Clinical and empirical applications of the Rey–Osterrieth Complex Figure Test

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The Rey–Osterrieth Complex Figure Test (ROCF), which was developed by Rey in 1941 and standardized by Osterrieth in 1944, is a widely used neuropsychological test for the evaluation of visuospatial constructional ability and visual memory. Recently, the ROCF has been a useful tool for measuring executive function that is mediated by the prefrontal lobe. The ROCF consists of three test conditions: Copy, Immediate Recall and Delayed Recall. At the first step, subjects are given the ROCF stimulus card, and then asked to draw the same figure. Subsequently, they are instructed to draw what they remembered. Then, after a delay of 30 min, they are required to draw the same figure once again. The anticipated results vary according to the scoring system used, but commonly include scores related to location, accuracy and organization. Each condition of the ROCF takes 10 min to complete and the overall time of completion is about 30 min.

INTRODUCTION

The Complex Figure Test was originally designed by Rey[1] as a means of evaluating visuospatial constructional ability and visual memory in brain-injured patients. Three years later, Osterrieth[2] invented a scoring system to standardize Rey's administration procedure and provided initial normative data on 230 children and 60 adults. Thereafter, this stimulus and procedure has been referred to as the Rey–Osterrieth Complex Figure Test (ROCF) and it is one of the most widely used neuropsychological tests for the evaluation of visuospatial constructional ability and nonverbal memory skills under both clinical and research settings[3]. Reproducing the ROCF is a complex cognitive task, which involves the ability to organize the figure into a meaningful perceptual unit. Therefore, the ROCF is considered to be a useful tool for the evaluation of frontal lobe function, which is required for strategic planning and organizing[4].

The ROCF task involves copying a complex geometric figure and then reproducing it from memory, either immediately, following a delay or both. Because of its popularity, many variations in ROCF administration have been reported, the main differences among studies being the presence or absence of Immediate Recall trials and the timing of the Recall trials[5–9]. It is important to note, however, that an Immediate Recall condition preceding a Delayed Recall condition may result in a higher score than if a Delayed Recall condition only is given[6,10].

The ROCF provides data about individual neuropsychological functions and brain dysfunctions, including attention and concentration levels, fine-motor coordination, visuospatial perception, nonverbal memory and organizational skills[11]. By analyzing the patients' performance, it is possible to effectively evaluate their neuropsychological dysfunction. In the Copy condition of the ROCF, successful copying of the figure requires sufficient attention and concentration; visuospatial perception for identifying the figure element and processing visual information; visual-motor function; and planning and organizational abilities, which aid in the executive skills, which are related to the right occipital–parietal lobe and the prefrontal lobe[6,12,13].

Performance on the two recall conditions helps the examiner to assess the visuospatial memory within declarative memory, which is related to the hippocampus and associated regions in the right temporal lobe[6,14,15]. Comparing performances between the Immediate Recall and the Delayed Recall/Recognition conditions enables differentiation of the encoding, storage and retrieval phases of the memory process. Long-term memory is defined as the ability to learn and retain new information, in which neuropsychologists distinguish between the specific ability to register information (encode), organize the information in a meaningful way (storage) and recall or recognize the information when needed (retrieval)[16]. Patients showing low performance in the Immediate Recall condition and, more accurately, in the percentage retention score between Copy and Immediate Recall conditions, may have some deficits in the encoding phase of their memory process. Patients with difficulties in the storage phase tend to show average or impaired performance in the Immediate Recall condition, but their performance worsens further in the Delayed Recall condition. This is commonly observed as low performance in a percentage retention score between Immediate and Delayed Recall conditions. Some patients with retrieval deficits may retain latent knowledge, but may be unable to access it readily. They show lower scores for Delayed Recall compared with delayed recognition (multiple-choice options), which indicates problems with retrieval in spite of relatively intact storage ability.

