COPYING STRATEGY ON THE REY-OSTERRIETH COMPLEX FIGURE TEST: PERFORMANCE IN NORMAL ADULTS

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DIANE J. MAILLET

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Diane J. Maillet

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Department of Psychology
Saint Mary's University
Halifax, Nova Scotia

Approved: _____
Irmingard Lenzer, Ph.D.
Faculty Advisor

Approved: _____
Philip Street, Ph.D.
Thesis Committee Member

Approved: _____
Joseph J. Gabriel, Ph.D.
Thesis Committee Member

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ABSTRACT

The purpose of the present study was to examine the performance of normal adults on the Rey-Osterrieth Complex Figure Test (ROCFT) especially with regard to procedural types, methods by which individuals proceed to copy the figure. Osterrieth identified seven procedural types that might be used by individuals in copying the figure: four generally used by adults (Types I, II, III and IV) and an additional three, more primitive, strategies (Types V, VI and VII) which might be used by children. It was found that a) normal adults did not use the procedural types as outlined by Osterrieth (1944). Fewer used procedural types I & II and more used types III & IV than reported by Osterrieth; b) the procedural type used was related to performance on both the copy and recall phases of the test with types I & II yielding better performance than either type III or Type IV; c) copying strategy, as measured by Bennett-Levy (1984), was related to performance on both the ROCFT copy and recall phases with higher strategy scores yielding the best performance; d) procedural type used was found to be related to the strategy score. It was concluded that both Osterrieth's procedural types and Bennett-Levy's strategy score are measures of perceptual organization. Various task and subject variables were examined to determine which were associated with choice of procedural type and performance on the ROCFT copy and recall phases. The following were found: procedural type, strategy score, and scores on the Category test were found to be the best predictors of the scores on

the copy phase; copy scores, Category Test scores, procedural type, strategy scores, age, and gender were found to be the best predictors of the scores on the recall phase; and strategy scores were found to be the best predictors of the procedural type used. The assessment of procedural type was found to be a reliable and quick indicator of perceptual organization and of value to the clinician in assessing performance on both phases of the ROCFT.

INTRODUCTION

The Rey-Osterrieth Complex Figure Test (ROCFT) is a test of constructional functions designed by Rey (1941) to investigate perceptual organization and immediate/delayed visual recall in brain damaged individuals (Figure 1). The test is divided into two phases: a) the copy phase which measures visuo-constructive function or in which the subject copies (draws) the complex figure while looking at the picture; and b) the recall phase which measures the amount and quality of recall of the original figure from short or long-term spatial memory.

In 1944 Osterrieth standardized the test using brain damaged and non-brain damaged children and adults. His orientation was primarily a developmental one and he looked at test performance of individuals varying from four to sixty years of age. His standardization of the test included three levels of evaluation.

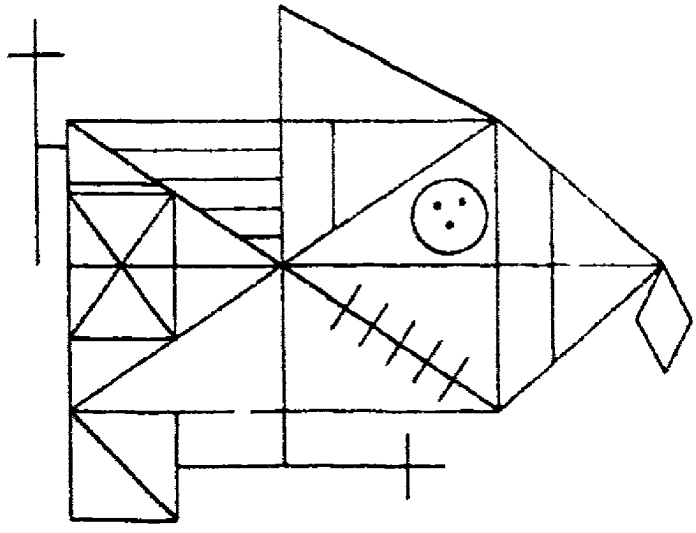

Figure 1. The Rey-Osterrieth Complex Figure.

The first involved an evaluation of the copying strategy used in reproducing the figure. Osterrieth believed that the way in which a person perceived the complex figure would strongly influence the manner in which it was copied (though he did not specify the nature of the relationship). He also felt that as perception develops with age, accordingly the copying strategy used in reproducing the figure would develop with age. He identified four copying strategies used by adults in copying the figure, and an additional three, more primitive, copying strategies which might be used by children. He called these copying strategies *procedural types* . The seven procedural types are listed in Table 1.

TABLE 1

PROCEDURAL TYPES (OSTERRIETH, 1944)

I. Subject begins by drawing the large central rectangle and details are added in relation to it
II. Subject begins with a detail attached to the central rectangle, or with a subsection of the central rectangle, completes the rectangle and adds remaining details in relation to the rectangle.
III. Subject begins by drawing the overall contour of the figure without explicit differentiation of the central rectangle and then adds the internal details.
IV. Subject juxtaposes details one by one without an organizing structure
V. Subject copies discrete parts of the drawing without any semblance of organization.
VI. Subject substitutes the drawing of a similar drawing (boat, house).
VII. The drawing is an unrecognizable scrawl.

Osterrieth's second method of evaluation concerned the accuracy of the person's reproduction of the figure, both in copy and recall phases. For example, he felt that omissions and errors in the

reproductions indicated an attentional deficit whereas awkwardness and distortions in the drawings indicated a problem in visuo-motor control. He developed a rigorous scoring system in order to measure the quantity and quality of reproductions of the figure (Appendix A). Here again, he felt that development played an important role in determining the degree of accuracy possible, and he described developmental levels and provided percentiles for each.

The third means of evaluation was the time required to complete the task. Osterrieth felt that it was of diagnostic interest to know whether an excellent or poor copy was completed very quickly or slowly. Norms were outlined for various ages.

In addition to the three methods of evaluation mentioned above, Osterrieth believed that performance on the recall phase indicated a person's natural capacity for immediate (or delayed) visual memory because s/he was not warned in advance that s/he would have to recall the figure and thus would not intentionally memorize it. Tombaugh and Hubley (1991) refer to this as an "incidental learning paradigm".

Since Osterrieth's study, the ROCFT has become widely used in the field of neuropsychology. Its administration has become standard procedure for many clinicians. The test has been used extensively in research with brain damaged populations. For example, Binder (1982) looked at the effects of unilateral lesions on the copying strategy used in copying the complex figure and on

the overall accuracy of the copy phase; Pillon (1981) compared the effects of parietal-occipital lesions with frontal lesions on visuo-constructive deficits and proposed separate methods of compensation for each deficit; Messerli, Seron and Tissot (1979) looked specifically at the effects of frontal lobe lesions; and Taylor (1969) compared the performance of patients before and after unilateral temporal lobectomies.

More recently, research has been done using the ROCFT to lateralize focal brain damage (Craft et al., 1987); to distinguish schizophrenics from manic depressives (Yurgelun-Todd et al., 1987); in predicting seizure laterality in temporal lobe patients (Loring et al., 1988a); in assessing patients with complex partial seizures post-surgically (Bachtler et al., 1990); and in differentiating organic memory deficits between patients with closed head injury and dementia of the Alzheimer's type (Bigler et al., 1989). The ROCFT has proved useful in all these endeavors. Yet, apart from Osterrieth's work (1944), there have been few studies looking specifically at the scores and procedural types associated with a *non-brain damaged* population. Normal populations have, of course, occasionally been used as control groups (Snow, 1979; Visser, 1973; and Binder, 1982), and Waber and Holmes (1985, 1986) used 454 unscreened children in developmental studies of the ROCFT. Although references made to non-brain damaged subjects have yielded general comments such as "brain damaged subjects deviate from normals in that the central rectangle does not exist for them (p. 23)" or "the fragmented or piecemeal approach to copying the

complex figure that is so characteristic of brain damaged persons reflects their inability to process as much information at a time as do normals...' (Visser, 1973), such comments are rather vague and reveal very little information about the actual performance of non-brain damaged individuals on the ROCFT.

Only very recently have studies looked at the performance of normals on the ROCFT in depth. Casey et al. (1991) classified undergraduates as either visualizers or verbalizers and attempted to determine whether these processing styles affected recall performance on the ROCFT. They found that visualizers showed better reproduction accuracy than did verbalizers, and that approximately 80% of verbalizers as well as visualizers reported using a visual strategy in reproducing the figure. It appears that the ROCFT does not lend itself easily to a verbal strategy. Visual and verbal processing styles can be considered as right and left hemisphere functions respectively. It would be valuable to note whether cerebral laterality (as measured by processing style) will affect the choice of copy strategy. Weinstein et al. (1990) looked at the effects of handedness, familial handedness and academic concentration on performance on the ROCFT in female college students. They found that the math/science left-handers subgroup and the math/science right-handers with left-handed relatives subgroup obtained higher mean scores than all other subgroups. The non-math/science right-handers were the poorest performers. It was also noted that the high-performing groups tended to use a more configurational strategy--or types I or II (right hemisphere)

whereas the poorer performing groups tended to use a more piecemeal approach--or type IV (left hemisphere). Bennett-Levy (1984) conducted a study looking specifically at the copying strategies used by normals (although he did not refer to Osterrieth's procedural types). He found that age and a measure of copying strategy (what he called strategy score) were the best predictors of recall performance. Ska et al., (1987) and Ska and Nespoulous (1988) examined the performance of normal elderly subjects on the ROCFT. They found that the aged subjects differed from the younger ones in the accuracy and final organization of the figure with the aged performing less well, and that the aged subjects reproduced less during the recall phase. These two studies also examined the copying strategies used and noted that the use of procedural types was not characteristic of a given age, and that the procedural type used was related to performance in recall until the age of 74. Delaney et al. (1988), and Tombaugh and Hubley (1991) looked at the test-retest comparability of the ROCFT and the Taylor Figure. Both found discrepancies in the recall phase with performance being better with the Taylor figure.

As mentioned above, Osterrieth (1944) identified seven procedural types used by brain damaged and non-brain damaged populations in copying the complex figure. He found that 83% of the adult control subjects followed procedural types I & II, 2% used type III, and 15% used the type IV procedure. He clearly stated his opinion that types I and II were the superior approaches and that they were used by the vast majority of normals. He also felt that

the "piecemeal" approach, or type IV, was indicative of possible brain damage. This view was shared by Visser (1980) and Binder (1982). Visser felt that for many brain damaged individuals, the figure is too complex to be appreciated in its entirety, and therefore must be broken into its components in order to simplify the task.

Maillet (1984) attempted to determine if Osterrieth's (1944) findings were still valid, forty years later. It was shown that the number of subjects using procedural types I-IV differed greatly from that found by Osterrieth (1944). For example, while Osterrieth noted that normals using procedural type IV were very few (9 of 60 subjects), Maillet found more than one third of subjects used this approach, and while Osterrieth noted only one subject of sixty used procedural type III, Maillet found 24% used it. Indeed, statistical analysis showed the procedural types to be equally distributed among the participants in Maillet's study, indicating that the use of Osterrieth's norms for procedural types in the assessment of individuals should be reconsidered. The sample for Maillet's 1984 study was drawn from a normal population. If Osterrieth and Visser are correct in believing that a piecemeal approach indicates brain damage, then more than one third of these subjects might be assumed to have brain damage. In fact, Maillet's results differed so greatly from those of Osterrieth that an attempt to replicate them would seem to be in order.

Another aspect that had not been fully investigated at the time of Maillet's (1984) study, was the relationship of Osterrieth's

procedural types to performance in the copy and/or recall phase of the test. Osterrieth (1944) offered observations in this regard, but conducted no empirical analysis. Binder (1982) also indirectly addressed the question of how copying strategies used in reproducing the figure may influence the resulting accuracy in copy, but he made no specific references to Osterrieth's procedural types.

Investigating this relationship, Maillet (1984) found that both copy and recall scores were indeed affected by the procedural type used to copy the figure. In particular, the scores on the recall phase differed markedly depending on which procedural type was used to copy the figure. This supported the hypothesis that those subjects who copy the figure by using an organizing, or configurational structure and by separating the parts from the whole, would have less difficulty remembering the whole figure than those who originally saw no structure in the figure and merely drew individual lines rather than distinct components. However, the scores of the copy phase showed much less difference related to procedural type used. This is consistent with Binder's (1982) finding that "a fragmented, piecemeal approach" to the copying of the complex figure does not necessarily lead to an impaired finished copy, and with Osterrieth's (1944) opinion that omissions and errors in the reproductions indicate an attentional deficit as opposed to a visuo-constructional deficit.

In 1984, Bennett-Levy supplemented Osterrieth's procedural types by developing a quantitative measure of copying strategy using

two Gestalt principles of perceptual organization, namely symmetry and good continuation, adapted from Wertheimer (1958) [See Appendix B]. He called this measure the *strategy score* . Bennett-Levy (1984) also investigated the relationship of this strategy score to copy and recall scores in a normal population, and suggested ways in which a copy strategy score might be used to advantage in clinical practice.

