

The Medical College of Georgia (MCG) Complex Figures: Four Forms for Follow-Up

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The Rey-Osterrieth Complex Figure is one of the most popular approaches to assessing visuoconstructional skill and nonverbal memory, and in addition to standard quantified scoring, provides a rich source of qualitative information regarding organizational approach to processing complex visual information (Lezak, 1995). A major limitation of the Rey-Osterrieth Complex Figure for memory assessment, however, is the absence of parallel forms. L. B. Taylor (1969) devised an alternative figure for the Rey-Osterrieth, and the Taylor figure is commonly used for follow-up neuropsychological evaluation. Performance on the Taylor figure, however, tends to be higher than on the Rey-Osterrieth (Tombaugh & Hubley, 1991; cf. also chapter 8 in this book), making direct performance comparisons more difficult. Further, in many instances such as long-term neuropsychological monitoring or with multiple assessments associated with studies of medication side effects, more than two forms are necessary to avoid a range of confounding effects associated with repeated exposure to the same stimulus material.

Given the lack of parallel forms, we developed four complex figures similar to the Rey-Osterrieth and Taylor figures (Meador et al., 1991, 1993). Two of the four figures are rectangular in orientation—as is the Rey-Osterrieth figure, and the remaining two are square—as is the Taylor figure. We incorporated some of the same elements used in the previous figures (e.g., parallel lines), but placed them in different locations. We added new components including sine waves, semicircles, and teardrops so that each administration would contain novel visual information (see Appendix 10-A). Our scoring system uses a 36-point scale, patterned after the 18-unit scoring system most commonly applied to the Rey-Osterrieth and Taylor figures (Lezak, 1995).

Many approaches to complex figure administration exist (cf. chapter 5 in this book for more details on Administration and Scoring procedures). Among the common administration options are choices for the duration of the delay for memory assessment,

whether to include both an Immediate and Delayed Recall condition, and whether the patient is warned that a memory component will be obtained. In general, we have followed the framework employed in our clinical application of the Rey-Osterrieth figure (see Loring, Martin, Meador, & Lee, 1990), using both an Immediate Recall (about 30 seconds following completion of the Copy Trial) and a 30-minute Delayed Recall component. However, there is a significant difference in our administration of MCG Complex Figures compared to our clinical application of the Rey-Osterrieth Complex Figure.

In standard neuropsychology practice, patients are not typically forewarned that a memory component for the Complex Figure will be forthcoming; thus, the memory recall can be considered more of an “incidental” rather than “explicit” memory task (also see chapter 8 in this book for further discussion of complex figure usage in explicit memory paradigms). In contrast, we designed the MCG Complex Figures for use in research applications with repeated measure designs. The memory component can be anticipated during the second and all subsequent evaluations; thus, failure to warn the patient about the memory component during the initial assessment is a source of systematic bias. Therefore, the instructions for the MCG Complex Figures explicitly state:

“In this test, I’d like you to copy the shape in the empty space below the page. Try to make the figure the same size and shape as what you see at the top of the page. When you’re finished copying the figure, I am going to take the paper away and ask that you redraw the figure from memory, and then again in about a half hour.”

After the Immediate Recall trial is administered, we again warn the patient about the upcoming Delayed Recall trial by saying; “I want you to try to remember as much of the figure as possible, because I am going to ask you to draw it again after a little while.”

Table 10-1
Performance on the Rey-Osterrieth, Taylor, and
MCG Complex Figures in Healthy Young Volunteers

	Rey-Osterrieth		Taylor		MCG Complex Figure							
					1		2		3		4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Copy	36.0	0.0	35.7	0.7	35.9	0.2	36.0	0.0	35.9	0.3	36.0	0.0
Immediate Recall	29.5	6.3	33.5	2.4	36.0	0.8	35.1	1.6	35.4	1.0	33.9	3.9
Delayed Recall	29.9	4.8	33.5	1.9	34.9	1.8	34.6	2.2	35.3	1.4	32.5	3.6

Note. $N = 10$. Mean age = 30 years. MCG = Medical College of Georgia.