It is important to consider hemisphere dominance in interpreting the ROCF results. In most individuals with no known impairments, language functions are concentrated in the left hemisphere, in contrast to the right hemisphere, which is specialized for visuospatial functions. In addition, because the two hemispheres differ in their information-processing capacities, patients with unilateral lesions show different constructional tendencies. Patients with right hemisphere dysfunction tend to take a piecemeal, fragmented approach, losing the overall gestalt of the stimuli[6]. They will typically focus on reproducing the small stimuli without appreciating the larger configuration that they form[17]. In contrast, patients with left-sided lesions may get the overall idea and proportions of the construction correct and their drawings may be symmetric, but they tend to omit details and ignore the smaller internal stimuli[6,17].

According to Binder's study[18], patients with left-hemisphere damage tend to break up the design into units that are smaller than normally perceived, whereas right-hemisphere damage makes it more likely that elements will be omitted altogether. Laterality differences emerge on Complex Figure Test recall trials. Patients with left-hemisphere damage tend to reproduce the basic rectangular outline and the structural elements as a configural whole, indicating that their processing is slow but ultimately reconstitutes the data as a gestalt, whereas patients with right-hemisphere damage continue to construct poorly integrated figures on recall trials. Rapport and colleagues[19,20] reported that measures of omission are more sensitive to the neglect phenomena that can accompany right-hemisphere damage, whereas accuracy scores are not as sensitive. Thus, the frequency of errors does not seem to relate to the sensitivity of specific hemisphere lesions as much as the qualitative features of these errors[12,18,21,22]. Historically, various scoring systems have been developed for the ROCF, including the traditional Osterrieth method (a quantitative scoring system) and a qualitative scoring system. The 36-point system that was originally developed by Osterrieth[2] is based on the presence and accuracy of 18 elements of the ROCF. However, it has limitations in evaluating qualitative components that reflects the organizational ability and executive functions that are required to understand the structural and design integrity of figures. Consolidation, which refers to the hypothesized process of reorganization within representations of stored information[23], is important in storing information as long-term memory. Executive/organizational functions help to organize randomized stimuli into a meaningful cluster so that consolidation (learning) can be facilitated and the memory process can be influenced. Several studies have shown that organizing the ROCF into a meaningful perceptual unit during the Copy condition enhances its subsequent recall from memory[24–27].

Qualitative scoring systems have demonstrated the multidimensional characteristics of the ROCF. Based on protocols of 454 children, Waber and Holmes[27] found that children at a younger age typically organize the left side of the figure accurately; as they mature, the right side becomes better integrated. This developmental progression is captured by the Developmental Scoring System (DSS) for the ROCF. The children with high organization levels tend to use the basic large rectangle as the prominent organizational–structural component. Waber and Holmes[27] interpreted this as meaning that children of an older age deal with information using logic, which is almost consistent with the cognitive developmental theory of Piaget[28], in which the cognitive development of children progresses from the concrete operational stage to the formal operational stage. The DSS measures four parameters (organization, style, accuracy and errors) of the ROCF performance, and provides objective quantification of a child's individual organization and stylistic approach to the ROCF. This allows a description to be made of the child's standing relative to broadly conceived age-referenced expectations[29]. The ROCF Copy scores increase with age and reach adult level at age 13 (ref. 30), after which no change occurs[31,32].

The Boston Qualitative Scoring System (BQSS) provides well-defined criteria for a comprehensive series of scores that are thought to assess visuo-constructional ability and executive functioning, predominantly for adults[33]. The executive function variables of the BQSS represent planning, fragmentation, confabulation and perseveration. These variables were found to be significantly correlated with the traditional executive measures, including the perseverative errors on the Wisconsin Card Sorting Test and the total number of words on the Controlled Oral Word Association Test[3]. The BQSS has been effective for identifying patients with Parkinson's disease, obsessive–compulsive disorder (OCD), and for individuals with frontal lesions who tend to use a more disorganized approach when copying the ROCF and show lower recall of the figure than healthy controls who use a more systematic approach[34–36].