Bennett-Levy noted that if the order in which a person copies lines or segments from the ROCFT represents a direct measure of perceptual organization at input, then the copy strategy should be highly related to the ROCFT recall score in a normal population. This is not necessarily the case with brain damaged persons, however. Bennett-Levy proposed that memory performance on the ROCFT may reflect at least two types of recall deficits--one which is a reflection of poor initial organization of the figure, and one which reflects a "forgetting" of adequately organized input. In the case of poor initial organization of the figure (or difficulty encoding the information) one can see how a person might possibly achieve an accurate copy of the figure despite a poor strategic approach. However, it is to be expected that there would be difficulty subsequently in recalling the figure. It is evident, then, that the copy score is not necessarily an accurate measure of initial encoding as had traditionally been thought, but that the copying strategy might be.

In his 1984 study, Bennett-Levy set out to investigate the relationship of various task and subject variables to performance on the copy and recall phases of the ROCFT. His results (using multiple regression) indicated that strategy score, copy time and age are the major determinants of copy score, while strategy score, copy score and age are the best predictors of later recall. He also found that estimated IQ and gender of the subject were mildly related to copy and recall performance.

The large amount of recall variance accounted for by the strategy score and the age of the subject indicated that the use of the regression technique to predict recall scores might be a valuable tool in clinical practice. Hence the following equation: predicted recall = (0.75 x strategy total) - (0.16 x age) + 8.01. (Although the copy score was significantly correlated with recall performance, it accounted for only 2 percent of the variance and it was felt that its inclusion in the equation would require more complexity of scoring and calculation than its marginal increase in predictive accuracy warranted.) Bennett-Levy demonstrated how this equation can be used to help clinicians to distinguish more precisely between recall deficits due to a failure of organization at input, and recall deficits due to forgetting.

It is clear that Osterrieth (1944) was justified in his view that a person's initial perception, or organization of the ROCFT figure has some relationship to ability to recall the figure. Bennett-

Levy (1984) demonstrated that the strategy used to copy the figure has a very large effect upon recall performance.

The question remains as to whether Osterrieth's norms for procedural types are still valid for current clinical practice and whether psychologists should seek to further quantify the information being assessed by these procedural types by adopting measures of copying strategy such as that proposed by Bennett-Levy (1984). Certainly Bennett-Levy's findings present a significant contribution to the field of neuropsychological assessment and warrant an attempt at replication.

Osterrieth's scoring criteria (generally excluding the developmental norms) are still being used today, as adapted by Taylor for his 1969 study. Many clinicians and researchers use both an immediate recall test and/or a delayed recall test (after 30 or more minutes). The test is widely used within the field of neuropsychology. However, only Ska et al. (1987) and Ska and Nespoulous (1988) were found by this author to mention the use of Osterrieth's procedural types. It appears that assessment of procedural types (or copying strategy in general) is disregarded by most clinicians.

Over the past few years, researchers have turned their attention to the question of whether Osterrieth's scoring criteria should be changed or expanded upon. Tombaugh and Hubley (1991) stated with regard to the ROCFT, that the "completed drawings may

be scored qualitatively for differential copying strategies, or quantitatively for accuracy of reproduction. "(p.587)

In terms of quantitative scoring, Bigler et al. (1989) and Tombaugh and Hubley (1991) adopted an itemized scoring system from Denman (1984) which divides the figure into 72 segments (as opposed to Osterrieth's 18). Waber and Holmes (1985) divided the figure into 64 segments. Zelko et al.(1988) compared Osterrieth's (1944) quantitative scoring with that of Waber and Holmes (1985) and found them to share a significant portion of variance with each other. Tombaugh and Hubley (1991) found no systematic differences between Osterrieth's (1944) and Denman's (1984) scoring systems, and Ska and Nespoulous (1988) noted that Waber and Holmes' (1985) more elaborate scoring system was no more effective in distinguishing between their two groups of interest than that of Osterrieth (1944). It would appear that Osterrieth's quantitative scoring criteria are adequate as they are.

More emphasis seems to have been placed on attempts to evaluate the qualitative aspects of the test, i.e., what has been referred to in this paper as the copying strategy. Waber and Holmes (1985) devised a system for evaluating not only accuracy but also organization and production style. Craft et al. (1987) and Yurgelun-Todd (1987) looked at performance process (what they call "process analysis") to lateralize focal brain damage and distinguish schizophrenia and manic depressive illness. Klicpera (1983), Kirk

and Kelly (1985), and Bachtler et al. (1990) have also made changes in the qualitative assessment of ROCFT performance.

It has been stated that the way in which a person perceives the complex figure will determine the choice of copying strategy s/he will use to copy it. This, in turn, will influence ability to reproduce the figure and later recall. Osterrieth (1944), Visser (1973) and Binder (1982) determined that a "piecemeal" approach to copying the figure was indicative of brain damage. Yet Maillet (1984), Ska et al. (1987), and Ska and Nespoulous (1988) found that non-brain damaged persons were as likely to use a piecemeal approach as a configurational one. The research thus far appears to indicate that a configurational approach (procedural types I & II) is the most effective one, leading to the best performance on the ROCFT. However, if one cannot attribute choice of copying strategy to brain damage, questions remain: "What determines the manner in which someone will perceive the Complex Figure? " and "What determines the copying strategy used to reproduce it?"

Finally, Maillet (1984) found scores on the recall phase also varied according to whether the ROCFT was administered first or last. Those who did the ROCFT last performed more poorly on the recall phase than those who did the ROCFT first, indicating that there was proactive interference from the preceding tests, namely the WAIS-R Block Design and the Embedded Figures Test. It was concluded that testing material made up of geometrical designs should not be administered before the ROCFT. No other such findings

have been reported in the literature. Thus it would be of relevance to note whether the order of administration of the tests in the present study which included geometric material (namely the Category Test) will affect performance on the ROCFT.

Hypotheses

The above discussion leads to the following hypotheses:

1) The percentages of procedural types used by the subjects of this study will not fit the percentages determined by Osterrieth (1944) for normal subjects.

2) The procedural type used will be related to the scores of the copy phase and, in particular, of the recall phase of the ROCFT.

3) Strategy score (as determined by Bennett-Levy, 1984) will be related to the scores of the copy and recall phases of the ROCFT.

4) The procedural type used will be related to the strategy scores.

5) The following variables will be related to choice of copying strategy and performance on the copy and recall phases of the ROCFT: gender, age, education, handedness, (personal and familial), number of math and math/science courses, intelligence, and left vs right cerebral laterality.

6) The order of testing material made up of geometric designs administered before the ROCFT will interfere with performance on the ROCFT recall phase.

METHOD

Subjects:

The population of interest for this study was a normal one, i.e., non-brain damaged. A sample of 105 volunteers was drawn from members and associates of the Church of Jesus Christ of Latter-Day Saints (47 male, and 58 female). Their mean age was 32.6 years, standard deviation 13.6 years, range 16-80 years. Their mean level of education was two years post high-school, with a standard deviation 2.2 years. Individuals with a history of epilepsy, head injury, or other neurological disorder were excluded from the study. In addition, members of the Church of Jesus Christ of Latter-Day Saints refrain from any use of alcohol, tobacco, tea or coffee and other harmful drugs, of possible benefit to the study by limiting the effects of substance abuse on the test results.

Procedure

All participants were seen individually, in the same room, and positioned in the same way with respect to the examiner. Each participant was first interviewed to determine the following information: years of education--grade 12 and over; number of math and math/science courses since and including high-school (including math, chemistry, physics, electronics, and computer programming) and history of head injury, epilepsy, or other

neurological disorder. The participants were asked to complete the following psychological tests: the Rey-Osterrieth Complex Figure Test, The Handedness Questionnaire, a measure of processing style (verbalizers vs visualizers) [see Appendix C], and the Category Test (as an estimate of intelligence and as potential geometric interference and order effects). The participants were separated into groups A and B, with odd numbered subjects in group A and even numbered subjects in group B. Tests were administered randomly, except for the ROCFT which was administered either first or last, to counterbalance the two groups in order to control for any potential order effects. Group A received the ROCFT first (the copy phase followed immediately by the recall phase) followed by the random administration of the other three measures. Group B was administered the tests in reverse order, i.e., the Handedness Inventory, the measure of processing style, and the Category Test, (administered in random order) and the ROCFT last.

Administration of each of the tests used the following instructions: ROCFT, as described by Osterrieth (1944 - procedural type, copy and recall score), and Bennett-Levy (1984 - strategy score); Handedness Questionnaire according Lezak (1983, page 223); measure of processing style according to Casey et al., (1991); and lastly, the Category Test as described by Reitan (1969). Note that the copy phase of the ROCFT was scored by the stringent criteria advocated by Bennett-Levy (1984) whereas the recall phase was scored much more leniently (as described by Lezak, 1983), looking rather for the presence or absence of parts of the figure than for

draughtsmanship and preservation of spatial relationships of different units of the figure.

Each subject was assigned a number and that number was placed at the top of each test protocol (including separate copy phase, recall phase, and strategy protocols). Each test was placed in a folder to be scored "en bloc" when data collection was complete.

RESULTS

The mean scores and standard deviations on all the measures are given in Table 2. Frequencies for various subject variables are given in Table 3. Comparison of scores for males and females found males performed significantly better on the recall phase than females ($F=4.79$, $df=1$, $p< .031$). The Category Test was associated with the number of math/science courses taken ($F=8.375$, $p<.005$) and with the strategy score ($F=5.914$, $p< .037$). Strategy scores were related to the number of math/science courses taken ($F=3.29$, $p<.041$).

The correlation matrix of the Rey performance measures, plus age, gender, education, number of math/science courses, handedness, processing style, and Category Test are presented in Table 4. The results indicate that all the ROCFT performance measures, with the exception of processing style used on the ROCFT, are significantly intercorrelated. The Category Test is also significantly correlated

with all measures of performance on the ROCFT, as well as with age, education, and number of math/science courses. In addition the recall scores were found to be significantly correlated with age and gender, and the strategy scores were found to be significantly correlated with the number of math/science courses taken.

TABLE 2

MEANS AND STANDARD DEVIATIONS ON ALL MEASURES FOR MALES, FEMALES AND TOTAL GROUP

	AGE	ED	MATH/SC	CATEGORY	STRICT COPY	RECALL	STRATEGY SCORE
Females	32.6*	2.8	6.0	52.3	29.6	20.7	21.8
(58)	12.1**	1.6	4.1	26.7	3.3	5.6	4.8
Males	32.6	3.2	7.5	43.4	30.2	23.4	23.3
(47)	15.3	2.8	6.7	25.5	3.1	7.0	5.2
Total	32.6	3.0	6.6	48.3	29.9	21.9	22.5
(105)	12.1	2.2	5.4	26.5	3.2	5.0	5.0

* First row, means
** Second row, standard deviations

In order to examine whether the percentages of procedural types used by the participants of this study fit the percentages described by Osterrieth (1944) for normals, a Chi squared test for goodness of fit was done to determine if a) the procedural types are equally distributed; or b) the procedural types are distributed according to Osterrieth's findings. Analysis of the data showed that although the procedural types were not equally distributed, contrary

to Maillet (1984), (x^2= 33.657; df=2; p<.000), neither did they did conform with the findings of Osterrieth (1944) (x^2=100.684; df=2, p<.000) (see Figure 2).