The scoring criteria that we apply are generally considered lenient, and we do not employ such a strict interpretation of the scoring criteria that a ruler and protractor are required to determine the accuracy of placement of figure components. We originally developed the MCG Complex Figures to measure antiepileptic drug effects on visuospatial memory. Thus, we tried to minimize the confounding effects of possible minor misplacement (e.g., slight overshooting resulting from rapid copy of the figure in the absence of any genuine constructional impairment) on quantitative memory performance.

After we developed the four MCG Complex Figures, we compared them to the Rey-Osterrieth and Taylor figures. We administered all six figures to 10 healthy volunteers who were right-handed and without a reported history of familial sinistrality, neurologic or psychiatric impairment (see Meador et al., 1993). Average level of education was high (mean = 17 years, range = 15-19 years), and the age was relatively young (mean = 30 years, range = 21-48 years) because the sample consisted of MCG students and staff. Thus, it is likely that these average performance values are higher than that of less well-educated and older individuals (cf. chapter 31 in this text for more discussion of education effects on complex figure production).

There were no significant performance differences in the Copy trials between either the Rey-Osterrieth, Taylor, or any of the MCG Complex Figures. As can be seen in Table 10-1, Copy performances for three of the six figures was a perfect 36/36, and the lowest average Copy score was 35.7/36. This high level of performance reflects our scoring criteria (Loring et al., 1990). The equivalence of the Copy performance for the Rey-Osterrieth and Taylor Complex Figures has been previously described (Duley et al., 1993; Kuehn & Snow, 1992).

Performance differences among the figures were found for Immediate Recall, with poorer recall detected for the Rey-Osterrieth Complex Figure. No significant difference was present among any of the remaining five figures (Taylor and MCG figures). The Rey-Osterrieth figure is more difficult to remember than the Taylor figure, a finding that has been previously reported (Duley et al., 1993; Kuehn & Snow, 1992), and discussed in detail in chapter 8 of this book. For all six Complex Figures, there was no significant decay of information over the imposed delay interval, with the overall level of memory performance on the ROCF continuing to be lower than the remaining five figures. Thus, the four MCG Complex Figures are comparable to the Taylor figure in difficulty, and easier than the ROCF where the scores were 3 to 6 points lower. Although, there is greater performance variability associated with MCG Complex Figure 4, no such difference was present in our sample of patients with intractable epilepsy.

MCG Complex Figure Studies

We have employed MCG Complex Figures to study the effects of scopolamine on visual memory, examine material-specific memory deficits, and investigate the cognitive effects of antiepileptic drugs. Our first application using MCG Complex Figures was in a group of 21 healthy volunteers to study the cognitive side effects of carbamazepine (Tegretol®) and phenytoin (Dilantin®; see Table 10-2). Individuals were administered a baseline neuropsychological assessment and were then randomly assigned into

Editor's Note: Overshoot and impulsive copying style may be important scoring characteristics if the MCG Figures were used as measures of other disorders, like ADHD.

Table 10-2
Performance on the MCG Complex Figures in Healthy Volunteers During Treatment With Carbamazepine (CBZ) and Phenytoin (PHT)

	Baseline 1		CBZ		PHT		Baseline 2	
	M	SD	M	SD	M	SD	M	SD
Copy	34	2	35	1	35	1	35	2
Immediate Recall	28	4	30	4	29	4	30	5
Delayed Recall	28	4	29	5	29	4	29	5

Note. $N = 21$. Mean age = 34 years (range = 21-48 years), mean education = 15 years (range = 12-22 years). MCG = Medical College of Georgia.

carbamazepine or phenytoin treatment conditions. After 1 month of treatment, they were tested again, tapered off their medication, and then switched to the other antiepileptic drug. Cognitive testing was again obtained at the end of the 1-month treatment. Although we employed a variety of different analytic measures, in part, due to the need to adjust for serum drug concentrations, Table 10-2 reveals an absence of any drug effect and the absence of any practice effect when comparing the first to the second baseline.