In the ROCF qualitative scoring systems, such as DSS and BQSS, colored markers and/or flowcharts are used to track a respondent's performance sequentially, which enables the scoring and estimation of qualitative features of visual organization ability or executive functioning. In contrast, in the ROCF quantitative system, only one marker is used. Unlike most of the scoring system, the Immediate Recall condition proposed by Meyers and Meyers[7] is administered 3 min after the Copy condition and, during the intervening 3 min, a verbal task, such as a controlled verbal fluency task, is administered. The time interval between the Immediate Recall and the Delayed Recall varies according to scoring systems, from 15 to 60 min. However, the most commonly used time interval between the Immediate and Delayed Recall is 30–45 min[9]. In addition, Meyer and Meyer[7] suggested that tasks involving visuospatial stimuli should not be administered between the Copy trial and the Recall trial; instead, verbal tasks should be administered.

Psychometric properties of each scoring system are described in the following paragraphs. In the quantitative scoring system[7], the inter-rater reliability coefficients ranged from 0.93 to 0.99 for total raw scores, with a median inter-rater reliability coefficient of 0.94. In addition, the test-retest correlations of the Immediate Recall, Delayed Recall/Recognition total correct were 0.76, 0.89 and 0.97, respectively. By correlating the ROCF scores with measures derived from the Wechsler Adult Intelligence Scale-Revised (WAIS-R) and from neuropsychological tests, it was revealed that the ROCF is a measure of visuoconstructional ability (Copy) and visuospatial memory (Recall). Although the results of the BQSS studies indicated good to excellent inter-rater reliability[23,33], the 1-year test-retest reliability was moderate in a sample of elderly participants[37]. The Pearson correlation between the BQSS Copy Presence and Accuracy (CPA) Summary scores and the Osterrieth's scores was 0.95, indicating excellent convergent validity for the BQSS CPA score[37]. A series of investigations examined the discriminant validity of the BQSS, including studies of participants with disorders, such as traumatic brain injury, dementia, attention deficit hyperactivity disorder (ADHD) and alcohol abuse[33]. However, additional studies need to be conducted to conclude the extent of BQSS's ability to discriminate between patient groups and healthy controls, and among different patients groups. In the DSS[27], reliability was 0.95 for Copy production and 0.94 for the Recall production. Reliability for the style rating was 0.88 for Copy production and 0.87 for Recall production. This revealed that the DSS can discriminate pathological populations from the normative sample and other control groups. Populations studied included those consisting of individuals with developmental disorders such as learning disabilities and ADHD, sensory deficits such as deafness, and neurodevelopmental disorders such as myelodysplasia and acquired head injury[27].

Until now, there has been a lack of strong evidence to indicate which system is superior. Osterrieth's original system has definite advantages in terms of standardization and availability of norms, whereas norms for all the qualitative systems are limited[11]. However, a number of studies indicate that the use of the qualitative scoring system will increase the utility of the ROCF in differentiating right-hemisphere from left-hemisphere dysfunction, and will also result in more selective localization of the dysfunction to the temporal lobes when the qualitative measures are used on the Delayed Recall trial[11]. Furthermore, the qualitative system will be useful in evaluating executive/organizational functions and the impact on memory and a child's developmental trend regarding organizational ability[4,24–27].

Professional manuals for administration, qualitative scoring and interpretation of the ROCF production and normative data have also been published. The stimulus card, booklet and manual for the BQSS[33], the Rey Complex Figure Test and Recognition Trial[7] and the DSS for the ROCF[27] have been published and can be purchased through Psychological Assessment Resource, Inc. (PAR: http://www3.parinc.com).

Similarly, the ROCF measures a variety of cognitive abilities, and the various systems have been developed for scoring them. Thereby, many studies using the ROCF have been conducted and have proven the clinical usefulness of the ROCF.

First, the ROCF has been used to evaluate visuospatial memory in various neurological and psychiatric disorders. Many studies[38,39] have demonstrated the association of memory impairment with temporal lobe epilepsy or temporal lobe surgery, and the ROCF performance of patients with right temporal lobe epilepsy is expected to show significant reductions in visuospatial memory, unlike in left temporal lobe seizures and normal control groups. The memory problems of the latter are attributed to an inability to transfer new information into a long-term storage system. Some studies[40], however, have found that visual memory is less lateralized than verbal memory, so these results are controversial. Patients with frontal lobe dysfunctions also have difficulties in copying and recalling the ROCF due to attention problems or deficits of appropriate strategies that are required to facilitate encoding of the information[41,42]. In addition, patients with Parkinson's disease are unable to correctly copy complex figures, such as those in the ROCF, due to frontal lobe dysfunction, and they show impairment of visuospatial memory function[43,44].

