THE COMPARATIVE EFFECTIVENESS OF THE BENDER GESTALT AND THE TRAIL MAKING TESTS IN DIFFERENTIATING BETWEEN PSYCHOTIC AND NORMAL CHILDREN

BENDER GESTALT VE TRAIL MAKING TEST'LERİNİN NORMAL VE PSİKOTİK ÇOCUKLARIN AYIRIMINDAKİ ETKENLİKLERİNİN MUKAYESESİ

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Bu çalışmanın amacı, psikotik ve normal çocukların Trail Making ve Bender Gestalt Testlerindeki performanslarının mukayesesidir. Bu testler 8-12 yaşlarında 30 psikotik ve 30 normal çocuğa uygulandı. İki grubun performans ortalaması kat'î ve yüksek seviyede anlamlı farklılaşmalar gösterdi. Trail Making Testi'nde Psikotiklerin % 67'si, Bender Gestalt Testi'nde ise sadece % 30'u ayırt edildiği halde, her iki testte de normal deneklerin hemen hemen % 100'ü normal sınırlar içinde kaldı. Netice olarak, Bender Testi'nin genel anormalliklere daha hassas, Trail Making Testi'nin ise, organik beyin hasarından husule gelen arızalara özgü spesifik bir test olduğu görünmektedir.

The purpose of this study was to campare the performance of psychotic and normal cihildren on the Trail Making and the Bender Gestalt Tests. These instruments were administered to 30 psychotic and 30 normal children, ranging in age from eight to twelve. The results showed striking and highly significant differences in the average performance of the two samples. On both tests, nearly 100 % of the normal sample scored in the normal range, as compared to 67 % of the psychotics on the Trail Making, and only

30 % on the Bender Gestalt Tests. Thus, the Bender appears to be more sensitive to general abnormality, the Trail Making test more specific to deficit from organic brain damage.

The Trail Making Test (TMT) was originally published in 1944 as one of the performance subtests of the Army Individual Intelligence Test. Armitage (1946) used the TMT to evaluate the effects of brain injury among soldiers, and his results appeared promising. A version of the TMT for children was prepared by Reitan (1955) by shortening the adult form. In a number of studies, the TMT has been shown to reflect psychological deficit in individuals with brain damage (Armitage, 1946; Reitan, 1955; Davids, Goldenburg, & Laufer, 1957; Reitan & Tarshes, 1959; Reed & Reitan, 1963a, 1963b), depression (Alvarez, 1962), schizophrenia (Brown, et. al., 1958), and chronic alcoholism (Fitzhugh, Fitzhugh, & Reitan, 1960). Virtually all studies have demonstrated that brain damaged patients perform significantly more poorly on the TMT than do non-brain-damaged controls. For example, Reitan (1955) reported that a cutting score of 12 on the two parts of the TMT combined separated a brain damaged sample for a control sample with but 17% of each sample being misclassified. In a later study, Reitan (1958) found that the same cutting score misclassified 15% of another brain damaged sample, against 16.7% of the new control sample.

The Bender Visual-Gestalt Test (BGT) was assembled by Lauretta Bender in 1938 from a set of simple designs employed earlier by Wertheimer (1923). The BGT has been used to test maturational level in children, and to estimate intelligence, organic brain damage, and psychological disturbance in both children and adults. American clinical psychologists used the BGT in army medical installations during World War II, and at least two manuals were issued by the U.S. armed services. Bender published her own manual in 1946. Later, Pascal and Suttell (1951) developed a more objective scoring system for adults, while Koppitz (1963) developed one for young children. Since the publication of Bender's manual, the BGT has come into widespread use as a clinical instrument.

The BGT literature, reviewed by Billingslea (1963), is ambiguous concerning the test's usefulness in differentiating patients with brain pathology from those with various types of psychological disorders. For example, Garron and Cheifetz (1965) found the BGT to be relatively inefficient in differentiating individuals with severe emotional disturbance from those with

brain damage. Moreover, while the BGT literature is replete with studies comparing the performance of those with brain damage and normal controls, there has been much less research on the BGT performance of emotionally disturbed or psychotic patients, especially children. Indeed, Koppitz (1962) found that five to ten year old children with emotional problems tended to have impaired BGT performance; only 32% of the disturbed children, as compared to 70% of the normal control sample, showed high BGT performance.

One problem with much of the past research on both the Bender Gestalt and the Trail Making tests is that only rarely are two or more such diagnostic instruments directly compared in the same study. As a consequence, there is little clear evidence concerning the *relative* effectiveness of these and other diagnostic procedures. While an ideal study would sample both a wide array of instruments and a wide variety of diverse subject populations, considerations of time and cost rarely permit that ideal to be met. The present study represents but a small step in the right direction by comparing the performance of psychotic and normal children on both the TMT and the BGT.