We have also used MCG Complex Figures to study the role of cholinergic function in visuospatial memory (Meador et al., 1993; see Table 10-3). Twelve healthy volunteers with a mean age of 31 years (range = 20-41 years) received an intramuscular injection of the anticholinergic scopolamine (0.007 mg/kg) or saline placebo in randomized counter-balanced cross-over design. Scopolamine had significant effects not only on the Immediate and Delayed Recall conditions, but also on complex figure Copy performance.

In both studies, individuals were healthy volunteers who were largely recruited from students and

staff at the Medical College of Georgia. Thus, although the performance levels that we report here may serve as a preliminary guide to expected levels, the user is cautioned that students and staff at MCG may be considered by many to be nonrepresentative of the population at large.

We have used Complex Figures to examine material-specific memory during the acute stage following anterior temporal lobectomy (ATL) in 29 patients ($L = 18$; $R = 11$). The patients averaged 33.4 years of age and had a mean level of 11.9 years of education. Patients were administered the ROCF during their preoperative neuropsychological evaluation, and MCG Complex Figure 3 approximately 1 week following surgery. No differential left-right laterality effects were present, although the patient group undergoing right anterior temporal lobectomy performed more poorly relative to left anterior temporal lobectomy group following surgery (preoperative difference = 2 points; postoperative difference = 6 points; See Table 10-4). Further, since we have subsequently shown that the Rey-Osterrieth Complex Figure can be 6 points lower than MCG Complex Figure 3, a reinterpretation of those results suggests that performance of both left and right ATL groups declined following surgery. Although no statistically significant group difference was present, a slightly greater decline in complex figure recall was present for right ATL patients.

More recently, MCG Complex Figures 2, 3, and 4 have been used in a study examining cognitive function in patients with poorly controlled seizures (average seizure frequency of 15 seizures/month; see Table 10-5). The patient sample averaged 37 years of age ($SD = 10$ years). Patients were tested twice at approximately 2 weeks apart before the antiepileptic drug topiramate (Toponax[®]) was added to the baseline antiepileptic drug therapy (monotherapy and polytherapy), and were then tested again after receiving

Table 10-3
Performance on MCG Complex Figures 1 and 2 in Healthy Volunteers During Treatment With Placebo or Scopolamine^a

	Placebo		Scopolamine	
	M	SD	M	SD
Copy	35.3	1.0	33.9	1.9
Immediate Recall	31.0	4.7	28.8	5.5
Delayed Recall	29.6	4.6	25.5	7.3

Note. $N = 12$. The figure used was counter-balanced across the two conditions, and the performance levels above are collapsed across both figures.

^a.007 mg/kg.

Table 10-4
Scores for the Rey-Osterrieth 30-Minute Delayed Recall
(Administered Pre-Operatively) and the MCG Complex Figure 3
(Administered Post-Operatively) in a Sample of Seizure Patients
Who Underwent Anterior Temporal Lobectomy (ATL)

	Left ATL		Right ATL	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Pre-Operative Scores (Rey-Osterrieth Complex Figure)	16	7	14	9
Post-Operative Scores (MCG Complex Figure 3)	19	7	13	12

Note. *N* = 29.

Table 10-5
Test-Retest Effects on the MCG Complex Figure, Collapsed Across Figures,
in a Sample of Poorly Controlled Seizure Patients

	Copy		Immediate Recall		Delayed Recall	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Baseline 1	34.0	2.9	21.5	7.4	21.0	7.3
Baseline 2	34.0	2.9	21.8	7.6	21.0	7.4
<i>SD</i> of Difference Scores	2.6		6.2		5.6	

Note. *N* = 162.

topiramate. The two baseline assessments on stable antiepileptic drug therapy prior to adding topiramate provide the opportunity to examine both form equivalence, and practice effects associated with repeated exposure.

The sample described here differs slightly in composition from the final sample included in the topiramate study because we included all patients with two baselines whether or not they completed the add-on phase of the study. Deviations from the final sample for the add-on analysis were not anticipated to be systematically different, however, and we felt the loss of demographic precision was more than offset by the larger sample available for MCG Complex Figure analysis. The two baselines can be conceptualized as an incomplete block design since only two of the three MCG Complex Figures were administered to any one patient; the specific figures were randomized.