Meanwhile, individuals with schizophrenia did not differ from the healthy control group in the ROCF Copy condition, but they performed poorly in the ROCF Recall condition[45]. These results are consistent with the view that schizophrenia patients primarily have problems related to temporal lobe dysfunction, in which association of external stimuli with their semantic meanings is impaired[46,47]. In addition, many studies have increased the clinical usefulness of the ROCF in various psychiatric patients, including those with depressive disorder[48–50], bipolar disorder[51], post-traumatic stress disorder[52], acute stress disorder[53] and chronic burnout syndrome[54].

Recently, it has been revealed that the ROCF involves planning and organizational strategy, and thereby the ROCF has been used as a useful tool for measuring executive function.

Savage *et al.*[24] conducted a study on organizational deficit in OCD patients using the ROCF and demonstrated, for the first time, the relationship between nonverbal memory dysfunction and the deficit of planning and organizational strategy in OCD patients. They found that immediate nonverbal memory problems in OCD patients are mediated by impaired planning and organizational strategies that are activated during the copying phase of the ROCF, which indicates that the primary deficit of OCD patients is planning and organizational ability, leading to nonverbal memory problems.

However, because these studies have measured the organizational strategies with a quantitative scoring system, they have not been able to comprehensively evaluate the executive functions that are required for performing the ROCF. Shin *et al.*[55] examined the relationship between nonverbal memory dysfunction and the deficit of planning and organizational strategy in OCD patients using the BQSS to provide both qualitative and quantitative measures of the ROCF.

The usefulness of the ROCF has been verified in many areas other than the clinical field, including developmental research. Many studies[56–58] have used the developmental scoring system of the ROCF (DSS) and have revealed the cognitive function of children with neuropsychological deficits, such as ADHD, learning disorders and tic disorders. They indicate that the ROCF could aid in finding organizational deficits in childhood neurodevelopmental disorders and in assessing a child's developmental trend regarding organizational ability.

Several other instruments can help to evaluate cognitive functions similar to those elucidated by the ROCF. Some instruments may be adopted to evaluate visuospatial constructional ability, including the Bender Visual Motor Gestalt Test[59], the Developmental Test of Visual-Motor Integration[60], the Hooper Visual Organization Test[61] and the Block Design and Object Assembly of WAIS-III[62]. The Visual Reproduction of Wechsler Memory Scale-III[63], the Benton Visual Retention Test[64], the Biber Figure Learning Test[65] and the Visual Spatial Learning Test[66] can evaluate visuospatial memory. To access executive function, various tests are available, such as the Wisconsin Card Sorting Test[67], the Object Alternation Test[68], the Stroop Test[69], the Verbal Fluency Test[70], the Design Fluency Test[71] and the Tower of London Test[72].

The complexity of the ROCF for a client completing the task is regarded as both its strength and its weakness. The ROCF has demonstrated sensitivity to unilateral brain damage in the right hemisphere[6,73,74]. Lee *at al.*[74] suggested that visual memory tests would be more likely to be sensitive to right temporal lobe damage if they consisted of "unfamiliar, complex, and difficult-to-verbalize visual stimuli" (p. 196). Compared with the Taylor complex figure[75] that is used for parallel form, the ROCF seems to have nothing to do with verbal mediation. Recent research has also shown that the developmental trend of organizational ability in the ROCF demonstrates the functional developmental process of the frontal lobe[27,29]. The ease of administration and the low cost of materials that are required for the ROCF are considerable advantages. The commercial availability of a manual, materials and a recognition trial should help to improve the usefulness of the ROCF – in practice, as well as in research[11]. However, as the complexity of the stimulus figure of the ROCF requires an integrative cognitive ability, it is likely that researchers will vary in terms of practicing the ROCF and scoring it[11]. Thus, a poor score on the ROCF would need to be carefully interpreted, as with other neuropsychological tests.

