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Traditional psychosocial treatment and rehabilitation approaches for criminals are notoriously ineffective. It is possible that this failure is due, in part, to the lack of recognition of biological factors in the causation of criminal behavior. The psychogenic perspective has been dominant in explaining and treating criminal behavior, although there is little substantive evidence for this view. On the other hand, evidence for biogenic factors, specifically organic brain dysfunction in criminals, has been accumulating. Evidence for this perspective points toward a causal relationship between a high incidence of neuropsychological deficits and criminal behavior. Implicated in this evidence are the frontal lobes of the brain which synthesize information about the outside world. This provides the means by which behavior of the organism is regulated in accordance with the effects produced by its actions. The purpose of the present study was to investigate possible links between brain function and criminal behavior with a parolee sample. The Trail Making test was administered

to parolees. The results were broken down by violent versus nonviolent offenders. The results showed statistical significance for test performance between the violent and nonviolent groups. The violent offenders made statistically significantly more errors, and took significantly more time to completion on both tests. However, the difference in performance with regard to total number of errors was not clinically significant. Differences in time to completion were significant.

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CHAPTER 1

INTRODUCTION

Traditional psychosocial approaches to the explanation and treatment of persistent criminal offenders are notoriously ineffective. This failure may be due, in part, to the lack of recognition of the role of biological factors in the causation of criminal behavior (Elliot, 1982; Yeudall, Fedora & Fromm, 1987). The psychogenic perspective contends that criminal behavior has no organic basis and is therefore due to environmental factors. This perspective has dominated traditional explanations of criminal behavior, even though little substantive evidence for it exists (Rimland, 1969; Tittle, 1983; Yeudall & Fromm-Auch, 1979).

On the other hand, the evidence for biogenic factors, specifically organic brain dysfunction in criminals, has been accumulating and has, in more recent years, become increasingly pervasive. Evidence for this perspective points toward a causal relationship between a high incidence of neuropsychological deficits and criminal behavior. However, this evidence has been gathered from special populations receiving medical treatment as opposed to populations of convicted individuals in general prison populations (Kandel & Freed, 1989). Furthermore, the evidence for biogenic causation in criminal behavior has been widely discrepant; some studies report a very high incidence of brain dysfunction, and others report virtually none (Stuss & Benson, 1984). Because the data from these studies are so contradictory in nature, it is necessary to provide further scientific research on the incidence of organic brain dysfunction in criminals.

History of Brain Research on Criminals

The frontal lobes synthesize information about the outside world received through the senses, and information about the internal states of the body, providing the means by which behavior of the organism is regulated in accordance with the effects produced by its actions. The frontal lobes judge and regulate ongoing perception and calculate appropriate responses to what is being perceived (Luria, 1980). The study of the relationship between the frontal lobes and behavior began with research on patients with minimal brain dysfunction (Moniz, 1937). Although the definition of minimal brain dysfunction is controversial, it is often defined as brain dysfunction severe enough to affect behavior, but not severe enough to result in "hard" neurological signs. Moniz's work showed there was a notable decrease in anxiety in patients who had undergone prefrontal leukotomies. Shortly thereafter the frontal lobes were believed to regulate a set of loosely defined "higher" functions of human behavior. Included among these are abstract behavior, ethics, foresight, awareness of self, and intellectual capacity (e.g., Rylander, 1939). The enlargement of the frontal cortex, it was contended, was one of the distinctive morphological developments in the evolution of the human brain.

From the beginning, frontal lobe research has produced considerable confusion because of discrepant data. Several studies concluded that the frontal lobes were not at all clearly involved in the regulation of any cognitive or emotional functioning (Hebb, 1939, 1945; Mettler, 1949). It is believed that this confusion was due to poor operational definitions (Kandel & Freed, 1989). Many of the reports were based on single case studies or patients with frontal lobe tumors (Teuber, 1964). Patients with frontal lobe tumors do not typically make a good index group to study, because the tumor may have caused injury to other parts of the brain (Teuber, 1964).