Our first analyses were conducted to identify possible practice effects, and these data are included

in Table 10-5. No practice effect was present, with equivalent performance on both the first or second complex figure administration. To facilitate individual patient interpretation, we have included standard deviations of the difference scores between the two variables in Table 10-5. Based upon the absence of significant practice effects, we formed summary scores by collapsing performance across the first and second assessments, and obtaining a mean of those two conditions (See Table 10-6). This was done to increase the sample size, thereby increasing the stability of the measurement, and to minimize the effect on our results that possible subject inclusion differences might have—since only two thirds of the patients received any specific MCG Complex Figure version. In this sample, there appears to be good equivalence between MCG Complex Figures 2 and 4, with memory performance of MCG Complex Figure 3 being poorer by approximately 2 points, which is smaller than the test-retest variability. In contrast to our initial study of healthy adults, comparable performance variability was present for all three figures.

Table 10-6
Comparison of MCG Complex Figures 2, 3, and 4
in Patients With Poorly-Controlled Seizures

	MCG Complex Figure 2 ^a		MCG Complex Figure 3 ^b		MCG Complex Figure 4 ^c	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Copy	33.6	2.3	33.6	2.3	34.6	2.4
Immediate Recall	22.8	7.4	19.8	7.8	22.2	6.8
Delayed Recall	22.2	7.7	19.4	7.2	21.5	6.8

^a*n* = 110. ^b*n* = 113. ^c*n* = 101.

Summary

The MCG Complex Figures have demonstrated value in repeated-measure designs. As has been the case with both the Rey-Osterrieth and Taylor figures before, many additional reliability and validity studies will need to be performed. Our experience, however, suggests that these figures fill a much needed void for those wishing to perform serial assessments of complex visual construction and visual memory function.

Acknowledgment

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Appendix 10-A Medical College of Georgia (MCG) Complex Figures