TABLE 3

FREQUENCIES OF SUBJECT VARIABLES

Procedural Type		
Types I & II	62	59%
Type III	15	14.3%
Type IV	28	26.7%
Total	105	100%

Strategy Score Level		
Low	3	2.9%
Medium	43	41%
High	59	56.2%
Total	105	100%

Handedness		
Left-handed	14	13.3%
Familial left	37	35.2%
Right-handed	54	51.4%
Total	105	100%

Number of Math/Science Courses		
Under 6	54	51.4%
6 or more	51	48.6%
Total	105	100%

Processing Style		
Verbalizers	62	59%
Visualizers	36	34.3%
Unsure	7	6.7%
Total	105	100%

Processing Style on ROCFT		
Verbalizers	50	47.6%
Visualizers	55	52.4%
Total	105	100%

TABLE 4

CORRELATION MATRIX OF ALL VARIABLES

	TYPE	COPY	RECALL	STRATEGY SCORE	AGE	GENDER	ED	MATH	HAND	CATEGORY	PROCESSING STYLE	PROCESSING STYLE ON ROCFT
TYPE	-	-.375****	-.218***	-.602****	.025 ns	.005 ns	-.009 ns	-.131 ns	-.016 ns	.181*	.078 ns	.040 ns
COPY	-	_	.409****	.380****	-.043 ns	.101 ns	.097 ns	.154 ns	.082 ns	-.370****	.022 ns	.130 ns
RECALL	-	-	_	.304***	-.304***	.208***	-.055 ns	.147 ns	-.059 ns	-.469****	.073 ns	.037 ns
STRATEGY SCORE	_	_	_	_	-.022ns	.146***	.122 ns	.199*	.012 ns	-.279**	.073 ns	.036 ns
AGE	_	_	_	_	_	.000 ns	.118 ns	-.002 ns	.023 ns	.484****	-.029 ns	-.058 ns
GENDER	_	_	_	_	_	_	.100 ns	.138 ns	-.051 ns	-.169*	.020 ns	.168*
ED	_	_	_	_	_	_	_	.578****	-.022 ns	-.233**	-.119 ns	.087 ns
MATH	_	_	_	_	_	_	_	_	-.016 ns	-.278**	-.073 ns	.091 ns
HAND	_	_	_	_	_	_	_	_	_	-.063 ns	-.155 ns	-.053 ns
CATEGORY	_	_	_	_	_	_	_	_	_	_	.009 ns	.011 ns
PROCESSING STYLE	_	_	_	_	_	_	_	_	_	_	-.003 ns	
PROCESSING STYLE ON ROCFT	_	_	_	_	_	_	_	_	_	_	_	.050 ns

p<C.05; p<0.01; p<0.001; p<0.0001

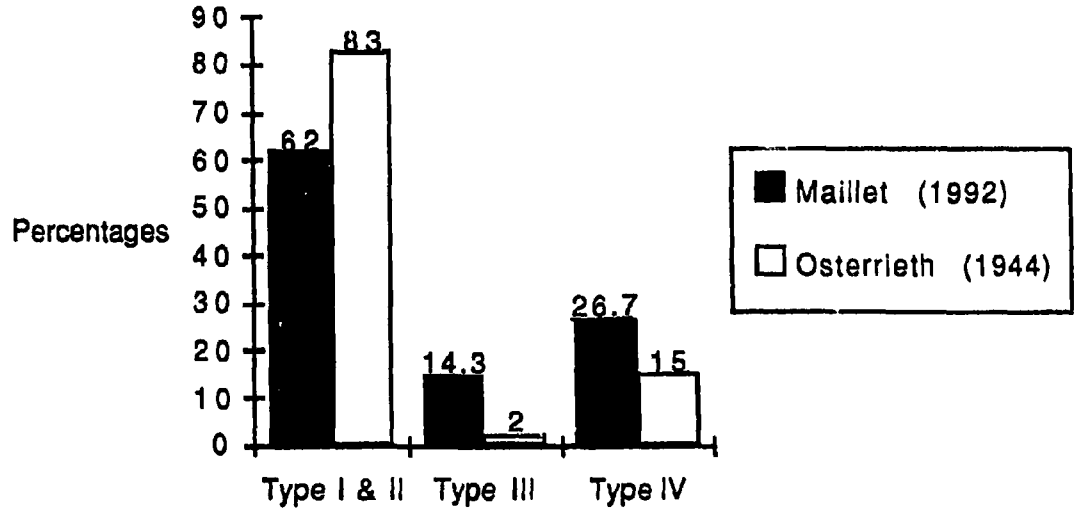

FIGURE 2: Percentages of Subjects Using Each Procedural Type

In assessing whether the procedural type used was related to the scores of the copy and the recall phase of the ROCFT, a one-way analysis of variance was conducted on each of the two test phases (copy and recall) comparing the means in groups of the four procedural types used. Types I & II were grouped together because they both reflect a configurational approach. For the copy phase, a significant relationship was found ($F=13.128$; $df=2,102$; $p<.0000$). A significant relationship was also found for the recall phase, ($F=3.421$; $df=2,102$; $p,.0365$). A test of multiple comparisons was used to determine which procedural types produced significantly different means. In the copy phase the Scheffe procedure found that types I & II combined, differed significantly from both types III and type IV at the .05 level. In the recall phase it was found, using the

Scheffe procedure, that types I & II combined differed significantly from type IV at the .05 level. See Figure 3.

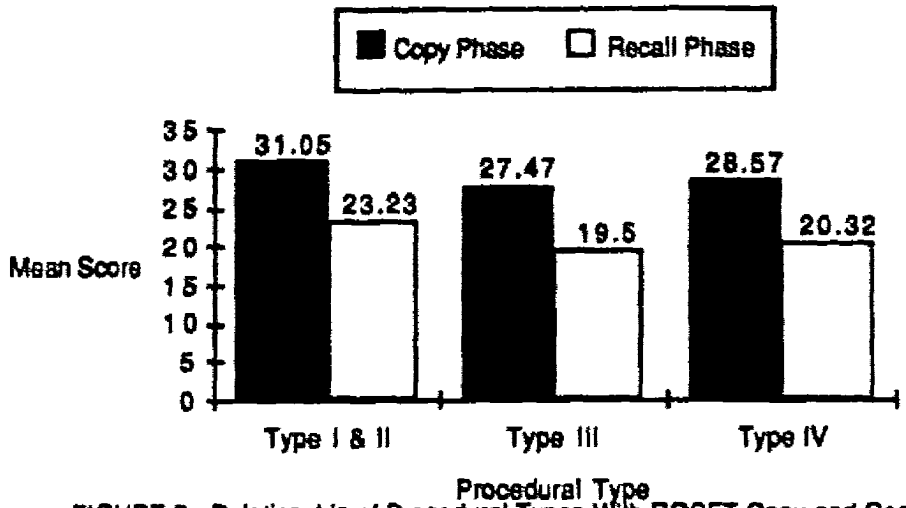

FIGURE 3: Relationship of Procedural Types With ROCFT Copy and Recall

In determining whether Bennett-Levy's (1984) strategy score was related to the scores of the copy and recall phases of the ROCFT, a one-way analysis of variance was conducted on each of the two test phases (copy and recall) comparing the means of low (1-11), medium (12-22), and high (23-33) strategy scores. Copy phase was significantly related to the level of strategy score ($F=6.96$; $df=2,102$; $p<.0015$). A significant relationship was also found for the recall phase ($F=4.007$; $df=2,102$; $p<.02$). The Scheffe procedure found (at the .05 level) that those who achieved a strategy score in the high range performed better on both the copy and recall phases of the ROCFT than did those who achieved a strategy score in the

medium range. Only three participants fell into the low range. See Figure 4.

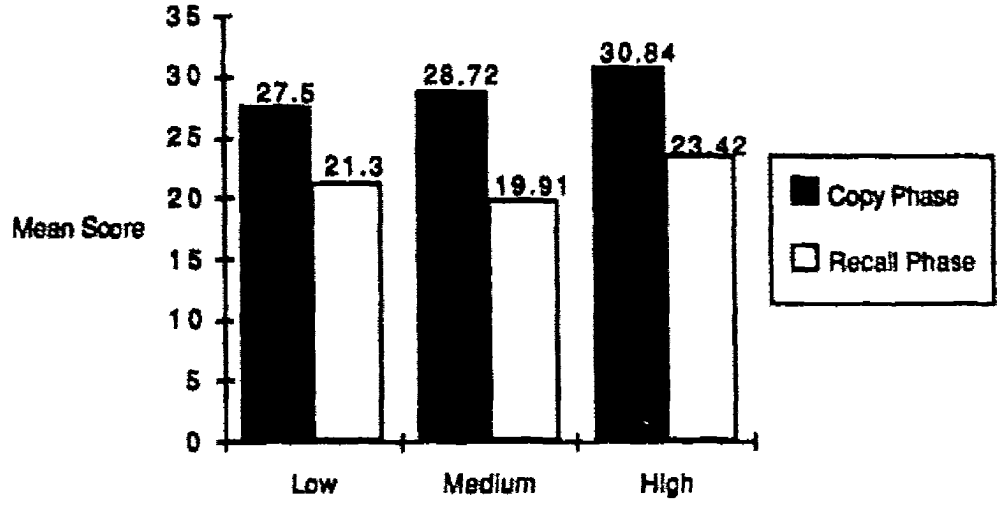

FIGURE 4: Relationship of Low, Medium and High Strategy Scores to Copy and Recall

In attempting to establish whether a relationship exists between the procedural types and the strategy scores, a one-way analysis of variance was conducted on the strategy scores comparing the means in groups of three procedural types: type I & II, type III, and type IV. The procedural type was significantly related to the strategy score ($F=33.82$; $df=2,102$; $p<.0000$). The Scheffe procedure found that types I & II differed significantly from both type III and type IV, with types I & II yielding higher strategy scores than either type III or IV. See Figure 5. Strategy score and procedural type were also found to be significantly correlated, $r=-.602$, $p<.000$.

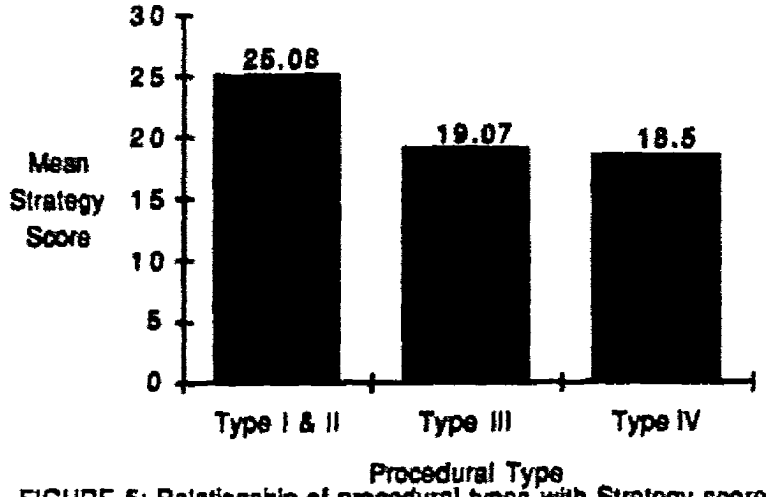

FIGURE 5: Relationship of procedural types with Strategy score

Multiple regression analyses were carried out to further investigate the relationships of the independent variables upon the ROCFT. Only those independant variables which were found to be significantly correlated with the dependant variables were included in the regression analysis. Table 5 summarizes the results of several possible regression models (see Appendix D for a more detailed summary). For the copy phase three variables were found to make significant independent contributions to the copy score. When considered individually, these variables accounted for the following percentage of the variance: strategy score, 14.38%, procedural type, 14.05%, and Category Test,13.72%. Stepwise multiple regression with PIN = .05 and POUT = .1 found procedural type and scores on the Category Test to be the best predictors of copy score, accounting for 25.2% of the variance.

TABLE 5

R^2 and Standard Error of Estimate (SEE) for Several Possible Regression Models*

DEPENDENT VARIABLE	INDEPENDENT VARIABLE	R^2	SEE
Copy	Type	.14053	2.99
	Strategy Score	.14377	2.99
	Category	.13716	3.00
	Category, Type	.23508	2.84
Recall	Type	.04747	6.25
	Copy	.16740	5.84
	Strategy Score	.09228	6.10
	Age	.09214	6.10
	Category	.21961	6.25
	Category,Copy	.38392	5.44
	Copy,Age,Gender	.27770	5.49
Type	Strategy Score	.36006	.70055
	Category	.03288	.80121
StrategyScore:	Type	.36006	4.03
	Math	.03977	4.93
	Category	.07654	4.89
	Type, Category	.62385	3.95
Category:	Type	.03288	26.20
	Copy	.13716	24.74
	Recall	.21961	23.53
	Strategy Score	.07654	25.60
	Age	.23467	23.30
	Education	.05441	26.26
	Math	.07750	25.90
	Age, Copy, Ed, Recall	.69016	19.56

*See Appendix D for a more detailed summary.

It was found that six variables, when considered individually, made significant contributions to the recall score. These variables accounted for the following percentages of the variance; Category Test, 21.96%, copy score, 16.74%, strategy score, 9.23%, age, 9.21%,

procedural type, 4.75%, and gender, 4.32%. Stepwise multiple regression with PIN = .05 and POUT = .1 found scores on the Category Test and the copy phase of the ROCFT to be the best predictors of recall scores, accounting for 28.39% of the variance.

When choice of procedural type was examined through regression analysis, it was found that two variables made independant contributions when considered individually. Strategy score contributed 36% of the variance and scores on the Category Test contributed 3.28% of the variance. Stepwise multiple regression with PIN = .05 and POUT = .1 found strategy scores to be the best predictor of choice of procedural type, accounting for 36% of the variance.

Regression analysis of strategy scores found three variables to individually contribute the following percent of the variance: procedural type, 36%, scores on the Category Test, 7.7%, and number of math/science courses taken, 4%. Stepwise multiple regression with PIN = .05 and POUT = .1 found procedural type and scores on the Category Test to be the best predictor of strategy scores, accounting for 38.9% of the variance.

Because of the unanticipated correlation of the Category Test with so many of the other variables, regression analyses were carried out to determine which variables contributed to scores on this measure. Eight variables were found to make significant contributions when considered individually. More detail can be found

in Table 5 or Appendix D. The following four variables were found to be the best predictors of scores on the Category Test by stepwise multiple regression with PIN = .05 and POUT = .1: age, copy scores, education, and recall scores. Their combined contributions to the variance was 47.63%, with age making the greatest contribution at 23.47%.