METHOD

Subjects

The subjects for this study were 60 children, all between the ages of eight and twelve years old, half of whom had been diagnosed as psychotic and half of whom served as normal controls. Some characteristics of the two samples are presented in Table 1. The normal sample consisted of 15 boys and 15 girls, three boys and three girls at each of five age levels. All normal subjects were volunteers from the Jefferson Road School in Rochester, New York; teachers selected the initial candidates for testing by excluding students with either very high or very low intelligence scores. The psychotic sample was composed of 22 boys aud 8 girls, approximately equally divided between two hospitals (the Convalescent Hospital for Children and the Rochester State Hospital, both in Rochester, New York). The great majority of the subjects were caucasians; there were two black children in the normal sample and three in the psychotic sample. No patients

Table 1

Characteristics of the Samples

	Psychotic (N=30)		Normal (N=30)	
	Males (N=22)	Females (N=8)	Males (N=15)	Females (N=15)
Age (in years)				
8	(5)	(1)	(3)	(3)
9	(4)	(2)	(3)	(3)
10	(5)	(1)	(3)	(3)
11	(4)	(2)	(3)	(3)
12	(4)	(2)	(3)	(3)
Age (in months)				
Mean	127	129	123	122
S.D.	19	19	16	14
I.Q.				
Mean	92	89		
Range	68-124	69-110		

were included in the psychotic sample if they were acutely ill, disoriented, confused, or uncooperative at the time of testing. The diagnosis for each of these patients was based on the information in their hospital records, including a detailed medical history, a psychiatric examination, a psychological evaluation, and any neurological reports. The American Psychiatric Association's *Diagnostic and Statistical Manual* was generally used for a diagnostic guide. The normal and psychotic samples did not differ significantly from each other in age (see Table 1). Since intelligence test scores were not available for the normal subjects, it is not possible to compare the two samples on this variable.

Procedures

All subjects were tested individually with three tests, the Bender Gestalt, the Trail Making, and a Muller-Lyer Illusion tests, using six different test administration orders. Since the order of administration had no significant effect on test performance, it will not be further discussed. In addition, the results for the Muller-Lyer illusion will also be excluded from this report; these findings will be described in a subsequent report.

The *BGT* consists of nine cards, on each of which is printed a simple figure, which the subject is instructed to copy. Each design was copied on a separate sheet of paper, and the time required to copy each design was recorded by the experimenter, using a stopwatch held as unobtrusively as possible. The *TMT* has two parts, each including a short sample followed by the actual test. *Part A* consists of a page on which 15 circles are randomly distributed; in each of the circles is a number, from 1 to 15. The subject is instructed to begin with the first circle (number 1) and to connect the circles by pencil in their correct numerical order. *Part B* consists of a similar page of circles, eight numbered from 1 to 8 and seven labeled from A to G. The subject is instructed to to again connect the circles with his pencil, proceeding this time in the order : 1, A, 2, B, w15. As with the *BGT,* the time required to complete each part of the *TMT* was recorded by the experimenter. Prior to the administration of either test, a few warm-up exercises-a simple arithmetic problem and the task of finding similarities and differences among four designs-were presented to insure that the subject was reasonably comfortable in the testing situation.

Analyses

TMT «raw scores» are the times, in seconds, required by each subject to complete each of the two parts of the test. These scores in turn were converted to a ten-point scale, based on Reitan's (1956) *TMT Manual.* The means, standard deviations, and frequencies for both scoring procedures are presented here for easy comparison with other studies. Both types of scores were also used in standard analyses of variance (ANOVA) to test the statistical significance of differences between the two samples.

For the *BGT,* in addition to copying time, four types of errors were scored : distortion of shape, rotation, integration, and perseveration. The

samples were again compared via ANOVA on copying time, each of the error types, and total errors.

RESULTS

Trail Making Test

Table (a) presents the *TMT* raw and converted score means and standard deviations, for both parts of the test and both samples of subjects. Table 3 presents the results of four two-way analyses of variance, for raw and converted scores and for each part of the test. Each ANOVA tests the significance of the differences between diagnostic samples, between sex groups, and the diagnosis-by-sex interaction. As Table 3 indicates, there were no statistically significant effects attributable to sex, and none of the

Table 2

Means and Standard Deviations of Raw Scores and Converted Scores of Normal and Psychotic Samples on Parts A and B of the Trail Making Test.