In the 1950s, the emphasis switched from the relationship of the frontal lobes and higher functions to the relationship between the frontal lobes and emotion and psychiatric disorders. Various emotions were noted in patients with frontal lobe lesions such as reductions in drive, enthusiasm, and energy as well as irritability and selfishness (e.g., Miller, 1971). Also noted were emotions such as depression, anxiety and fear (e.g., Williams, 1952). However these studies' conclusions were to be pronounced in later years as questionable (Nauta, 1971). A great deal of individual variation was seen in the type of psychiatric disorders and characteristics with the frontal lobe lesions.

It was not until the 1960s that scientists began consistently defining task-specific impairments demonstrated by frontal lobe patients. Milner (1964, 1984) and her colleagues limited the scope of their research to the definition and discussion of specific abilities, rather than reviewing and attempting to integrate the more inconsistent findings of the past. This allowed researchers to isolate and identify specific abilities that were impaired with frontal lobe lesions.

Teuber (1964) hypothesized that frontal lobe deficits were not simply memory deficits, but rather the inability of the patients to utilize feedback cues in their anticipation of events to adjust behavior accordingly. Luria (1966) attributed to the frontal lobes the capacity of foresight, planning and, in general, the regulation of impulses. He later identified a reliable perseverative tendency in frontal lobe patients when patients could not adjust their behavior according to the information given by external cues.

Nauta (1971) similarly concluded that frontal lobe patients were unable to integrate internal and external pieces of information to appropriately adjust behavior. A plan of action cannot be kept in abeyance intact for any length of time unless it is matched by environmental stimuli. Therefore, one of the deficits of the frontal lobe patient lies in an inability to maintain a stable behavior. Luria (1973), based on clinical studies, likened the impulsive behavior of frontal lobe patients to that of young children in whom the frontal lobes are not completely grown. Frontal lobe patients exhibited lack of self-control, violent emotional outbursts, and gross change in character.

Luria (1973) concluded that the prefrontal areas are critical for the programming of complex motor acts, for appreciating feedback and for sustaining goal directed behavior. Accordingly, frontal lesioned patients show deficits in mental flexibility and tendencies toward perseveration. Perseveration is the continuation of a particular response pattern when changed circumstances have rendered it inappropriate. Flexibility entails the ability to modify dominant response tendencies. For example, frontal lesion patients have difficulty maintaining a cognitive set based on examiner's instructions. This set is easily disrupted by competing habits or other stimuli. Luria (1973) concluded that the role of the frontal lobes in directing and modulating social interaction is related to their role in attentional scanning, the process of preferential responding to stimuli and affective evaluation.

The theory that frontal lobe immaturity may be a possible contributor to delinquent behavior was proposed by Pontius in 1974. This theory evolved from several other theories, and hypothesized that prior to full maturation of the frontal lobe (accomplished after the final growth spurt) cognitive inflexibility will mark behavior. This theory was tested (Pontius & Ruttiger, 1976) when researchers noted cognitive inflexibility in stories told by normal versus delinquent youths. The investigators concluded that the delinquent subjects had less mature frontal lobes than controls. It should be noted however, that the study used an unstandardized measure (story telling inflexibility) of frontal lobe impairment with no information on reliability or validity, and further employed no empirical support for its claims to measure frontal lobe maturity. Moreover, basic assumptions about the growth of the frontal lobe areas are not supported by other research (Kandel & Freed, 1989).

Delinquent males were studied further by Berman and Siegal (1976). Investigators compared adjudicated adolescent delinquent males with volunteer males of similar socio-economic class. All subjects were given the Weschler Adult Intelligence Scale (WAIS) and the Halstead-Reitan Neuropsychological Battery. Performance for delinquents was inferior on the WAIS. Performance was impaired on the Trails A test, which the investigators conceptualized as a measure of the ability to organize spatial perceptions. The Trails B test is conceptualized as adding a verbal-symbolic manipulation to the spatial and perceptual demands of Trails A. On the Trails B, delinquent subjects' performance was poor enough for them to be categorized as brain damaged. Investigators attributed this to the "strong verbal component" of the Trails B test. The investigators concluded that the delinquent group suffered from an overall impoverishment of adaptive abilities (e.g., ability to envision long term consequences, ability to learn from experience, etc.) compared with controls. Further, delinquents showed deficits in verbal, perceptual and nonverbal conceptual spheres.