Maillet (1984) found that testing material made up of geometric designs administered before the ROCFT interfered with performance on the ROCFT recall phase. Accordingly, for the present study, a T-test for independant groups was conducted on each of the two test phases (copy and recall) comparing the means of the two treatment groups; ROCFT first = Group A, ROCFT last = Group B. In the copy phase, group A did not differ significantly from group B ($t=1.48$; $df=102.98$; $p<.142$). There was also no difference between groups A and B in the recall phase ($t=1.63$, $df=102.12$, $p<.106$). The order in which the tests were administered did not affect performance on either the copy or the recall phases of the ROCFT.

DISCUSSION

The purpose of this study was to examine the performance of normal adults on the Rey-Osterrieth Complex Figure Test, especially with regards to copying strategy. A discussion of the hypotheses addressed in this study follows.

HYPOTHESIS 1: The percentages of procedural types used by the participants of this study will not fit the percentages determined by Osterrieth (1944) for normals.

The first hypothesis was confirmed. The percentages of procedural types used by the participants of this study did not fit the percentages determined by Osterrieth (1944). Where Osterrieth found 83% of normals using procedural types I & II, the present study found only 59%; where Osterrieth found 2% using type III, the present study found 14.3%; and where Osterrieth found 15% using type IV, the present study found 26.7%. The findings of the present study are significantly different from those found by Osterrieth in 1944 and indicate that *the use of procedural types III and IV are much more prevalent among normals than Osterrieth's research would indicate.* Although types I and II have been found to be the superior approaches, yielding better performance on both the copy and recall phases, (Osterrieth, 1944; Maillet, 1984; Ska and Nespoulous, 1988; the present study) it is clear that normals are not limited to these strategies. As for the opinion of Osterrieth (1944) and Visser (1980) that type IV is indicative of brain damage, it does not seem probable that more than one quarter of the participants in this "normal" sample could be considered impaired in terms of perceptual organization.

The present findings are consistent with those found by Ska and Nespoulous (1988). Although they did not statistically compare their findings with the percentages determined by Osterrieth (1944), they noted that in their normal sample there were as many adults and elderly subjects who constructed the figure using type IV as there were using types I and II. Their subjects were grouped according to age and the percentages of procedural types used ranged from 30-53% for types I & II, 0-10% for type III, and 41-60% for type IV. Clearly these numbers do not agree with those published by Osterrieth (1944) as representative of a normal population.

HYPOTHESIS 2: The procedural type used will be related to the scores of the copy phase and, in particular, of the recall phase of the ROCFT.

This hypothesis was confirmed. The present study shows, as did that of Maillet (1984), that the procedural type used in copying the figure predicts scores on both the copy phase and on the recall phase, especially the copy phase (Figure 3). Although the findings for the copy phase in Maillet's 1984 study were somewhat less conclusive (see Appendix E), this discrepancy is possibly attributable to the more stringent scoring criteria used in the present study, which resulted in a greater range in scores.

As to the recall phase, recall scores for those using types I & II were shown to be significantly better than for those using type IV.

This again confirms the findings of Maillet (1984) that subjects who copy the figure by using an organizing structure would have less difficulty remembering the whole figure than those who originally saw no structure in the figure, and merely drew a juxtaposition of details. Visser (1973) felt that unusual sequencing strategies (type IV) used in copying the figure were a result of the subjects reduced capacity for processing visual information. If this is the case, it stands to reason that if a person cannot fully process the figure visually, s/he will have difficulty in recalling it.

The observation was also made that those subjects who did well on the recall phase but used procedural type IV in copying the figure, generally proceeded to draw the figure from memory using procedural type I or II. It could be assumed then that, although these subjects copied the figure using procedural type IV, at some point in their copying they noticed that there was an organizing structure to the figure, and this is reflected in their recall of the figure. Rey (1941) noted that "those subjects who replace their initial faulty approach quickly by a more mature one may have been inattentive and nonchalant, or too hasty or bewildered, so that they performed less well than they could have "(p. 332). The preceding comment perhaps sheds some light on the reason so many normal adults chose an inferior approach to copying the figure. Also, it might be of diagnostic importance to the clinician to observe the procedural type used on the recall phase as well as on the copy phase, and to question the client on the reasons for a change in procedural type.

HYPOTHESIS 3: Strategy score (as defined by Bennett-Levy, 1984) will be related to the scores of the copy and recall phases.

This hypothesis was confirmed. When strategy scores were divided into three levels of low, medium, and high scores, it was found that the high strategy scores predicted significantly better scores on both the copy and recall phases of the ROCFT than did medium strategy scores. The criteria for determining strategy scores were developed by Bennett-Levy (1984) using principles of perceptual organization (i.e., good continuation and symmetry). The strategy score is intended as a measure of the person's initial organization of the figure. Thus it can be concluded that the differences in performance seen on the copy and recall phases of the ROCFT are a result of varying levels of perceptual organizational ability. We are left with the question of how strategy scores are related to Osterrieth's procedural types; this is addressed in hypothesis 4.

HYPOTHESIS 4: The procedural type used will be related to the strategy scores.

This hypothesis was confirmed. Logic would seem to dictate that procedural types (as well as strategy score) are also measures of perceptual organization as evidenced by the superior performance of those using a configurational approach (type I & II) when compared to the piecemeal approach of type IV in copying the figure. The present study found that the procedural type used was related to

The present study found that the procedural type used was related to the strategy score, with the configurational approaches yielding scores in the high range of strategy scores and the piecemeal approach yielding scores in the medium range. Since the strategy score is a quantitative measure of perceptual organization, it follows that the procedural type also indicates perceptual organization. It would appear that types I & II reflect a high ability of perceptual organization, whereas type III and type IV reflect poorer ability in this area.

HYPOTHESIS 5: The following variables will be related to choice of copying strategy and performance on the copy and recall phases of the ROCFT: gender, age, education, handedness (personal and familial), number of math and math/science courses, intelligence, and left vs right cerebral laterality.

Of all the variables examined in this study, the following were found to have no correlation with any measures of ROCFT performance: handedness, and left vs right cerebral laterality (as measured by processing style). As handedness might also be considered as a measure of cerebral laterality, within the scope of this study, it would seem reasonable to conclude that cerebral laterality does not influence choice of copying strategy or performance on the ROCFT. This conclusion is contrary to the findings of Casey et al. (1991) and Weinstein et al. (1990). Casey et al. 91991) found that visualizers (right hemisphere) performed better than verbalizers (left hemisphere) in reproducing the complex figure from memory. The present study does not support these

earlier findings (t=-.53; df=74.83; p<.596). Weinstein et al. (1990) noted that in a female sample, the math/science left-handers subgroup and the math/science right-handers with left-handed relatives subgroup obtained higher mean scores than all other subgroups. In attempting to replicate these results, the present study failed to confirm any significant differences among subgroups (see Appendix F for details). Some possible explanations for this discrepancy are: 1) Weinstein et al. (1990) used the scoring system of Waber and Holmes (1985, 1986) rather than that of Osterrieth (1944) which was used in the present study, and 2) the limited sample size of the present study meant small numbers in some of the subgroups.

Intelligence and the Category Test

Before continuing, a word should be said concerning the Category Test, included in the present study as an estimate of intelligence. The rationale was based upon the comments of Gregory (1987). He felt that the Category Test is "a good choice when the examiner wants a pristine measure of capacity to learn that is not so directly anchored in acquired knowledge and skills as the WAIS-R ."(p.147) He also stated: "The Category Test measures the subjects ability to generate hypotheses and to validate or discard them on the basis of experience. The subject must be able to induce general hypotheses from specific examples and to learn from ongoing experience whether the hypotheses are correct or not. Successful

TABLE 4

CORRELATION MATRIX OF ALL VARIABLES

	TYPE	COPY	RECALL	STRATEGY SCORE	AGE	GENDER	ED	MATH	HAND	CATEGORY	PROCESSING STYLE	PROCESSING STYLE ON ROCFT
TYPE	-	-.375****	-.218***	-.602****	.025 ns	.005 ns	-.009 ns	-.131 ns	-.016 ns	.181*	.078 ns	.040 ns
COPY	-	_	.409****	.380****	-.043 ns	.101 ns	.097 ns	.154 ns	.082 ns	-.370****	.022 ns	.130 ns
RECALL	-	-	_	.304***	-.304***	.208***	-.055 ns	.147 ns	-.059 ns	-.469****	.073 ns	.037 ns
STRATEGY SCORE	_	_	_	_	-.022ns	.146***	.122 ns	.199*	.012 ns	-.279**	.073 ns	.036 ns
AGE	_	_	_	_	_	.006 ns	.118 ns	-.002 ns	.023 ns	.484****	-.029 ns	-.058 ns
GENDER	_	_	_	_	_	_	.100 ns	.138 ns	-.051 ns	-.189*	.020 ns	.168*
ED	_	_	_	_	_	_	_	.578****	-.022 ns	-.233**	-.119 ns	.087 ns
MATH	_	_	_	_	_	_	_	_	-.016 ns	-.278**	-.073 ns	.091 ns
HAND	_	_	_	_	_	_	_	_	_	-.063 ns	-.155 ns	-.053 ns
CATEGORY	_	_	_	_	_	_	_	_	_	_	.009 ns	.011 ns
PROCESSING STYLE	_	_	_	_	_	_	_	_	_	_	-.000 ns	
PROCESSING STYLE ON ROCFT	_	_	_	_	_	_	_	_	_	_	_	.050 ns

p<0.05; p<0.01; p<0.001; p<0.0001

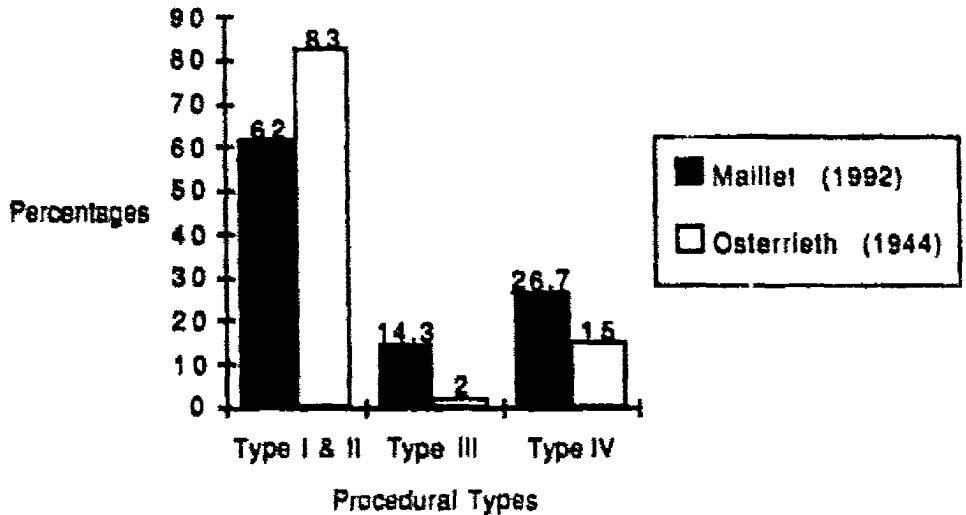

FIGURE 2: Percentages of Subjects Using Each Procedural Type

In assessing whether the procedural type used was related to the scores of the copy and the recall phase of the ROCFT, a one-way analysis of variance was conducted on each of the two test phases (copy and recall) comparing the means in groups of the four procedural types used. Types I & II were grouped together because they both reflect a configurational approach. For the copy phase, a significant relationship was found ($F=13.128$; $df=2,102$; $p<.0000$). A significant relationship was also found for the recall phase, ($F=3.421$; $df=2,102$; p,.0365). A test of multiple comparisons was used to determine which procedural types produced significantly different means. In the copy phase the Scheffe procedure found that types I & II combined, differed significantly from both types III and type IV at the .05 level. In the recall phase it was found, using the

intelligence, the findings concerning the Category Test are valuable in their own right. Certainly a more searching look should be made into the assumptions and applicability of this test in the clinical field today.

Copy Phase

The scores on the copy phase of the ROCFT were significantly correlated with scores on the recall phase, the Category Test, the strategy scores and the procedural type used. Both the strategy score and the procedural type used were found (by analysis of variance) to be related to the copy score. Thus we may conclude that the copy phase reflects not only constructional functions but is also influenced by perceptual organization (as indicated by strategy score and procedural type). A configurational approach to copying the figure will yield a better finished product than will a piecemeal approach. The difference, however, will be primarily one of neatness and draughtsmanship (see Appendix G) and should not necessarily be taken as an indication of impairment. No single neuropsychological measure should be considered in isolation, but rather should be viewed in conjunction with other tests, with the observed behavior of the client on each test, and with the history of that individual client.