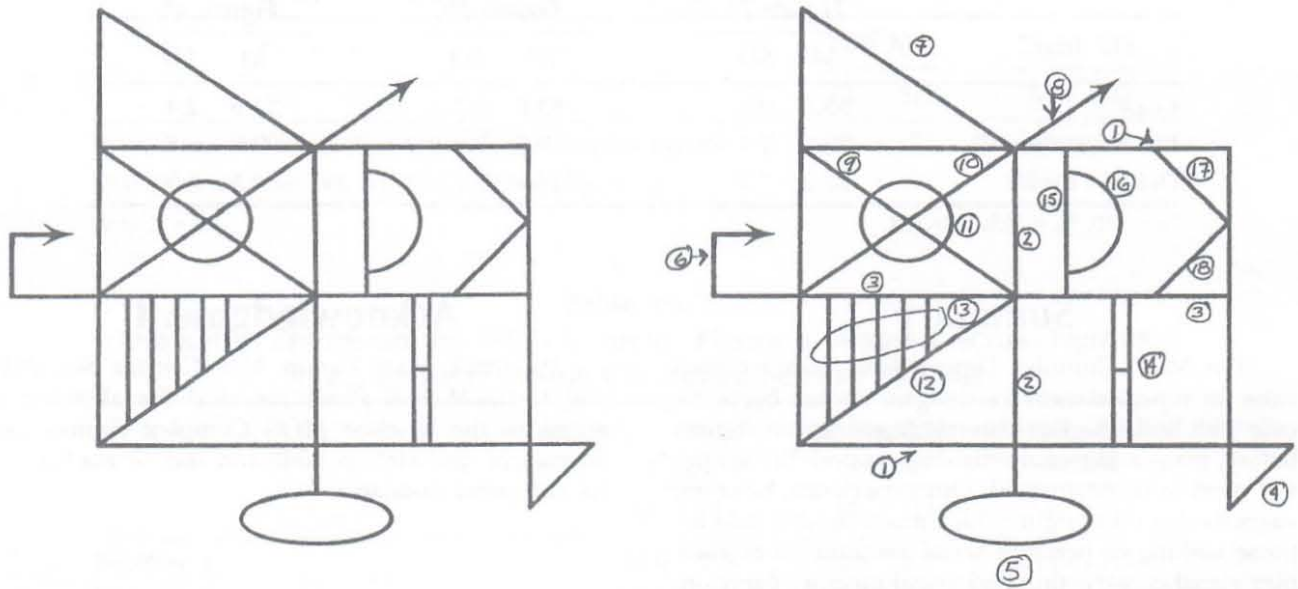


Figure 10-A1. Medical College of Georgia Complex Figure 1 with marked scoring elements. Copyright © 1988, 1989, 1990 by Kimford J. Meador, Howard S. Taylor, and David W. Loring. All rights reserved. Reproduced by permission.

MCG Complex Figure 1 Scorable Elements

1. Large rectangle
2. Vertical midline of 1
3. Horizontal midline of 1
4. Small triangle on the outside right hand corner of 1
5. Oval with attaching line at the bottom of 1
6. Bent arrow to the middle-left of 1
7. Triangle above left upper quadrant of 1
8. Tilted arrow at top of 1
9. Diagonal in upper left quadrant of 1 (top left - lower right)
10. Second diagonal in left quadrant of 1 (bottom left - upper right)
11. Circle in upper left quadrant of 1
12. Diagonal in lower left quadrant of 1
13. Five vertical lines in lower left quadrant extending above 12
14. Vertical lines and small horizontal connection line ("H") in lower right quadrant of 1
15. Vertical line in right upper quadrant of 1
16. Semicircle attached to the right of 15
17. Diagonal line at upper right corner of upper right quadrant in 1
18. Diagonal line in upper right quadrant extending from 17 to 3