Spellacy (1977) studied adolescents to investigate the hypothesis that organic impairment contributes to impulse dyscontrol and associated violent behavior in adolescents. Administering the MMPI and parts of a neuropsychological battery drawn from a clinical battery in use at the University of Victoria Neuropsychological Laboratory to violent versus nonviolent adolescent males, the investigator found the groups differed significantly on the neuropsychological test variables. They did not differ on the MMPI. That is, the neuropsychological assessment showed greater power in predicting group membership. Spellacy reasoned this finding to be in support of the hypothesis that the violent group has more members with impaired brain function than the nonviolent group. These results are consistent with the hypothesis that organic impairment contributes to impulse dyscontrol and associated violent behavior. It should be noted that the violent group's "impairment" was not diagnosed medically.

The same investigator followed up his study with adult males (as opposed to juveniles) (Spellacy, 1978). While the groups (violent or nonviolent) differed significantly on both the MMPI and the neuropsychological tests, the MMPI showed only a 79% accuracy in the classification of violent or nonviolent. The neuropsychological tests, however, showed a 95% accuracy rate. Spellacy concluded that neuropsychological tests should be definitely included in any test battery attempting to evaluate potentially violent persons. These results further implicate poor impulse control and disinhibition with violent behaviors. According to the author, the lack of control in the lives of violent persons is not simply a function of gross personality type, but also may be observed in areas of cognition, memory and motor behavior. This was interpreted as a possible organic contribution to the poor control seen in these persons.

Several reports based on clinical observation included the anterior regions of the brain (frontal as well as temporal) in the indication of criminal behavior. One study showed that 37% of a 124 patient sample admitted for episodic dyscontrol or violence, were diagnosed with temporal lobe epilepsy (Elliot, 1978, 1982). Elliot examined the remarkable similarities between Cleckley's criteria for psychopathy (1976) and symptoms associated with various neurological conditions. The author noted a considerable overlap between the constellation of behavioral patterns shown by psychopaths and especially those shown by patients with frontal lobe lesions.

Yeudall and From-Auch (1979) did a series of related studies that were described in the same article. In the first, criminals were compared with patients with depressive symptoms and with normal controls. The depressives and the criminals had significantly more anterior dysfunction than the controls as determined by the Halstead-Reitan Neuropsychological Battery. It is notable that because criminals did not differ from the depressives, this study does not reveal any dysfunctions that are specifically related to criminal behavior.

The second study (Yeudall & From-Auch, 1979) compared institutionalized delinquents with normal community controls on the Halstead-Reitan Neuropsychological Battery. The delinquent subjects had a significantly higher incidence of anterior dysfunction relative to controls. These results were supported by electroencephalograph (EEG) data.

The final study (Yeudall & From-Auch, 1979) compared 86 violent criminals to 79 normal controls. Using the Halstead-Reitan, again criminals had significantly more anterior dysfunction. No nonviolent criminals were used in this study, so it is not possible to say whether the neuropsychological differences were due to violence or simply criminality.

In a study of adolescents referred for neuropsychological testing and counseling because of learning disabilities, Spreen (1981) addressed the question of the relationship between neurological deficit and criminal behavior. Contrary to other reports, the results indicated that the presence of a learning disability in itself did not increase the likelihood of criminal behavior. Furthermore, the author's results showed very little support for the hypothesis that neurological impairment increases the likelihood of subsequent criminal behavior or delinquency.

Sackeim et al. (1982) did a review of hemispheric asymmetry in the expression of moods. They found that right side lesions tended to produce euphoric mood states, whereas left side hemispheric lesions were associated with dysphoric mood states. Thus, it is possible that hemispheric differences may account for the differences found in the 1950s in the emotions of frontal lobe lesioned patients.

Using an extensive neurological and intellectual battery, Yeudall, From-Auch and Davies (1982) studied male and female adolescent delinquents. Again, compared with controls, a high percentage of the delinquents showed neuropsychological deficits implicating the anterior regions of the brain, including the frontal lobes. Violent and nonviolent offenders did not differ on these measures. This may be explained by institutionalization or drug abuse (Grant et al., 1978). The results from this experiment were interpreted as suggesting that delinquents may have problems in planning their actions, and more importantly, in perceiving the consequences of these actions. It should be noted that the lack of differences seen in the violent versus nonviolent groups may be due to the low number of violent offenders included in the study (Yeudall et al., 1982).