Comment should be made on the choice of stringent scoring criteria for the copy phase in this study. Although Osterrieth's (1944) scoring criteria were used, the copy phase in this study was scored much more strictly than would normally be the case with

most clinicians. Osterrieth gives no precise criteria to illustrate the degree of misplacement that constitutes "misplaced", and these criteria may vary quite markedly among examiners. Bennett-Levy (1984) rationalized his choice of strict scoring on the copy phase after personal communication with Taylor (1969). According to Bennett-Levy, Taylor reports "that he uses very stringent criteria to assess both copy and recall . . . assess(ing) accuracy in terms not only of presence, distortion and misplacement of the figure, but also draughtsmanship (e.g. the diagonal cross, the horizontal line and the vertical line of the large rectangle should intersect at the center of the figure) . "(p.109). These more stringent scoring criteria were adopted in this study in order to control for ceiling effects. It was thought that a large number of copies may have otherwise obtained maximum scores. It was also hoped that this would make the test more sensitive to the effects of strategy score and procedural type. However, the author actually rescored the copy phase using the more lenient criteria generally employed, and reanalyzed the data for hypotheses two and three, and the results were, in fact, virtually identical to those found with the strict scoring, confirming both hypotheses. (More detail can be found in Appendix H.)

Recall Phase

The following variables were found to be significantly correlated with the recall phase of the ROCFT: copy score, strategy score, procedural type, age, gender, and score on the Category Test. In addition, analysis of variance found gender to be related to the

skills (Harris, 1977; Bennett-Levy, 1984); however, it is surprising that gender differences were not also found in the copy phase and the strategy score.

Multiple regression surprisingly revealed scores on the copy phase and on the Category Test to be the best predictors of recall scores within a normal population, accounting for 38.4% of the variance. These results are somewhat different from those found by Bennett-Levy (1984), who found that the regression equation for recall accounted for 54.5 percent of the variance, with strategy scores accounting for the greater proportion of variance (20%). Given the significant relationship of strategy score with the recall phase seen in analysis of variance, this author was expecting to replicate Bennett-Levy's (1984) findings. In fact, strategy score was found to make an independant contribution of only 9%. Even when the Category Test was removed from the equation, stepwise multiple regression did not include the strategy score in the equation, but rather brought in age and gender along with the copy scores. One must, therefore, look upon the findings of Bennett-Levy as questionable, or at least as warranting further investigation. Perhaps the difference in results might be attributable to the difference in age in the two samples. Bennett-Levy's (1984) oldest participant was 49 years of age, whereas in the present study the oldest was 80. Memory (especially visual memory) has been shown to deteriorate with age (Lezak; 1983, Ska and Nespoulous, 1988); perhaps in the present sample, the recall scores reflect, to some extent, forgetting of adequately stored information as opposed to an

perhaps in the present sample, the recall scores reflect, to some extent, forgetting of adequately stored information as opposed to an inability to retrieve information that was not adequately encoded in the first place. This might account for the reduced amount of variance accounted for by the strategy score in this sample as compared to Bennett-Levy's. Ska and Nespoulous (1988), in looking at a sample of normal elderly subjects, concluded that until the age of 74, there was a relationship between the encoding strategy and performance in recall; however, in subjects over 75 memory problems developed differently and the relationship between the encoding strategy and the results in recall became insignificant.

Procedural Type

The best predictor of procedural type was found to be the strategy score, accounting for 36% of the variance. Likewise the best predictor of the strategy score was found to be the procedural type, also accounting for 36% of the variance. Note that the standard error of estimate for both regression equations was less than one. This is in keeping with the finding (through analysis of variance) that the procedural type used is significantly related to the strategy score. Clearly they are merely different means of measuring the same thing--perceptual organization. The strategy score allows for a more quantitative measure, whereas Osterrieth's procedural types are more qualitative. However, it is this author's opinion that the procedural type still holds relevance for the clinician today. It provides essentially the same information as

does the strategy score but requires much less time to calculate. It remains a valuable diagnostic tool in calculating perceptual organizational ability, providing valuable information when examining performance on the copy and recall phases of the ROCFT. For example, use of procedural type I or II coupled with poor performance on the recall phase would seem to indicate a deficit in visual memory rather than poor performance as a result of inadequately processed information. In contrast, the same poor recall performance coupled with a type IV procedural approach might be more indicative of a perceptual problem rather than one of memory.

It is interesting to note that Ska and Nespoulous (1988) (who are the only researchers found to make use of Osterrieth's procedural types) observed that the use of procedural types appear not to be related to age. Their sample ranged from age 30 to 84.

Another interesting finding was that strategy score varied according to the number of math/science courses taken (although no similar finding was found for procedural type). Those with more math/science courses tended to achieve higher strategy scores. This would tend to lend support to the theory advocated by Weinstein et al. (1990) that cerebral lateralization affects visual spatial abilities. They argued that handedness (and familial handedness) would affect performance on the ROCFT, and went further to say that as mathematical talent had been associated with left-handedness, mixed handedness, and right-handers with a family history of left-

handedness (Benbow, 1988), then a high academic concentration of, math/science courses could influence visual spatial abilities. While this position was not supported in the current study with regard to ROCFT copy and recall performance, these results must remain inconclusive because of the small numbers in the left-handed subgroups.

HYPOTHESIS 6: The order of testing material made up of geometric designs administered before the ROCFT will interfere with performance on the ROCFT recall phase.

This hypothesis was not confirmed. In this study, the order in which the tests were administered did not affect performance on either the copy or the recall phases of the ROCFT. This is contrary to the findings of Maillet (1984) where the scores on the recall phase were found to vary depending on whether the ROCFT was administered first or last. Those who did the ROCFT last performed more poorly on the recall phase than those who did the ROCFT first, indicating that there was proactive interference from the preceding tests, namely the WAIS-R Block Design and the Embedded Figures Test. At issue is the order of administration of tests in a testing situation, where testing material made up of geometric designs should be administered after the ROCFT in order to optimize performance on the recall phase. Anecdotally, this author has noted the proactive interference of visual stimuli on performance on the ROCFT recall phase in a clinical setting where a client included a

partial drawing of a bicycle in his recall drawing. He had been asked earlier in the testing session to draw a bicycle. Another client drew parts of the Wechsler Memory Scale visual components in his ROCFT recall drawing. Again, this test had been administered earlier in the testing session. It is this author's opinion that testing material comprising geometrical figures or other visual stimuli administered before the ROCFT could compromise performance on the ROCFT recall. Accordingly, it was expected that the prior exposure to geometrical figures in this study would influence recall performance. Perhaps the nature of the Category Test used in this study, because of the repeated exposure to similar visual stimuli was enough to ensure that its stimuli were sufficiently distinct to not interfere proactively with the ROCFT when it was administered at the end of the session.

Additional Findings

It is difficult to determine what qualifies as impaired performance on the copy or recall phase of the ROCFT. No cut off scores have been given. However, the present sample of normal adults includes several protocols which would have been considered impaired by most clinicians (see Appendix I for examples). For the copy phase, 15 participants scored below one standard deviation from the mean (mean=29.9), 7 of which scored below two standard deviations. For the recall phase, 18 participants scored below one

standard deviation from the mean (mean=21.9), 5 of which scored below two standard deviations. Thus approximately 5 - 15% of this sample might easily have been labeled brain-damaged on individual assessments. Yet these individuals are known to function well in their day to day lives, some even holding employment in areas that might be considered to require spatial abilities.

The above finding raises concern regarding interpretation of test results in the neuropsychological setting. It appears that a certain proportion of the normal population will perform at a level below that which might be expected. Although one cannot deny that their performance implies impairment, the more important issue may be how that impairment is compensated for in the individual's day to day functioning. Care should be taken not to overemphasize weaknesses in a person's performance on neurpsychological testing when these weaknesses bear little relevance to the person's daily living. For example, an acquired deficit in visual spatial ability might be very significant in the life of an architect, whereas it could conceivably be of little relevance in the life of a grocery clerk. The grocery clerk could quite probably compensate in other ways for his/her impairment, whereas the architect's livelihood depends on these abilities. In addition, the clinician should exercise care in interpreting test results according to existing norms, especially when the elderly are involved. Many tests have been standardized on limited samples. The findings in this study concerning the Category Test are a good example of this. *The only acceptable explanation for 41% of this sample falling into the impaired range on this test is the*

inadequacy of the norms used to interpret performance . Fortunately, this issue has been receiving attention in the literature, and norms are now becoming available for older populations on various testing measures.

SUMMARY DISCUSSION

The ROCFT is an assessment measure which is gaining much popularity in clinical neuropsychology, having been adopted as an integral part of testing batteries in many settings. The present study set out to examine the performance of normal adults on this test, especially with regard to copying strategy. Regarding procedural types, the present study calls into question the norms established by Osterrieth (1944) It was found that the percentage of persons using the various procedural types did not agree with those stated by Osterrieth (1944). Indeed, judging by the present sample, it appears that the normal population will exhibit a much more diverse range of perceptual organization than was originally thought by Osterrieth (1944).

As well as could be determined, the sample for the present study was a normal one. The possibility exists, however, that some participants may, in fact, have been impaired. It is difficult to state unequivocally whether the observed differences in performance are due to a normal range of behavior or whether they reflect some impairment. The nature of the task of separating brain damaged from non-brain damaged inidividuals is such that we may

never be sure. There appears to be no question, however, that the choice of procedural type IV does not necessarily indicate impairment. Impaired perceptual ability will no doubt lead to this copying strategy; but, as noted by Rey (1941), procedural type IV might also be adopted as a result of inattention, nonchalance, or apprehension. Regardless of the *reason* for the use of this copying strategy, it is still quite probable that performance on the copy and recall phases of the test will be compromised. Accordingly, care should be taken by the examiner to attempt to ascertain the reason for the use of this copying strategy. Given the relationship of copying strategy with other performance measures on the ROCFT, if an individual is suspected of chosing an inferior copying strategy for reasons other than impairment, care should be taken in interpreting performance on the copy and especially the recall phase.

The strategy score, outlined by Bennett-Levy (1984), reflects perceptual organizational ability. Because of the demonstrated relationship between strategy score and procedural type, it was concluded that the procedural types are also a measure of perceptual organization. It was found that both the strategy score and the procedural type used will predict performance on the copy and the recall phases of the ROCFT. Accordingly, both measures could potentially be used to infer one of two kinds of recall deficit: reflecting either a "forgetting" of adequately organized input; or reflecting poor initial organization of the figure.

The strategy score gives a more quantitative measure of perceptual organization than do the procedural types. Other researchers cited above have also developed more elaborate methods of evaluating copying strategy. Such methods hold a valuable place in research, where they appear to be used almost exclusively, few clinicians consider copying strategy in their routine assessment of clients. The present study has shown that assessing performance on the ROCFT without consideration of the copying strategy could result in the loss of valuable diagnostic information. The more quantitative means of assessing copying strategy, such as Bennett-Levy's strategy score, require time and effort. Osterrieth's procedural types can be assessed easily during test administration and provide essentially the same information as do the more elaborate methods. They have proven to be a quick and simple means of assessing perceptual organizational ability.

Several task and subject variables were examined in an attempt to assess the factors relating to choice of copying strategy. The findings were inconclusive. Other research seems to indicate that gender, handedness, and academic concentration may play a role (Casey et al.,1991; Weinstein et al., 1990). Further research is warranted.

Unexpected findings were seen concerning the Category Test. Its high correlation with all performance measures on the ROCFT leads to the question of whether the applicability of this measure as it is currently used should be investigated. Reitan (1966) indicated

that the Category Test could be considered a measure of current adaptive ability, in which "the individual must have the ability to note similarities and differences in stimulus material, construct hypotheses taking into account these similiarities and differences, then test and adapt these hypotheses in accordance with confirming or disconfirming feedback" (Sterns, 1987). Clearly, a person's adaptive ability would be compromised in this task by the visual stimuli in the test if s/he were impaired in either perceptual organization or visual recall. Also the numerous indications of impairment found in this normal sample lead to the conclusion that the norms on the Category Test need to be reevaluated. Certainly they should be used with great caution and in conjunction with information gathered through other tests, interviews and observations.

In conclusion, assessment of copying strategy has been found to provide valuable additional information regarding performance on the ROCFT. Although the norms for Osterrieth's (1944) procedural types have been called into question, it is felt that procedural type remains the most efficient means of measuring copying strategy in a clinical setting. More quantitative measures may be warranted in a research situation.

performance requires a systematic and flexible approach to problem solving. (p.146)"

The Category Test, as a neuropsychological measure, has been found to be up to 90% effective in distinguishing between brain-damaged subjects and normal nonpsychiatric subjects (Wheeler, Burke and Reitan, 1963). The present study, however, has revealed some rather startling results with regard to this test. Generally, the cutoff score for impairment is 51 or more errors. The normal sample used in this study had a mean number of errors of 48.3 with 41 percent of participants scoring within the impaired range (i.e., more than 51 errors). *Surely the norms for this test need to be reexamined* . The individuals in this sample are known to be highly functioning with regards to employment, interpersonal relationships and church responsibilities. In addition, the sample showed a higher than average education level, with a mean of two years schooling after high-school. At least 31% were college graduates. Norms for the Category Test were derived on a relatively young normative sample (Boll, 1981); however, Lewinsohn (1973) and Pauker (1977) have noted that the sensitivity of the Category Test to aging shows up in higher error scores beginning in the forties. In the present research, 27% were aged 40 or over, and of that 27%, 65%, fell within the impaired range. Thirty-eight percent of the total sample were under 40 and fell within the impaired range. Although age was found to be the greatest predictor of scores on the Category Test, accounting for 23.47% of the variance, clearly it does not account exclusively for the "poor" performance of this sample.