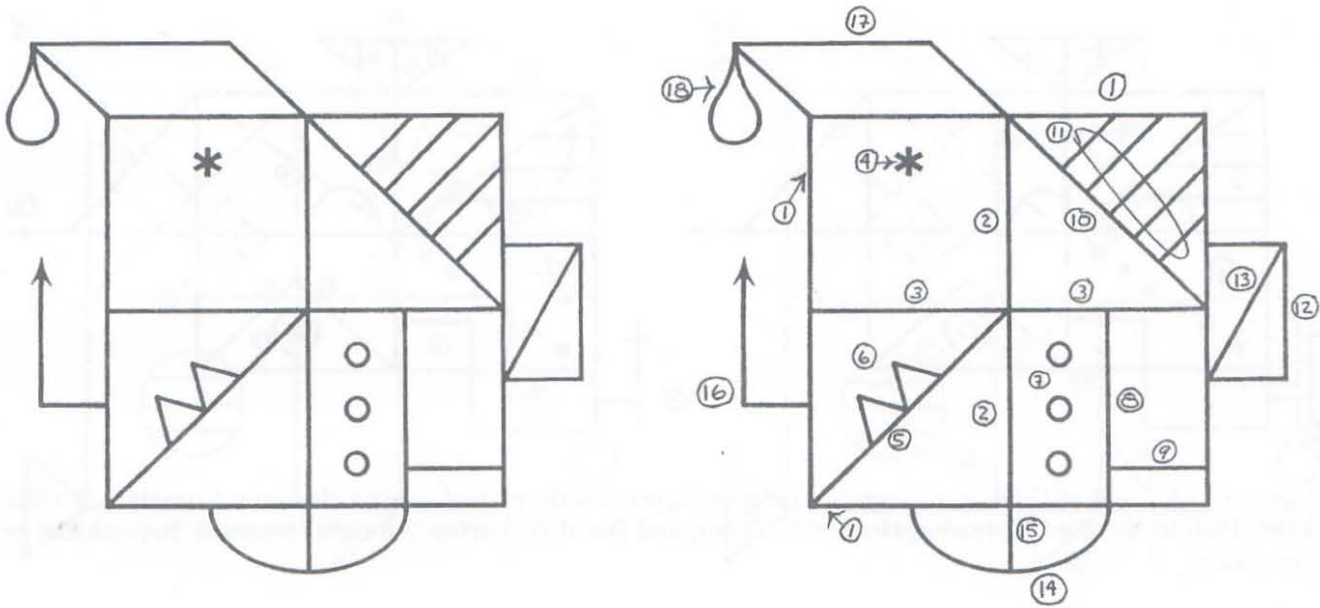


Figure 10-A2. Medical College of Georgia Complex Figure 2 with marked scoring elements. Copyright © 1988, 1989, 1990 by Kimford J. Meador, Howard S. Taylor, and David W. Loring. All rights reserved. Reproduced by permission.

MCG Complex Figure 2 Scorable Elements

1. Large square
2. Vertical midline for 1
3. Horizontal midline for 1
4. Asterisk in the upper left quadrant of 1
5. Diagonal in the lower left quadrant of 1
6. Two triangles attached to 5
7. Three circles in the lower right quadrant of 1
8. Vertical midline in the lower right quadrant of 1
9. Horizontal line to the right of 8
10. Diagonal line in the upper right quadrant of 1
11. Five diagonal lines perpendicular to 10
12. Small rectangle to the right of 1
13. Diagonal line in rectangle 12
14. Semicircle at the base of 1
15. Vertical line in 14
16. Angled arrow to the left of 1
17. Parallelogram above 1
18. Teardrop attached to the left of 17

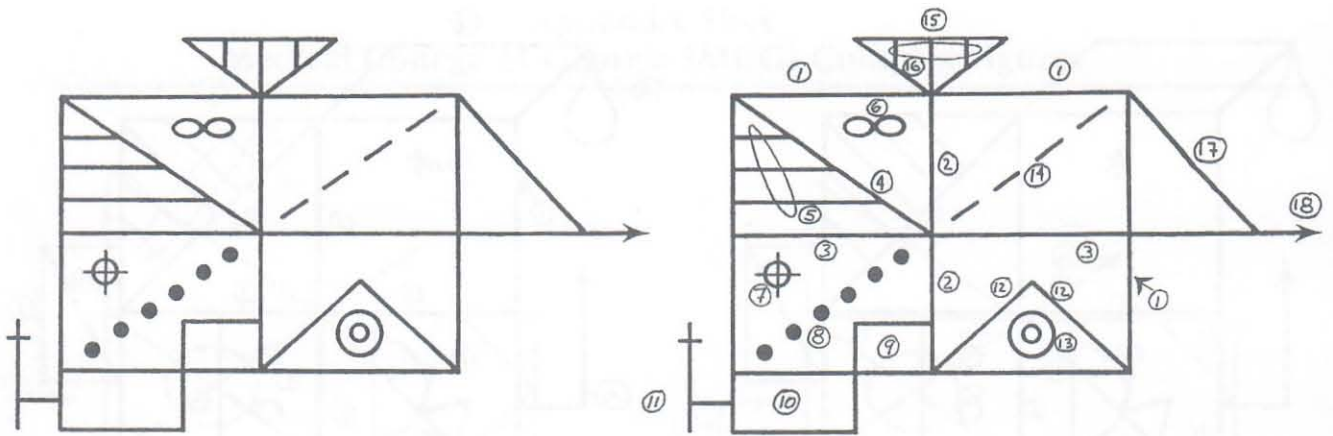


Figure 10-A3. Medical College of Georgia Complex Figure 3 with marked scoring elements. Copyright © 1988, 1989, 1990 by Kimford J. Meador, Howard S. Taylor, and David W. Loring. All rights reserved. Reproduced by permission.