This protocol introduces, comprehensively, four representative scoring systems, including the quantitative scoring system, the BQSS, the DSS and Savage's scoring system. Based on this guidance, researchers will be able to select and use the ROCF scoring system to suit their purpose. In particular, as strategic planning and organizing is required for reproducing the ROCF, it is emphasized that the ROCF would be helpful for the evaluation of executive function that is mediated by the prefrontal lobe, as well as visual construction ability and visuospatial memory.

To avoid repetition, only the administration procedure for the BQSS[33] for three conditions, which is the most commonly used scoring system for clinical and research purposes, is presented in the Procedure section, plus the Recognition condition[7].

MATERIALS

SUBJECTS

- Human subjects **! CAUTION** The study protocol for research purposes must be approved for use by the appropriate Human Subjects Committee or Institutional Review Board. Informed consent must be obtained following the established institutional and national guidelines.

EQUIPMENT Writing materials: colored or black pens, pencils or felt-tip markers, according to the examiner's purpose

- Stop watch

EQUIPMENT SETUP

Stimulus card and booklet for scoring ROCF materials have some variation according to the scoring system being used, but they commonly include the stimulus card (stimulus figure) and the booklet for scoring. The stimulus card is a complex geometric figure that consists of rectangles, triangles, crosses and various other details. Many variations of Rey's[1] original complex figure have been presented in the research literature, and photocopies of original figures have exhibited increasing distortion[7]. Some professionals[7,33,76] have published professional-quality reproductions of the original figure and booklet commercially. These figures reveal slight differences in size and line quality, but are presented on 8 × 11-inch sheets.

The published booklet commonly includes a summary page for recording the raw scores and the associated standardized scores, and for profiling selected scores. It also includes other pages that record scoring of Immediate Recall, Delayed Recall and/or Recognition. In addition, a flowchart is provided for the examiner to draw on simultaneously with the respondent and to make notes during the Copy, Immediate Recall and Delayed Recall conditions.

PROCEDURE

Copy condition (the BQSS)[33]

1| Place the stimulus and the blank response sheet horizontally on a table in front of the respondent. Be prepared to provide the respondent with a series of colored markers, and/or to keep a stroke-by-stroke flowchart of their work.
▲ CRITICAL STEP Colored markers should be avoided for individuals who are easily distracted, who are susceptible to stimulus pull, or who display other clinical difficulties that could result in undue bias by switching markers; in these cases, only the flowchart is used.

2| Give oral instructions as follows: "I'm going to ask you to copy this figure. You don't have to be a great artist; I just want you to copy it as carefully and as accurately as you can. I'm going to be giving you different colored markers to draw with, so each time I hand you a new marker, just switch markers with me. The colored markers are only used so that I can remember how you're drawing the figure; you don't have to worry about which colors you use. There is no time limit, so take as much time as you need to draw the figure as carefully and as accurately as you can. You may begin now."
▲ CRITICAL STEP If you use a flowchart instead of colored markers, remove the oral instruction referring to switching colored markers.

3| Begin timing the session as soon as the oral instructions have been given. If the respondent attempts to rotate the stimulus card or the blank response sheet prior to drawing, return it to its original horizontal orientation. However, if the respondent rotates the stimulus card after drawing has started, let the subject have his or her own way and record the rotation.

4| Track the pen stroke order. This step can be done in two ways, using colored markers or a flow chart. You can use either one, or both. When using colored markers, switch the colored markers when the respondent: starts to draw an element, but before completing it, begins to draw another element; pauses while drawing; fragments an element of the figure; or commits other pertinent planning errors (Stern *et al.*[33] noticed that it was not useful to switch markers using a previously decided time period, e.g., every 30 s). Switching markers should never force fragmentation while the respondent is in the middle of or drawing an element. When using a flowchart, track the respondent's renditions of the figure while the respondent is copying the stimulus, either instead of, or in addition to, the use of colored markers. The use of colored markers provides a rich visual record of the order of pen stroke, but a flowchart may be more accurate and complete than colored markers in depicting the order of pen strokes. The decision as to which method to use is based in part on the respondent's characteristics and in part on the examiner's preference.