Another finding of note in the present study was the highly significant correlation of the Category Test with both the copy and the recall phases of the ROCFT. In fact, of the eight variables which were significantly correlated with the Category Test, copy and recall scores were among the four variables indicated through stepwise multiple regression as the best predictors of Category Test errors. In addition, the Category Test was included in the regression equation for both the copy and the recall phases. Clearly, this test has a strong visual spatial component, not only with regards to perceptual organization, but seemingly with visual memory as well. This is also evidenced by the fact that the scores on the Category Test were found to vary according to the level of strategy score, with those who received scores in the high level of strategy score producing significantly fewer errors on the Category Test than those who received strategy scores in the medium level. Strategy scores, as has already been stated, are a reflection of perceptual organizational ability. Thus poor performance on the Category Test *may not be indicative of an inability to learn in situ as Gregory (1987) stated, but rather of an inability to process and/or remember the visual stimuli which make up the test.*

For the above reasons the Category Test was not considered to be an adequate estimate of intelligence. Gregory (1987) suggested it as an alternative to the WAIS-R, which he termed "a predominantly left-brain test". It turns out that the Category Test may be a measure of the other extreme, a predominantly right-brain test. Although the current study was left without an estimate of

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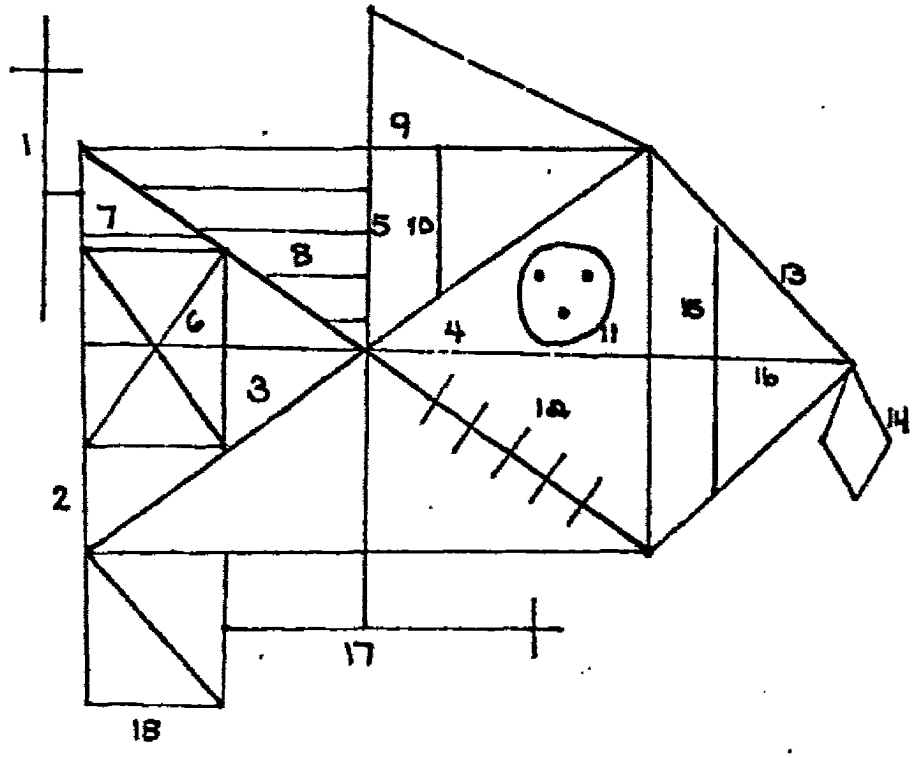
APPENDIX A

Scoring system for Rey-Osterrieth complex figure test

1. Cross upper left corner, outside of rectangle
2. Large rectangle
3. Diagonal cross
4. Horizontal midline of 2
5. Vertical midline
6. Small rectangle, within 2 to the left
7. Small segment above 6
8. Four parallel lines within 2, upper left
9. Triangle above 2, upper right
10. Small vertical line within 2, below 9
11. Circle with three dots within 2
12. Five parallel lines with 2 crossing 3, lower right
13. Sides of triangle attached to 2 on right
14. Diamond attached to 13
15. Vertical line within triangle 13 parallel to right vertical of 2
16. Horizontal line within 13, continuing 4 to right
17. Cross attached to low center
18. Square attached to 2, lower left



Scoring:

Consider each of the eighteen units separately. Appraise accuracy of each unit and relative position within the whole of the design. For each unit count as follows:

Correct	placed properly	2 points
	placed poorly	1 point
Distorted or incomplete but recognizable	placed properly	1 point
	placed poorly	½ point
Absent or not recognizable		0 points
Maximum		36 points

Source for scoring:

L.B. Taylor, Montreal Neurological Institute.

APPENDIX B

Scoring Criteria For Bennett-Levy's (1984) Strategy Score

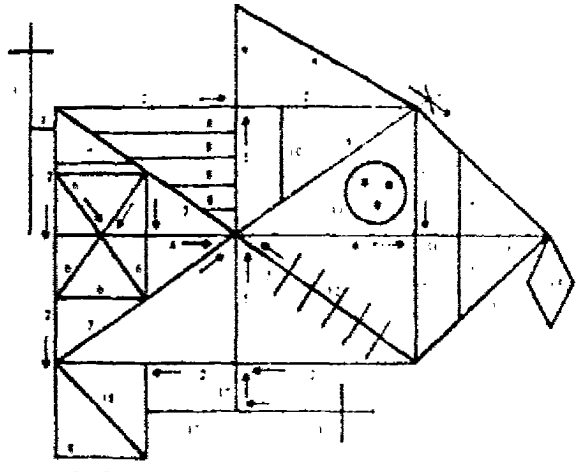


Figure 1. The Rey-Osterrieth figure. Numbers indicate the order in which the [illegible] arrows, the points of good continuation, and the [illegible] two lines for further details. Good continuation [illegible] direction of the arrows or in the reverse direction.

GOOD CONTINUATION. Good continuation was said to have been demonstrated when a straight line was drawn as one piece and continued until its final intersect with another line. Seventeen points of good continuation for the Rey-Osterrieth figure are illustrated by arrows in Fig. 1; there are, of course, a number of other possible good continuation points (e.g. the diagonal cross has 14 or 15 potential good continuation points). However, lines were not 'poorly' continued by our subjects at any point other than those shown in Fig. 1. Additionally, one point of 'poor' continuation is illustrated by the crossed arrow at the intersection of the two triangles. Subjects wee awarded a point if they did not continue the line at this intersection; others, who copied the line in one piece from the top of the upper right triangle to the apex of the right-hand triangle as if it were a straight line, lost one point.

The maximum good continuation score is 18 points, consisting of the 17 points shown in Fig. 1, plus the point of 'poor' continuation.

SYMMETRY: The scoring of the principle of symmetry was predicated on the assumption that the order in which a subject draws the components of the Rey figure should accurately reflect the structure and symmetry that the subject perceives within the figure. Points were therefore awarded for the successive construction of symmetrical units, and their symmetrical components. *Cunningham* (1980) also has argues that the output order of subjects' drawings may mirror the internal representation of visual stimuli.

The symmetry scoring system is illustrated in Fig. 2. Symmetry points were gained when the following rules were observed:

(1) The component parts of symmetrical figures were drawn successively (e.g. Unit 2 rectangle outline; Unit 3 diagonals; Unit 13 vertices; Unit 18 outline). Two points were awarded for the successive construction of components of the three figures which are symmetrical about *two* explicit (i.e.presenting the figure) axes of symmetry (Units 2,3 and 4 + 5) (See Fig. 2A). One point was awarded for the figures which are symmetrical about just *one* explicit axis of symmetry (e.g. the left and right halves of the large rectangle (Fig.2C); the small rectangle (Unit 6); the diagonal cross (Unit 6; Unit 13; Unit 18).

(2) One point was awarded when a symmetrical figure *or* an axis of symmetry within a symmetrical figure was drawn *immediately* after a symmetrical figure (e.g. Unit 3,4 or 5 after 2; 15 after 13), *or* a symmetrical component (e.g. 3 after 5; 4 after 5; 16 after 15) *or* an axis of symmetry (e.g. 3 after 4; 13 after 16) *or* a completion line of a symmetrical figure whose components had not been drawn successively (e.g. Fig. 2F(ii)).

(3) One extra point was awarded for drawing the large rectangle first; the justification for this was that it is the 'best' figure, being symmetrical about two explicit axes and being'closed'; *further if it was drawn before any other figure*, it would not gain a point on rule 2.

These principles are illustrated in Fig. 2. To take just one example, 2A: the rectangle gets 1 point on rule 3 and 2 points on rule 1; the vertical axis 1 point for succession (rule 2) and 2 points for being constructed together (rule 1); the vertical axis 1 point for succession (rule 2); the horizontal axis 1 point for succession (rule 2); and the composite horizontal/vertical cross, *without extensions* (otherwise it ceases to be a symmetrical figure about two axes), 2 points on rule 1. Note however, that while 2 symmetry points are gained by this configuration, 3 good continuation points are lost.

Figure 2 illustrates several other interesting features of the scoring system. Three exceptions to rule 1 are shown in Figs 2D, 2E and 2F (i); rule 1 is formally contravened since not *every* side of these figures is drawn successively when the large rectangle has previously been constructed. However, it seems parsimonious to assume that these units are perceived as symmetrical figures when the remaining components are drawn successively. 2C illustrates a symmetrical *arrangement* achieved by a piecemeal approach to the construction of the large rectangle; 2E(ii) illustrates this for the small internal rectangle. Again, note that both these configurations will lose good continuation points. 2D shows two alternative 3 point arrangements for the right-hand triangle; the axis of symmetry is worth 1 point in 2D(i), but not 2D(ii), because of rule 2; in 2D)ii)m rules 1 and 2 combine to give 2 points for the triangle vertices. 2F(ii) shows a case where rule 1 is contravened, since only two sides of the square are drawn successively. No points are awarded for this configuration.

There are, of course, other symmetrical units in the figure such as the diamond and the two crosses. These have been omitted from the scoring system because almost all subjects construct the component parts consecutively.

The maximum symmetry score a subject can achieve is 18 points. This follows from a combination of 2A, 2D(i), 2E(ii), and 2F (i).

STRATEGY TOTAL. The strategy total is the sum of the good continuation and symmetry scores. There is a theoretical *maximum* of 36 points, which no subject *can* achieve because at three points in the construction of the figure, good continuation and symmetry strategies are in direct conflict.

APPENDIX C

CRITERIA FOR ASSESSING PROCESSING STYLE

These criteria are taken from the following publication:

Casey, M.B., Winner, E., Hurwitz, I., DaSilva, D. 91991). does processing style affect recall of he Rey-Osterrieth or Taylor complex Figures. *Journal of clinical and Experimental Neurospychology,* 14(4), 600-606.

" To assess subjects' preference for either a visual or a verbal style of processing, we used a modification of a sentence-picture verification task developed by Macleod, Hunt, and Matthew (19780. We presented subjects with three written sentences describing spatial relationships between a star and a plus (e.g., 'Plus is below Star.' After each sentence subjects turned the page to find a picture of a star either above or below a plus. Subjects were to indicate whether the sentence just read was a true or false description of the picture. To insure that subjects had several trials on which to base their self-report of the strategy used, subjects were given three trials prior to making their judgment.

"After completing the items, subjects were asked to indicate the strategy they used to solve the task. They were asked to circle one of the strategy descriptions below: (1) I read the words in the sentence, memorized them, turned the page, and compared the sentence in my mind to the picture before me. (2) I read the sentence, converted the words to a picture representing the words, turned the page, and compared the picture in my mind to the picture before me. (3) Sometimes I used strategy 1 and sometimes I used strategy 2. (4) I so not know which strategy I used. We used Richardson's (1977) terms, 'verbalizer' (option 1 above) and 'visualizer' (option 2 above) to classify subjects into the verbal or visual processing style categories, respectively. Subjects using option 3 above were designated as partial visualizers, since they

reported spontaneously converting the words into an image on at least some of the trials.