		Part A				Part B			
		Raw Scores (in seconds)		Converted Scores		Raw Scores (in seconds)		Converted Scores	
		M	SD	M	SD	M	SD	M	SD
Normal	Boys	25.93	12.76	9.60	0.91	52.67	20.13	7.73	2.28
	Girls	24.07	7.40	9.93	0.26	51.53	14.94	8.20	1.82
Psychotic	Boys	38.23	24.29	8.59	2.65	96.50	70.85	5.31	2.95
	Girls	45.25	44.94	8.87	3.18	126.00	94.77	4.75	3.99

Table 3

Analyses of Variance for Parts A and B of the Trail Making Test.

	Raw Scores					
		Part A			Part B	
	df	MS	F	df	MS	F
Between Diagnostic Samples (A)	1	3689.18	6.98	1	46067.97	14.57
Between Sex Groups (B)	1	87.51	0.17	1	2648.78	0.84
A X B	1	260.12	0.49	1	3089.00	0.98
Ss Within Groups	56	528.16		56	3162.26	

	Converted Scores					
		Part A			Part B	
	df	MS	F	df	MS	F
Between Diagnostic Samples (A)	1	14.07	3.41***	1	113.24	15.33
Between Sex Groups (B)	1	1.25	0.30	1	0.03	0.00
A X B	1	0.00	0.00	1	3.53	0.47
Ss within Groups	56	4.12		56	789	

*** $P < .001$

for both samples and both parts of the test. Using the cutting scores recommended by Reitan, 100% of the normals would be correctly diagnosed in *Part A*, while 17% of the psychotics would be called abnormal. For *Part B*, interactions between sex and diagnostic sample were significant. On the other hand, all differences between the two samples were *highly* significant ($p < .001$). In Table 4, the distributions of converted scores are presented

Table 4

The Distribution of Converted Scores on the Trail Making Tests for Normal and Psychotic Samples

	Part A				Part B				Parts A+B			
	Normal		Psychotic		Normal		Psychotic		Normal		Psychotic	
	f	%	f	%	f	%	f	%	f	%	f	%
10	26		23		10		4					
9	2		0		6		0					
8	1	100%	2	83%	2	93.7%	4	60%				
7	1		0		4		4					
6	0		0		3		4					
5*	0		0		3		2					
4	0		1		2		2					
3	0	0%	3	17%	0	6.6%	0	40%				
2	0		0		0		3					
1	0		1		0		7					

20	10		4	
19	5		0	
18	3		4	
17	3		4	
16	3	96.7%	4	67%
15	2		1	
14	3		2	
13*	0		1	
12	1		2	
11	0		2	
10	0		1	
9	0		0	
8	0		0	
7	0	3.3%	0	33%
6	0		0	
5	0		2	
4	0		2	
3	0		0	
2	0		1	
1	0			

* Reiten's cutting point.

93.4% of the normals would be correctly diagnosed, and 40% of the psychotics would be given abnormal diagnoses. For the combined test, 96.7% of the normals scored in the normal range, while 33% of the psychotics scored in the abnormal range.

Bender Gestalt Test

Table 5 presents the mean time required to copy the designs for the subjects in each of the two samples. In contrast to the *TMT*, where the psychotic children took longer to complete the test than did normal children, just the reverse was true on the *BGT*.

Table 5

Mean Time (in Seconds) for Each Drawing on the Bender Gestalt Test

	Means				Standard Deviations			
	Psychotic		Normal		Psychotic		Normal	
Card	B	G	B	G	B	G	B	G
A	12.3	11.6	11.3	16.6	7.6	4.2	5.1	13.8
1	26.2	22.2	30.3	28.9	12.1	11.4	12.6	15.8
2	40.6	31.1	57.8	39.7	18.0	10.6	28.4	20.2
3	30.0	24.5	35.9	30.9	14.9	4.1	16.4	18.4
4	12.1	10.5	15.7	13.5	5.6	3.6	9.1	8.0
5	22.3	22.2	41.3	24.1	12.5	9.8	27.6	10.9
6	17.4	16.2	23.9	15.7	9.3	7.9	12.6	11.4
7	25.0	35.0	36.5	35.4	10.0	14.5	14.4	28.2
8	17.0	20.6	26.9	22.5	6.6	5.9	12.8	12.4
Average	22.5	21.5	31.1	25.3	10.7	8.0	15.6	15.5

Table 6 presents the mean number of errors in copying the designs for both samples and for both sex groups. The resulting ANOVA shows that the differences between boys and girls was significant (girls made more errors than did boys), and the differences between samples was *highly* significant (the average psychotic child made five times as many errors as the average normal child!). The sex-by-sample interaction was not significant.