5| When the respondent has completed the task, record the time taken to make the copy and remove both the ROCF stimulus card and the response copy production.

6| Do not tell the respondent that he or she will be asked to reproduce the figure again at a later stage.

Immediate Recall condition (the BQSS)[33]

7| Place a new blank response sheet horizontally in front of the respondent, as soon as the Copy trial has ended.

8| Begin the following oral instruction immediately after placing the response sheet on the table: "Now I'm going to ask you to draw the figure again from memory. I'm still going to be switching markers with you, and you don't have to worry about which colors you use. Again, take as much time as you need to draw the figure as carefully and as accurately as you can. Please begin."

9| Begin timing the respondent's performance and tracking the stroke order using an identical process to that used in the Copy condition.

10| When the respondent has completed the task, record the time required to complete this Immediate Recall and remove the response production.

Delayed Recall condition (the BQSS)[33]

11| After waiting 20–30 min, place a new blank response sheet horizontally in front of the respondent.

12| Perform the following oral instruction: "A little while ago I asked you to copy a figure. Now I'm going to ask you to draw the figure again from memory. I'm still going to be switching markers with you, and you don't have to worry about which colors you use. Again, take as much time as you need to draw the figure as carefully and as accurately as you can. Please begin."

13| Time the respondent's performance and track the stroke order using an identical process to that in the Copy condition.

14| When the respondent has completed the task, record the time taken for the Delayed Recall and remove the response production.

Recognition condition (Rey Complex Figure Test and Recognition Trial)[7]

15| After the Delayed Recall trial, place the recognition response sheets and pen on the table.

16| Give the following oral instruction: "Some of the designs that are printed on this page are part of the larger figure that I asked you to copy earlier. Circle the figures that are part of the larger design you copied. Each figure on these pages is facing the same direction as in the original, complete design. There are four pages, and the designs are numbered 1 to 24. Please begin."

● TIMING

Overall time of administration: about 40–60 min
Copy: varies according to the respondent's speed to copy, but it is usually completed in approximately 10 min
Immediate Recall and Delayed Recall: varies according to respondent's speed of drawing, but approximately 10 min
Interval of Immediate Recall and Delayed Recall: approximately 20–30 min

ANTICIPATED RESULTS

Various scoring systems that yield both quantitative and qualitative indices of the ROCF performance have appeared in the literature. The scoring and interpretation methods of published four scoring systems are presented here.

The Quantitative Scoring System[1,7]

In Rey's scoring system[1], the ROCF stimulus is divided into 18 units and each unit is scored separately in terms of both accuracy and placement. Meyers and Meyers[7] developed the standardized approach to scoring of the ROCF based on the scoring criteria of Rey[6]. **Table 1** presents the general scoring criteria of Meyers and Meyers[7] for drawing the ROCF. Unit scores are summed to obtain the raw score of drawing; thus, raw scores ranging from 0.0 to 36.0 may be obtained for the Copy, Immediate Recall and Delayed Recall conditions. Standardized T scores based on age are also obtained. A low Copy score indicates reduced visual-perceptual and visuomotor integration skills, and low Immediate Recall and Delayed Recall scores suggest reduced visuospatial recall ability. Additionally, information about encoding patterns and storage processes can be obtained through profiling analysis. For example, a high Immediate Recall score combined with a low Delayed Recall score indicates a disrupted memory storage process.

The BQSS[33]

The BQSS provides 17 dimensions of qualitative scores and six summary scores based on these dimensions. The 17 dimensions include Presence; Accuracy; Placement; and Fragmentation, in which low scores indicate a piecemeal approach to the

TABLE 1 | Scoring criteria for ROCF drawing[7].