"Following administration of the ROCFT, participants were asked to assess the strategy they had just used when reproducing the figure. They were asked to circle one of the strategy descriptions below: (1) I saw the parts of the picture in my mind and copied my mental image. I did not use verbal labels as an aid (e.g., I saw a picture of a circle in the upper half of the figure and then drew it). (2) I reminded myself of the parts of the figure by using verbal labels (e.g., I said to myself, 'There's a circle in the upper half' and then I drew it.)' "

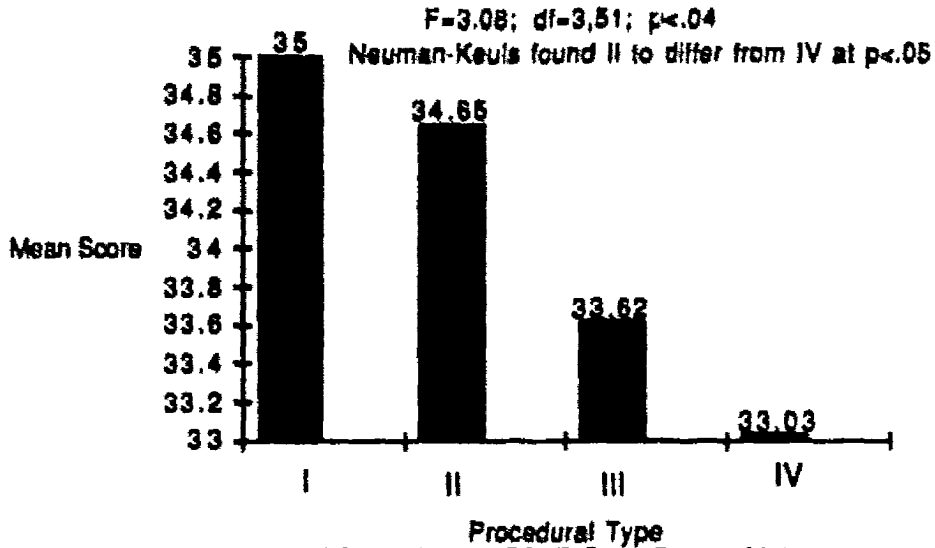
APPENDIX D

SUMMARY OF SEVERAL POSSIBLE REGRESSION MODELS

Dependent Variables	Independent Variables	R	R^2	F	R^2Ch	FCh	SEE
Copy:	Type	.37488	.14053	16.84****			2.99
	Strategy	.37917	.14377	17.29****			2.99
	Category Test	.37035	.13716	16.37****			3.00
	Category, Type	.37448	.14053	16.84****	.14053	16.84****	2.99
	(Stepwise)	.48485	.23508	15.67****	.09454	12.61****	2.84
Recall:	Type	.21787	.04747	5.13*			6.25
	Copy	.40915	.16740	20.71****			5.84
	Strategy	.30378	.09228	10.47***			6.10
	Age	.30354	.09214	10.45***			6.10
	Gender	.20793	.04324	4.65*			6.26
	Category Test	.46862	.21961	28.99****			5.65
	Category, copy	.46862	.21961	28.99****	.21961	28.99****	5.65
	(Stepwise)	.53285	.38392	20.22****	.06433	9.16**	5.44
	Copy, Age, Gender	.40910	.16740	20.71****	.16740	20.71****	
	(Stepwise-no Category)	.49940	.24920	16.93****	.08180	11.12***	
		.52700	.27770	12.94****	02850	3.98*	5.49
Type:	Strategy	.60005	.36006	57.95****			.7005
	Category Test	.18132	.03288	3.50			.8612
	Strategy (Stepwise)	.60005	.36006	57.95****			.7005
Strategy:	Type	.60005	.36006	57.95****			4.03
	Math	.19943	.03977	4.27*			4.93
	Category Test	.27665	.07654	8.55**			4.84
	Type, Category	.60005	.36006	57.95****	.36006	57.95****	4.033
	(Stepwise)	.62385	.38919	32.50****	.02913	4.87*	3.95
Category:	Type	.18132	.03288	3.50			26.20
	Copy	.37035	.13716	16.37****			24.74
	Recall	.46862	.21961	28.99****			23.53
	Strategy	.27665	.07654	8.53**			25.60
	Age	.48443	.23467	31.58****			23.30
	Gender	.16898	.02855	3.03			26.26
	Education	.23325	.05441	5.93**			25.90
	Math	.27840	.07750	8.65**			25.59
	Age, Copy, Ed, Recall	.48443	.23467	31.58****	.23467	31.58****	23.30
	(Stepwise)	.59746	.35696	28.31****	.12229	19.40****	21.47
		.65077	42350	24.73****	.06655	11.66****	20.43
		.69016	.47632	22.74****	.05282	10.09**	19.56

*p<0.05; **p<0.01; ***p<0.001; ****p<0.0001

APPENDIX E



Relationship of Procedural Types With ROCFT Copy Phase (Maillet, 1984)

APPENDIX F

ASSESSMENT FOR EFFECTS OF SEX, HANDEDNESS, AND ACADEMIC CONCENTRATION ON ROCFT PERFORMANCE

NUNBER OF SUBJECTS IN EACH GROUP

GROUP	NUMBER
Female math/science left-handers and ambidextrous subjects	3
Female math/science right-handers with familial sinistrality	10
Female non-math/science left-handers and ambidextrous subjects	3
Female non-math/science right-handers with familial sinistrality	12
Female math/science familial right-handers	15
Female non-math/science familial right-handers	16
Male math/science left-handers and ambidextrous subjects	3
Male math/science right-handers with familial sinistrality	9
Male non-math/science left-handers and ambidextrous subjects	4
Male non-math/science right-handers with familial sinistrality	6
Male math/science familial right handers	11
Male non-math/science familial right-handers	13

ONEWAY ANALYSIS OF VARIANCE TABLE

INDEPENDANT VARIABLE	SOURCE	DF	SS	MS	F	Eprob
Copy	Between	11	105.55	9.60	.9210	.5239
	Within	93	968.84	10.42		
	Total	104	1074.39			
Recall	Between	11	496.16	45.11	1.1272	.3595
	Within	93	3721.40	40.02		
	Total	104	4217.56			
Strategy	Between	11	355.63	32.33	1.3384	.2162
	Within	93	2246.51	24.16		
	Total	104	2602.13			

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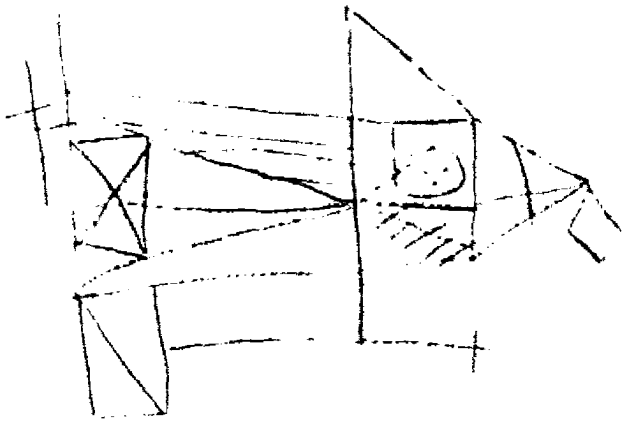
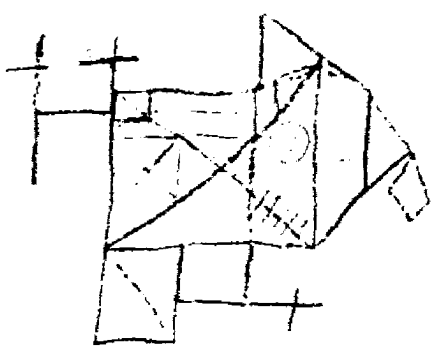
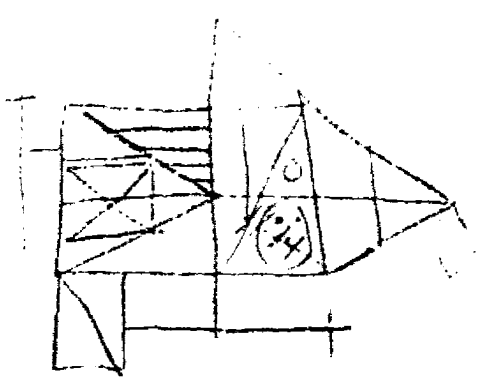


Female, age 21, ed. 3 yrs post high-school, type IV, score 20



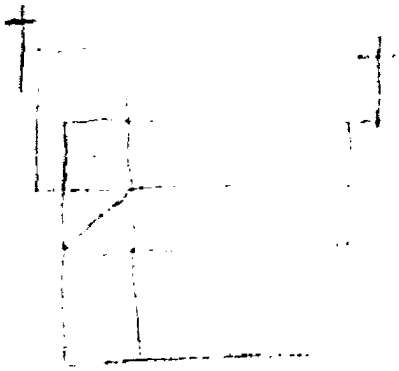
Male, age 23, ed. 2 years post high-school, type III, score 23



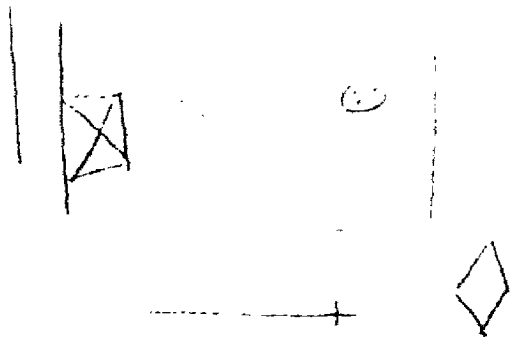
Female, age 39, ed. < than high-school, type IV, score 23

EXAMPLES OF POOR PROTOCOLS (Recall)

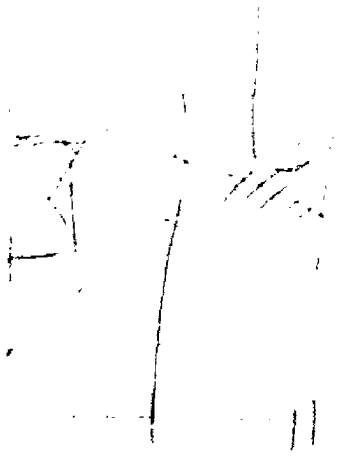
Female, age 25, ed. 1 yr post high-school, type III , score 11



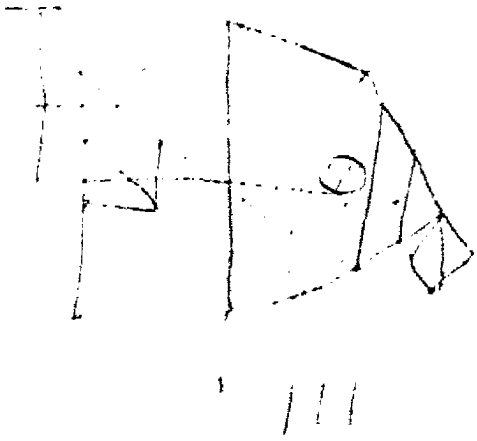
Female, age 43, ed. high-school, type II, score 10.5



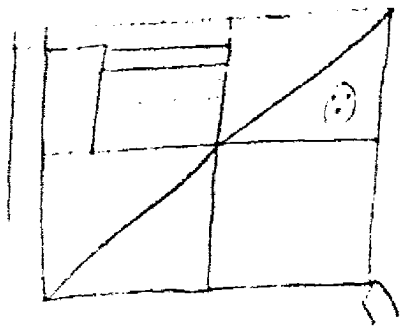
Female, age 20, ed. high-school, type IV, score 12



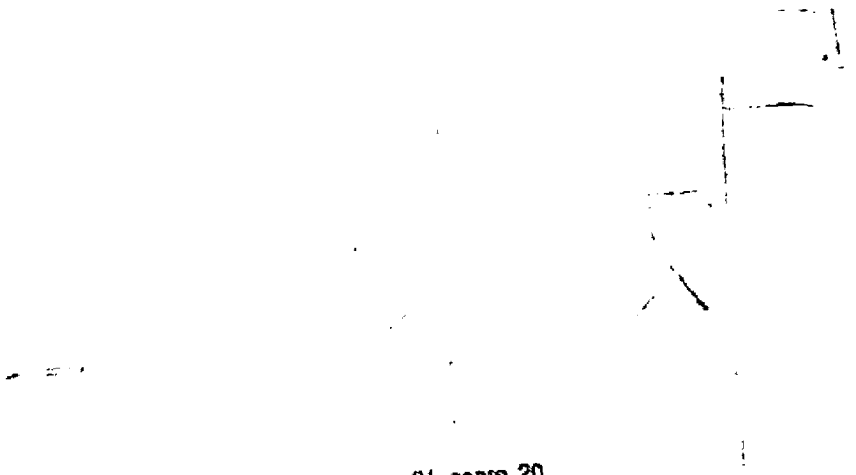
Male, age 45, ed. high-school, type III, score 5



Male, age 30, ed 7 yrs post high-school, type IV, score 17

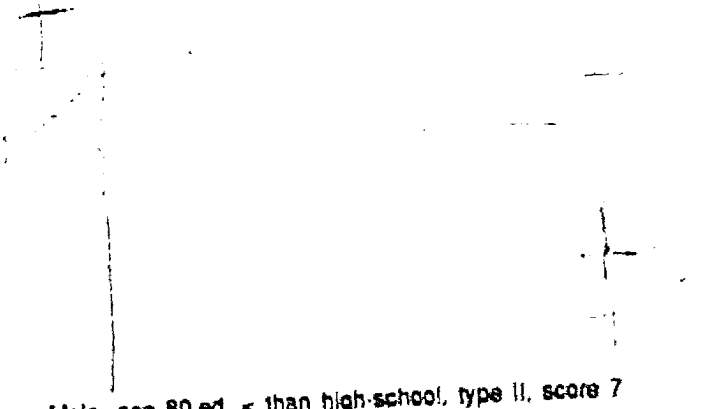


Female, age 25, ed 1 yr post high-school, type I, score 8.