Table 6

Means and Standard Deviations and Anova for Bender Gestalt Total Error Scores.

Diagnostic Group.	Sex Group.	M	SD
	B	1.07	1.16
NORMAL	G	2.00	1.31
	B + G	1.53	1.23
	B	7.09	4.33
PSYCHOTIC	G	8.88	3.36
	B + C	7.57	4.07

	df	MS	F
Between Diagnostic Samples (A)	1	547.72	59.49***
Between Sex Groups (B)	1	24.31	2.64**
A X B	1	2.38	0.26

** $P < .01$
*** $P < .001$

Table 7 presents the distribution of these total error scores in both samples. Using the cutting score previously suggested in the *BGT* literature as most effectively separating brain damaged from normal subjects, 100% of the normal children would be correctly diagnosed as normal, while 70% of the psychotic children scored in the abnormal range.

Table 7

The Distribution of Total Error Scores on the Bender Gestalt Test for Normal and Psychotic Samples

Scores	NORMAL						PSYCHOSIS					
	BOYS		GIRLS		TOTAL		BOYS		GIRLS		TOTAL	
	f	%	f	%	f	%	f	%	f	%	f	%
0	6		2		8		1		0		1	
1	5		4		9		0		0		0	
2	1		3		4		1		0		1	
3	3	100%	4	100%	7	100%	2	36%	1	12.5%	3	30%
4			2		2		4		0		4	
5							3		0		3	
6							1		0		1	
7							2		2		4	
8							1		0		1	
9							0		2		2	
10							1		1		2	
10							1		1		2	
11							3		0		3	
12		0%		0%		0%	0	64%	1	87.5%	1	70%
13							0		0		0	
14							1		1		2	
15							1				1	
16							1				1	
N	15		15		30		22		8		30	

Table 8 presents the relative frequency of different *types* of errors in each sample. Rotation errors occur *very* rarely among the children in the normal sample, while the average psychotic child made about one and a half such errors in the eight opportunities he had to do so. As a consequence, when a rotation error is made, one can be reasonably certain that the protocal comes from an abnormal subject. Indeed, there was no error type that was not made at least twice as often on the average by a psychotic as by a normal child.

Table 8

The Relative Frequency of Different Types of Errors in Each Sample

Error Type	Maximum Errors Possible	Normal Sample	Psychotic Sample	Ratio : Psychotic/ Normal
Distortion	10	.90	4.17	4.6
Rotation	8	.03	1.43	47.7
Integration	9	.30	1.60	5.3
Perseveration	3	.30	.73	2.4
Total	30	1.53	7.93	5.2

The intercorrelations among all of the BGT and TMT scores, plus sex, age, and diagnostic sample, are presented in Table 9. These correlations were separately computed in the total sample ($N = 60$), and in each of the two subsamples ($N = 30$); correlations based on the total sample are presented above the main diagonal of Table 9, while those based on the normal sample are listed above those from the psychotic sample below the main diagonal. The point-biserial correlations presented in the first row of this table indicate the extent to which each of the BGT and TMT scores was related to the normal versus psychotic classification. Note that while all of the BGT and TMT scores were significantly associated with diagnostic classification, by far the most differentiating variables were Bender distortion errors and total errors.

As Table 9 indicates, sex did not have any profound effect on these test scores. None of the relationships between sex and TMT scores were

TABLE 9

Intercorrelations among the BGT and TMT Scores in Each of the Subsamples and in the Total Sample