Contrary to Yeudall, Fromm-Auch and Davies' (1982) findings, Tarter, Hegedus, Alterman, and Katz-Garis (1983) found no differences between adolescent groups in their investigation. Three groups were studied: violent, nonviolent and sex offenders. EEG measures, neurological exam and all other tests failed to show any relationship between groups. Due to lack of adolescents with psychotic or neurological impairment, the investigators speculated that their subject group was relatively neuropsychiatrically intact. Psychosis and neurological impairment, when controlled in an investigation, will yield non-significant differences between violent, nonviolent and sexual offending groups.

Subsequently, Tarter, Hegedus, Winsten and Alterman (1984) compared delinquents who had been abused as children to those who had not. The investigators demonstrated that as a group, abused/violent delinquents were found to be significantly more neuropsychologically impaired than the nonabused/nonviolent delinquents. No non-delinquents were used. The performance suggested anterior impairment based on poor performance on verbal or linguistic processes. However, the results have been called "problematic" (Kandel & Freed, 1989). A major test of verbal processes in this study was from a standard intelligence test, and it is widely agreed that intelligence tests are among the least sensitive to neuropsychological damage (Kandel & Freed, 1989; Milner & Petrides, 1984). Of further consideration, the abused delinquent group was significantly more violent then the nonabused group. Differences in performance thereby may have been due to a third variable, thus it is difficult to conclude that the observed differences were due to abuse rather than violent behavior.

Brickman, McManus, Grapentine, and Alessi (1984) administered scholastic and neuropsychological batteries to male and female delinquents having histories of multiple violent felonies. The violent and recidivistic delinquents showed distinctly abnormal neuropsychological patterns of functioning not only in the higher cortical functions, but also in temporal sequencing, rhythmic functioning and expressive speech. These latter findings suggest temporal lobe involvement.

Gorenstein (1982) hypothesized that the disinhibition exhibited by criminals may be somehow related to frontal lobe dysfunction. Testing the frontal lobe functions of perseverance and cognitive flexibility, Gorenstein's results showed that relative to controls, psychopaths exhibited a performance pattern common in frontal lobe lesioned patients. Results led the investigator to speculate that although psychopaths are able to acquire concepts, they are hampered by the tendency to persist with a previously reinforced, but currently maladaptive response set. Gorenstein further contended that impaired cognitive flexibility or perseveration seems to characterize the thinking of psychopaths. In view of this deficit, behaviors that are more frequently practiced, favored by stimulus cues, or that are currently being focused on will be relatively refractory to the modification of newly introduced reinforcement. Gorenstein's findings provided a strong argument for a conceptualization of psychopathy based on organic factors, specifically deficits in cognitive processes associated with frontal lobe functioning.

These findings were criticized, however, by Hare (1984). Hare addressed Gorenstein's hypothesis but used a different operational definition of psychopath, utilizing his own research scale based on Cleckley's (1976) criteria for psychopathy. Hare demonstrated that psychopaths in a prison population did not show the signs of frontal lobe impairments. It should be noted, however, that Hare did not attempt a replication of Gorenstein's study, and furthermore, used a prison population as opposed to a treatment population.

In an attempt to resolve the differences found in the above two studies, researchers attempted a replication of Gorenstein's study, examining the relative effects of psychopathic personality on several measures of frontal lobe impairment (Hoffman, Hall & Bartsch, 1987). Because the effects of substance abuse provide an alternative explanation for frontal lobe deficits in a psychopathic population, the effects of alcoholism on frontal lobe impairment were also examined. Results from this investigation did not support the notion that certain behaviors associated with psychopathic personality disorders may be derived from dysfunction in the frontal lobes. Nor was any relationship shown between frontal lobe impairment and the level of general alcoholism. Psychopathic subjects were found to perform similarly to controls on all tests selected. The results were essentially consistent with those found by Hare (1984).