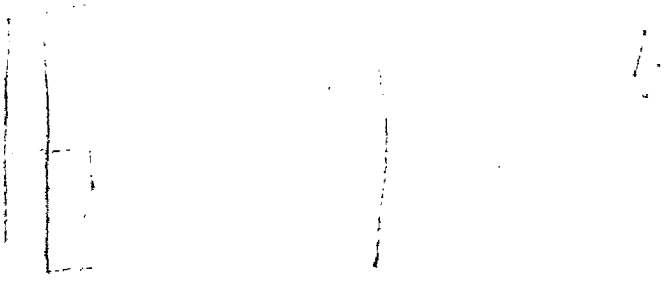


Male, age 56, ed. < than high-school, type IV, score 20

Female, age 21, ed. 3 yrs post high-school, type IV, score11.5



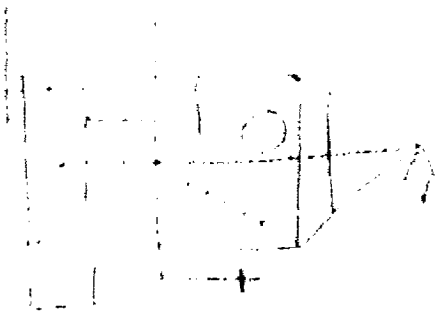
Male, age 80,ed. < than high-school, type II, score 7



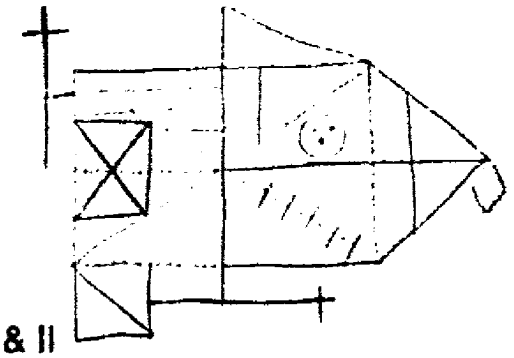
Male, age 51, ed. 12 yrs post high-school, type IV, score 8.5

APPENDIX G

Examples of Relationships of Procedural Types on ROCFT Copy Phase

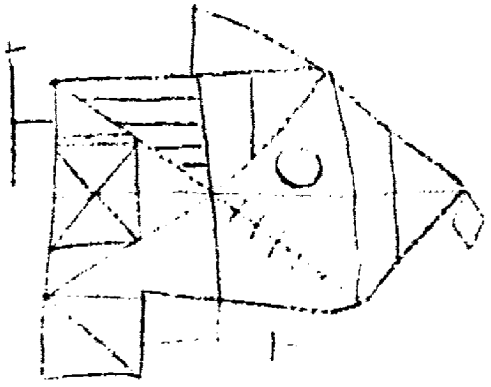


Female, age 34, ed. 6yrs post high-school, score 35

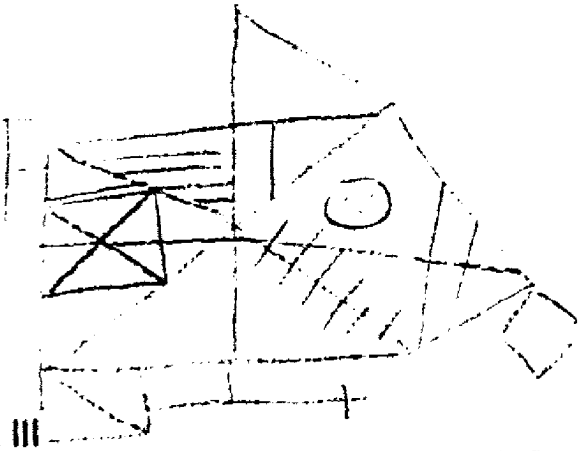


Female, age 19, ed. 2 yrs post high-school, score 35

TYPES I & II

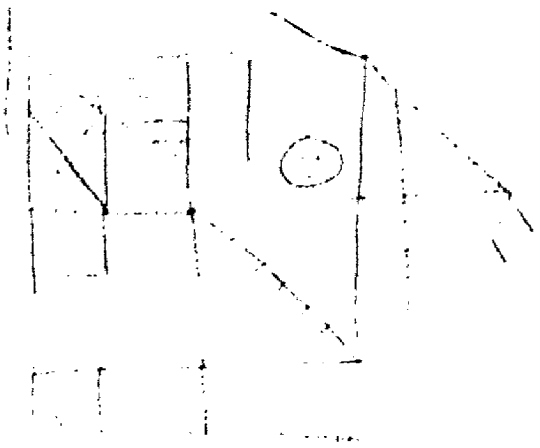


Male, age 45, ed. high-school, score 25

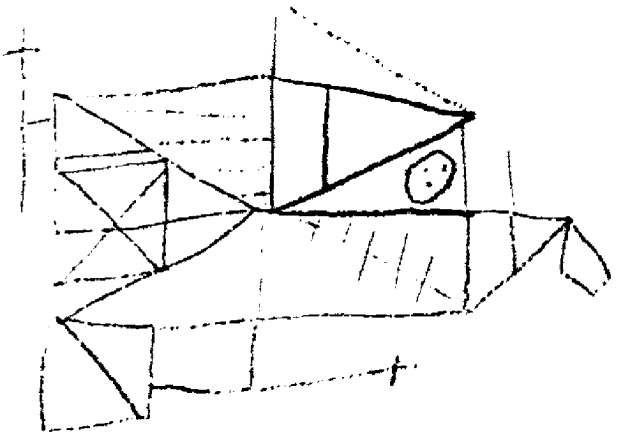


Male, age 21, ed. high-school, score 31.5

TYPE III



Female, age 18, ed. 5 yrs post high-school, score 27



Male, age 37, ed. 4 yrs post high-school, score 28

TYPE IV

APPENDIX H

RESULTS OF LENIENT SCORING ON ROCFT COPY

ONEWAY ANALYSIS OF VARIANCE TABLE FOR LENIENT SCORING ON THE COPY PHASE (EFFECTS OF PROCEDURAL TYPE AND STRATEGY SCORE)

INDEPENDANT VARIABLES	SOURCE	DF	SS	MS	F	Fprob
Type:	Between	2	96.85	48.43	17.188	.0000
	Within	102	287.38	2.82		
	Total	104	384.23			
Strategy:	Between	2	40.73	20.37	6.0476	.0033
	Within	102	343.50	3.37		
	Total	104	384.23			

DESCRIPTIVE SAMPLE CHARACTERISTICS FOR STRICT AND LENIENT SCORING CRITERIA FOR COPY PHASE (MAILLET, 1992)

STRICT SCORING											
Percentiles	5	10	20	30	40	50	60	70	80	90	100
Score	23	26	27	28	29	30	31	32	33	34	36

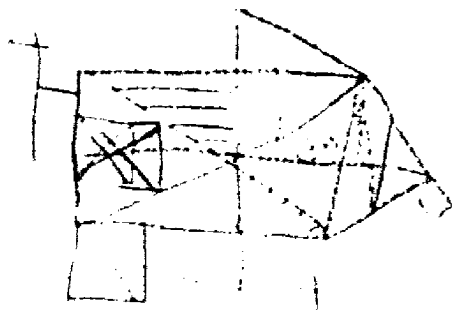
LENIENT SCORING											
Percentile	5	10	20	30	40	50	60	70	80	90	100
Score	30	31	33	33	34	30	35	35	35	36	36

PERCENTILE NORMS FOR OSTERRIETH'S 1944 SAMPLE ON COPY PHASE

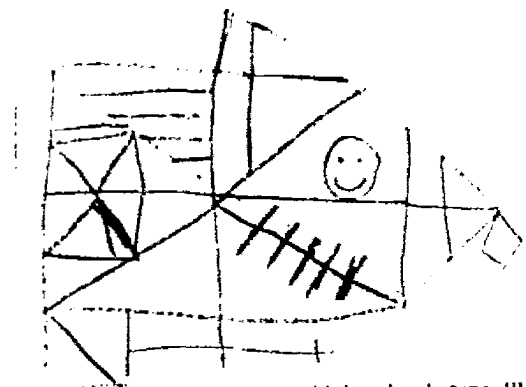
Percentile	5	10	20	30	40	50	60	70	80	90	100
Score	-	29	30	31	32	32	33	34	34	35	36

APPENDIX I

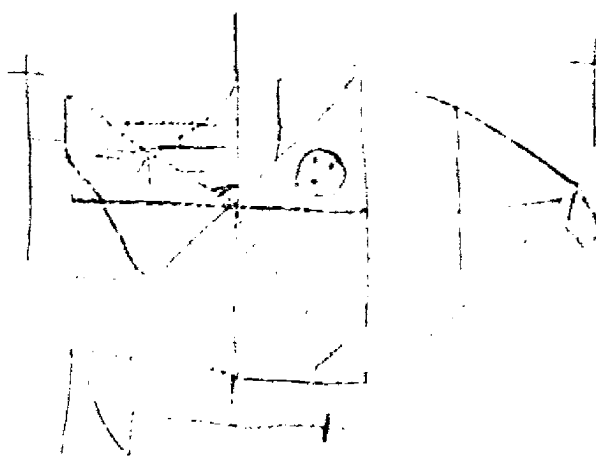
EXAMPLES OF POOR PROTOCOLS (copy)



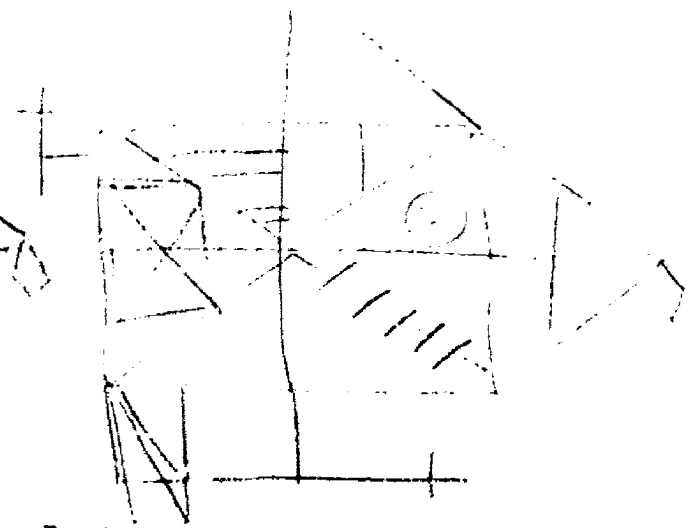
Male, age 56, ed.< than high-school, type IV, score 25.5



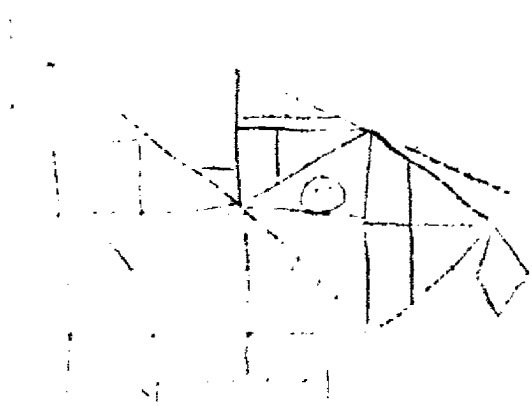
Female, age 28, ed. 1 yr post high-school, type III, score 27



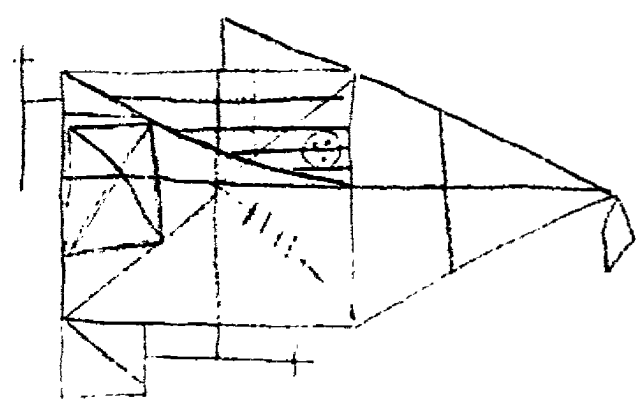
Male, age 20, ed. high-school, type III, score 25



Female, age 26, ed. 1 yr post high-school, type II, score 26



Female, age 26, ed. 2 years post high-school, type IV, score 27.5



Male, age 22, ed. .5 yrs post high-school, type I, score 27.5