Score	Accuracy	Placement
2	Accurately drawn	Correctly placed
1	Accurately drawn	Incorrectly placed
1	Inaccurately drawn	Correctly placed
0.5	Inaccurately drawn, but recognizable	Incorrectly placed
0	Inaccurately drawn and unrecognizable, or omitted	Incorrectly placed

figure and poorly integrated elements. Configural Presence, Cluster Presence and Detail Presence are evaluated for Presence. Configural Element and Clusters are evaluated for Accuracy. Cluster Placement and Detail Placement are evaluated for Placement; Planning, which measures overall planning ability based on the drawn order of the elements; Neatness, which indicates how neatly the figure was drawn by the number of wavy lines, gaps, overshoots and cross-outs; Vertical Expansion, Horizontal Expansion and Reduction, which measure size distortion; Rotation; Perseveration; Confabulation, which is a rating of additions to the figure, such as the intrusion of a previous visuospatial task or a novel addition to the figure; and Asymmetry, which is the comparison of distortion and/or lack of details on the right and left sides of the figure.

The six summary scores include Presence and Accuracy Scores, which are quantitative scores as a global assessment of impairment; Immediate Retention, which represents the percentage of information lost or gained from the Copy to the Immediate Recall conditions, based on the Presence and Accuracy summary scores; Delayed Retention, which represents the percentage of information lost or gained from the Immediate to the Delayed Recall conditions; Organization, which evaluates Fragmentation and Planning, and provides a more general organizational estimate.

The DSS[27]

Three scores (Organization, Accuracy and Errors) and a rating for Style under three conditions are obtained. Organization scores based on criteria features of the ROCF range from 1 to 13 and a high score indicates a highly organized and accurate reproduction. According to the organization score, basal organization level, which refers to children's developmental level of visual organization, is determined.

A style score is derived from the weightings of the features that are present in the child's production and that are dependent on the basal organization level. There are three main style categories (Part-oriented, Intermediate and Configurational), and two subcategories within the Intermediate category (Outer Configuration/Inner Part and Outer Part/Inner Configuration), providing a general indication as to whether the child's cognitive style favors broad perspective over details, or vice versa. In general, Part-orientation is more typical of younger children and, with increasing age, the production of children becomes more configurational. Thus, style ratings provide a useful indication of developmental trends.

Accuracy scores are a count of the number of line segments of the ROCF that are represented in the child's production out of 64 segment units. The 64 units are grouped by figural category, consisting of the base rectangle and the main substructures that yield a Structural Elements Accuracy Score, and the outer configuration structures and internal details that yield an Incidental Element Accuracy Score. In the Copy condition, the accuracy score indicates the goodness of performance for a child in organizing, monitoring and reproducing the material. In the Recall conditions, with age, children recall the structural elements relatively better than the incidental elements, which indicates a developmentally improved ability to perceive the underlying organizational framework and to use this framework to facilitate recall.

The total error score is the number of errors made, the sum of rotation errors, perseveration errors, misplacement errors and conflation errors. A high score may mean poorly developed metacognitive strategies and confusion about how the elements of the figure are related to one another. In recall conditions, high error scores may reveal that the material is distorted in memory.

Savage's Scoring System[24]

Two Scores (Construction accuracy and Organization strategy) are obtained. Construction accuracy is quantified using a scoring system that was developed by Denman (1987), in which 24 segments of the figure are evaluated, using criteria such as sector location, line angles, line length and line number. Each segment has three criteria, each of which is assigned one point. Score ranges from 0 to 72 and high scores indicate good ability to construct and recall visual details, rather than how well the component is organized.

Organizational strategy includes quantitative analysis and descriptive analysis of organizational sequence. In quantitative analysis, five elements (base rectangle, diagonals, vertical midline, horizontal midline and vertex of triangle) are evaluated and assigned one point for each, except for base rectangle. Base rectangle is assigned two points, as it is important for the fundamental organization of the figure. Score ranges from 0 to 6 and high scores indicate a good ability to organize. In descriptive analyses of organization sequence, subjects who start figure construction with details are identified. Details are components other than the five basic configural units. In this case, the next two constructed units are further examined to evaluate whether the subject eventually produced one of the five configural units. This provides information about early organizational sequence.

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Corrigendum: Clinical and empirical applications of the Rey–Osterrieth Complex Figure Test

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