MCG Complex Figure 3 Scorable Elements

1. Large rectangle
2. Vertical midline of 1
3. Horizontal midline of 1
4. Diagonal line in left upper quadrant of 1
5. Three horizontal lines extending to 4
6. Infinity sign in left upper quadrant of 1
7. Circle and cross in lower left quadrant of 1
8. Six diagonal dots in lower left quadrant of 1
9. Small rectangle in lower left quadrant of 1
10. Small rectangle extending from bottom of 1
11. Cross attached to 10
12. Right angle in lower right quadrant of 1
13. Two concentric circles placed under 12
14. Four dashed lines in upper right quadrant of 1
15. Triangle atop 1
16. Three vertical lines in 15
17. Triangle to the right of 1
18. Arrow attached to the right of 17

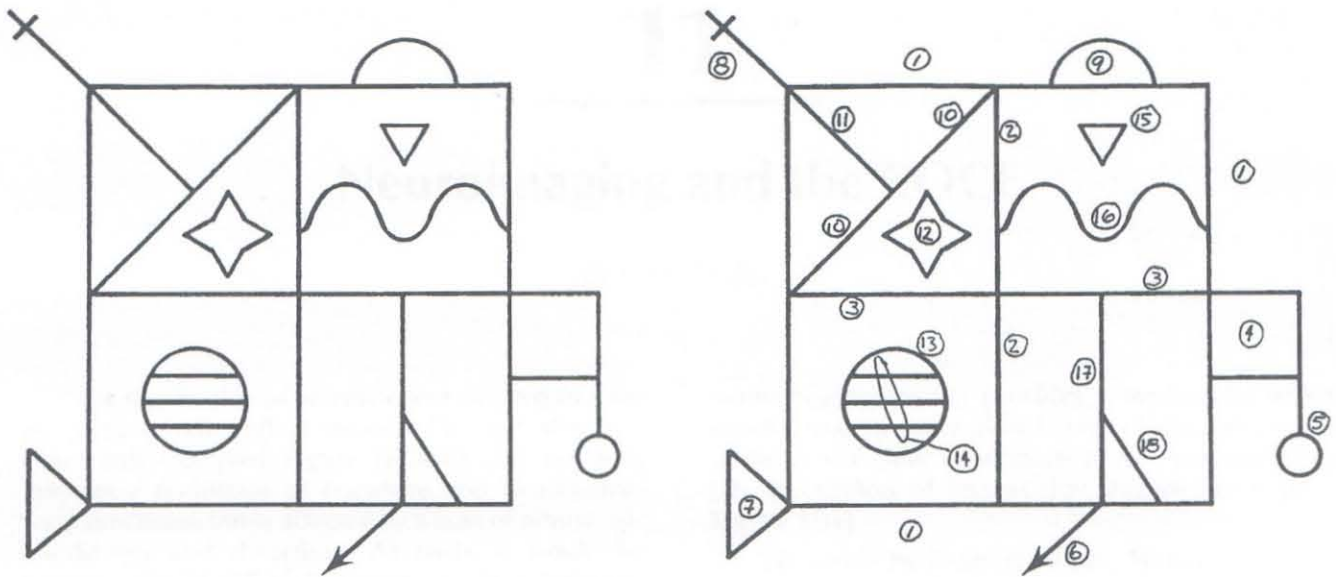


Figure 10-A4. Medical College of Georgia Complex Figure 4 with marked scoring elements. Copyright © 1988, 1989, 1990 by Kimford J. Meador, Howard S. Taylor, and David W. Loring. All rights reserved. Reproduced by permission.

MCG Complex Figure 4 Scorable Elements

1. Large square
2. Vertical midline of 1
3. Horizontal midline of 1
4. Rectangle to the right of 1
5. Circle, with stem, attached to 4
6. Angled arrow attached at bottom of lower right quadrant
7. Small triangle outside lower left corner of 1
8. Cross outside of upper left corner of 1
9. Semicircle on top of 1
10. Diagonal line in the upper left quadrant of 1
11. Perpendicular line to 10
12. Star in the upper left quadrant of 1
13. Circle in the lower left quadrant of 1
14. Three horizontal lines inside of 13
15. Small triangle in upper right quadrant of 1
16. Sine wave in upper right quadrant of 1
17. Vertical midline in the lower right quadrant
18. Diagonal line extending to the right of 17