not be rejected.

B. Expecting a curvelinear shape of the examined dependence, I have attempted to point out the best curvelinear model from the three possibilities: multiplicative, exponential or reciprocal models [24]. In the multiplicative models I have applied logarithmic transformations of both (independent and dependent) variables, in the exponential models – only of the dependent variable, and in reciprocal models I have replaced the dependent variable with its' reciprocal before the estimation of the regression equation. Then I introduced the modified data to a linear equation of the regression [5, 7, 16]. The above procedure indicated that the best approximation of the examined dependence is by the multiplicative model: ln Y = ln a + b ln X, concretely: ln Y = 3,26181 – 1,08144 ln X. F for this equation is 3,7532639, which corresponded with the probability a = 0,06016, which – according to Brzeziński, is still allowed in the case of psychological investigations, particularly in preliminary analysis [27]. The variable correlation coefficient's square $R^2 = 0,0899$ means, that the proposed equation of regression explains almost 9% of the variability of the dependent variable [24]. In other words, 9% of the variability of results in the range of a mean degree drawing rotations in the Bender test may be explained by the influence of the level of attention measured by the means of a Digit Span test – simple repeated.

4. I have not found any significant difference between the mean rotation degree in the group of persons with organic brain damage and in the group without such a damage.
5. One-way analysis of variance, did not show neither the dependence between the number of rotations and the level of attention of the examined persons, nor significant difference between mean rotation degree in the 4 examined groups.

Discussion

Two methods of statistical analysis (the non-parametric method – Kruskal-Wallis test, and the parametric method – simple regression analysis) confirmed the dependence of mean degree rotation of the drawings from the level of attention, measured by means of the Digit Span test (part I – simple repeated). The estimation of the appointed shape dependence was difficult, because it is of a complicated nature. From amongst the examined possibilities, the multiplicative model of regression was the closest, in which the dependence expressed the formula: ln Y = 3,26181 – 1,08144 ln X. This equation explains an almost 9% variability of the mean rotation degree results in the examined group, which does not mean, that it is the entire explanation of the attention influence on the rotation. If another method of estimation of rotation was used, the dependence perhaps would be different. Relatively a small examined group (40 persons) allows to appreciate the obtained results only as a preliminary explanation requiring a confirmation on larger material.

It would be interesting to find the factors responsible for the remaining percentage (about 91%) of variability in the mean degree of drawing rotation in Bender test. Further explanation requires the dependence between the drawing rotation and organic brain damage. According to the data from the literature such dependence does exist [1, 3, 5, 6] – the examination herewith conducted, did not confirm this dependence in the mean degree of rotations. Maybe other methods of estimating rotations, as well as a selection of the subgroups according to the aetiology and lesion localisation from the organic damaged patients group have a significant meaning.

Conclusions

1. This study confirmed a dependence of the mean degree drawing rotation in Bender test from the level of attention evaluated by mean of Digit Span test (part I – repeated directly).
2. The indicated dependence is of a curve-linear character and is expressed by the formula: ln Y = 3,26181–1,08144 ln X.
3. The above equation allows an explanation of almost 9% of the variability in the mean rotation degrees obtained in the study.

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Address: Ewa Jarzębska
Department of Neurology
Medical Academy
50-420 Wrocław
Traugutta 118
Poland