Subsequent researchers were able to resolve the contradiction still evident in the research in light of Gorenstein's (1982) findings (Devonshire, Howard, & Sellars, 1988). Utilizing two samples of patients, the authors found that those patients categorized as psychopathic by legal criteria (Hare's Psychopathy Checklist) showed no differences on performance measures. That is, if Hare's criteria were used to define psychopathic and non-psychopathic, no differences between groups on performance related to frontal lobe function would be found. However, those classified by Blackburn's (1974) "primary" and "secondary" psychopathic types yielded significant results. The authors concluded that the discrepancy between Gorenstein's (1982) findings and Hare's (1984) findings could be parsimoniously explained by their use of different selection criteria to select their psychopaths.

Neuropsychological deficit and violent behavior were addressed by Bryant, Scott, Golden, and Tori (1984) as a follow up to Spellacy's work (1977, 1978). It was hypothesized that intelligence may be a factor in addition to neuropsychological impairment in determining violent behavior. Subjects were administered the Luria-Nebraska Neuropsychological Battery. The results indicated that violent offenders tend to have a higher incidence of serious neuropsychological deficits. Further, those inmates classified as brain damaged by the Luria-Nebraska Neuropsychological Battery had a significantly higher rate of violent criminal activity than those with no brain damage. Moreover, the violent group also demonstrated impaired performance on tasks requiring the abilities to plan, create, organize and execute goal-directed behaviors. This was especially true for tasks requiring sustained attention and concentration.

The majority of the studies seem to lend support to the theory that offenders with violent histories tend to perform significantly poorer on neuropsychological tasks, specifically pertaining to the frontal lobes. In addition to this, there appears to be a connection with impaired impulse control. Given the diversity of populations studied, diagnostic criteria employed, and choice of measures, it is remarkable that any similarities are shown at all. This may be an argument for the robust nature of the findings which manifests across groups and procedures.

There are a great many contradictions in the literature. Accounting for these contradictions are a number of factors: lack of appropriate controls for possible confounding variables; inconsistent operational definitions; unstandardized procedures to measure frontal lobe dysfunction; and lack of corroborating evidence (e.g., EEG scans, medical diagnosis of brain dysfunction). Thus interpretation of the literature is problematic (Kandel & Freed, 1989; Miller, 1987). Without question, further research is needed in this area.

Significance of Present Study

The present study was designed to add to the literature by studying a different segment of criminals: those currently on parole. To avoid confounding, the control data were taken directly from Halstead's national standardized sample. Further, sex was controlled by testing only males. Violent and Nonviolent groups were defined respectively as those who have been convicted at any time of a crime against persons, and those who have been convicted of crimes against property. The measure was the standardized Trailmaking Test.

CHAPTER 2

Method

Subjects

Participants were 134 male convicts currently on parole in Kansas. Participation was contingent upon which parolees had scheduled appointments during the weeks of testing; those who participated were those reporting for meetings with their parole officers during the several weeks of data collection. Mean parolee age was 31.35 years of age with a standard deviation of 7.19. The youngest parolee was 19 years old, and the oldest was 59 years old.

Subjects were divided into two groups of 67 each: Violent (those who have been convicted of crimes against persons at any point in their legal history, e.g., assault, murder, battery); and Nonviolent (those who have never been convicted of a crime against persons but have been convicted of crimes against property, e.g., theft, burglary). This information was ascertained from the convicts' Department of Corrections criminal records. Because the subject pool was largely homogenous, socioeconomic strata, education and age were not separately studied.

Instrument

The parolees were administered the Trail Making Test (Reitan, 1986), which is divided into two sections, Trails A and Trails B. Both are pencil and paper tests, with Trails A always preceding Trails B. The Trails A test consists of 25 circled non-repeating numbers (1-25) placed randomly, but in such a way that when the numbers are connected no drawn lines will intersect, on a sheet of 11.5" x 8" paper. The subject is first given a sample test and is instructed to draw a line connecting each circle in serial order as quickly as possible. This is to ensure that instructions are comprehended. After completion of the sample, the Trails A test is given. The beginning circle, 1, and the ending circle, 25, are designated respectively with **START** and **END**. Test performance is timed with a stop watch and the number of errors (as defined by the manual) are recorded by the examiner.