		BENDER-GESTALT Errors							TRAIL MAKING Time				
		Sex	Age	Time	Dist.	Rotat.	Integ.	Pers.	Total	Part A	Part B	Total	Mean	S. D.
Diagnostic Sample (0 = N; 1 = P)		.24	.13	-.31+	.72++	.60++	.49++	.28+	.71++	.32+	.43++	.42++	0.50	0.50
Sex(0 = F;1 = M)		-	.02	.10	.08	.06	.20	-.23	.04	.04	.01	.02	0.62	0.49
Age		.03	-	-.08	.13	.08	.17	.06	.15	.14	.17	.17	124.90	17.63
		-.04	-											
BENDER GESTALT TEST	Time	.27	-.38+	-	-.24	-.14	-.32+	-.10	-.26	.07	.04	.05	25.40	9.63
		.04	.45+	-										
	Dist.	-.18	-.15	-.24	-	.64++	.65++	.38+	(.93++)	.43++	.56++	.55++	2.53	2.29
		-.14	.14	.16	-									
	Rotat.	-.19	.05	.01	.02	-	.49++	.30+	(.78++)	.32+	.42++	.41++	0.73	1.18
		-.15	-.01	.14	.42+	-								
	Integ.	-.05	-.04	-.38+	.22	-.09	-	.29+	(.80++)	.32+	.34++	.34++	0.95	1.33
		-.01	.18	-.14	.54++	.31	-							
	Pers.	-.44+	-.04	.01	-.08	-.11	-.07	-	(.53++)	.14	.21	.20	0.52	0.77
		-.26	.06	-.05	.36+	.21	.24	-						
	Total	-.36+	-.14	-.35	(.79++)(.07)	(.62++)(.31)		-		.42++	.53++	.52++	4.73	4.52
		-.17	.14	.06	(.87++)(.66++)	(.76++)(.53++)		-						
TRAIL MAKING TEST	Part A	.09	-.08	.28	-.36+	.00	-.31	-.13	-.46+	-	.82++	(.90++)	32.35	23.76
		-.10	.17	.26	.40+	.17	.26	.09	.36	-				
	Part B	.03	-.48++	.09	.16	-.04	-.21	-.12	-.05	.31	-	(.98++)	78.25	61.53
		-.17	.26	.39+	.44+	.23	.20	.14	.38+	.82++	-			
	Total	.07	-.40+	.20	-.04	-.03	-.30	-.15	-.25	(.69++)(.90++)		-	110.78	81.90
		-.16	.24	.37+	.45+	.22	.23	.13	.39+	(.91++)(.99++)		-		
Mean	N.	0.50	122.70	28.38	0.90	0.03	0.30	0.30	1.53	25.00	52.10	77.10		
	P.	0.73	127.10	22.42	4.17	1.43	1.60	0.73	7.93	40.10	104.40	144.47		
S.D.	N.	0.51	15.43	11.52	0.92	0.18	0.65	0.53	1.31	10.30	17.43	22.82		
	P.	0.45	19.61	6.11	2.07	1.33	1.52	0.91	4.32	30.41	77.35	103.83		

Note:--Correlations above the main diagonal are based on the total sample (N = 60); below the diagonal, correlations based on the normal subsample (N = 30) are listed above those from the psychotic subsample (N = 30).

+ $p<.05$ ( ) = Part-Whole correlations
++ $p<.01$

significant, nor were any such relationships among the BGT variables in the psychotic subsample. However, normal girls tended to make significantly more perseveration errors than normal boys, perhaps because they typically took a bit less time to complete the BGT drawings.

Perhaps the most tantalizing relationships in Table 9 are those involving BGT or TMT *time*. For example, diagnostic sample turned out to moderate the relationship between age and time: among the normal children, age was negatively related to testing time; in the psychotic sample, age was positively related to time. That is, normal children took less time as they were older, while the reverse was true among the psychotics (sug-

gesting, perhaps, that older psychotic children are generally more debilitated than younger ones). Interestingly, time spent on the BGT was only weakly (if at all) related to time spent on the TMT; this relationship was not significant in the normal (and total) sample, low but significant in the psychotic sample. Moreover, BGT time was not generally related to error rate. On the other hand, the relationship between TMT time and BGT error rate was again moderated by diagnostic sample : the relationships tended to be slightly negative in the normal sample and slightly positive in the psychotic sample.

Finally, Table 9 provides some evidence on the relations among different types of BGT errors, and between the two parts of the TMT. In the normal sample, the BGT error types were virtually unrelated, probably at least in part because the incidence of errors was so low. In the psychotic sample, where the error frequency was much higher, the four types of BGT errors were moderately related. Much the same phenomenon occured when both parts of the TMT were correlated: this correlation was not significant in the normal sample, yet it was extremely high in the psychotic sample.

Discussion

The results of this study suggest that the Trail Making and the Bender Gestalt tests, both of which are typically used to screen for organic brain damage, are *differentially* sensitive to the performance deficits associated with psychosis. Specifically, the Bender appears to be far more sensitive to the general personality abnormality associated with psychosis than is the Trail Making test. And, while no direct comparison was possible with the present samples, it would appear that the Trail Making test provides a more specific indication of brain damage than does the Bender.

As a consequence, one must be quite cautious in inferring brain damage from either test alone, and especially from the Bender, since ostensibly none of the subjects in this study would be so diagnosed on neurological grounds. On the other hand, to the extent that one assumes some structural anomolies in the genesis of all psychotic conditions, then one would expect such clinical signs of brain damage in a psychotic sample. In any case, it is clear that far more research is needed before the clinician can confidently use these instruments for differential diagnostic purposes.

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