The Trails B test consists of 13 circled non-repeating numbers (1-13) and 12 circled non-repeating letters (A through L), totaling 25 circles. These circles are randomly placed so that no drawn lines will intersect, on a sheet of 11.5" x 8" paper. The subject is first given a sample test, and instructed to draw a line from the circled 1 to the circled A, from A to 2, from 2 to B and so on, in order, until reaching the end. This alternating number-letter pattern is repeated for the test, where the subject is instructed to connect the circles in serial order as quickly as possible. The beginning circle, 1, and the finishing circle, 13, are designated respectively with **START** and **END**. Time to completion and the number of errors are recorded by the examiner.

Procedure

All parolees arrived at the Parole Office for their regularly scheduled meetings with their parole officers. After meeting with their parole officers, they were instructed to meet with the experimenter. All parolees were seated individually at a table in a closed room with the experimenter. The subjects read an informed consent form, and were asked to sign it. Date of birth, criminal history, number of convictions, highest grade completed and history of drug abuse were later recorded by the investigator from criminal records.

A number 2 pencil and the Trails A test were provided. Instructions were read, and the test was administered. At the completion of the Trails A test, the instructions for the Trails B test were given, and the Trails B test was administered.

CHAPTER 3

Results

To provide a baseline comparison, Reitan's (1986) norms for time to completion on the Trail Making Test were used. These data provide a cutting point which yields a "hit" rate of 84.9% for brain damage (Reitan, 1986). Scores of 39 seconds or lower are considered normal for Trails A, that is, there is a low probability of brain impairment. The cutting point for Trails B is 91 or fewer seconds for non-impairment.

The Trails A and Trails B test protocols were divided by Offense (violent or nonviolent subjects) and by Trails test (Trails A and Trails B). Performance on the tests was assessed by time to completion and number of errors. Statistical analysis for time to completion (measured in seconds) on the Trails A and Trails B tests was done using a 2 (offense) x 2 (trails) mixed-factors Analysis of Variance (ANOVA). The Trails is the within-subjects factor, and the Offense is the between-subjects factor. Statistical analysis for number of errors on the Trails A and Trails B tests was also done using a 2 (offense) x 2 (trails) mixed-factors ANOVA. The resulting means and standard deviations from the data are presented in Table 1.

Table 1

Means and Standard Deviations of Nonviolent and Violent Offender Times to Completion and Errors

TIME TO COMPLETION

	A		B		
Group	Mean	SD	Mean	SD	Total
Nonviolent	29.96	9.16	72.79	23.56	51.38
Violent	31.40	10.36	88.15	35.65	55.94
Total	30.68		80.47		55.76

NUMBER OF ERRORS

	A		B		
Group	Mean	SD	Mean	SD	Total
Nonviolent	.15	.36	.90	1.16	.53
Violent	.12	.33	1.70	1.87	.91
Total	.13		1.30		.72

ANOVA results for Time to Completion are shown in Table 2. For purposes of clarification, OFFENSE represents violent and nonviolent offenders, and TRAILS is the test form (A and B).

Table 2

ANOVA Source Table of Results From 2x2 Analysis for Time To Completion

	SS	DF	MS	F
BETWEEN BLOCKS/SUBJECTS				
OFFENSE (O)	4730.88	1	4730.88	6.79*
ERROR	91911.63	132	696.30	
WITHIN BLOCKS/SUBJECTS				
TRAILS (T)	166102.93	1	166102.93	531.65***
O x T	3241.13	1	3241.13	10.37**
ERROR	41240.94	132	312.43	

Note. The (*) means probability to the .01 level. The (**) means probability to the .001 level. The (***) means probability to the .0001 level.

Significant main effects were found for OFFENSE and TRAILS, and the OFFENSE x TRAILS interaction was also significant. Significance was found at the .01 level for the main effect of OFFENSE. The Violent group took significantly more time to completion than the Nonviolent group. Post-Hoc statistical analysis of the interaction was done using a Tukey HSD. A significant difference was found between the Violent group on the Trails B and the Nonviolent group on Trails B at the .05 level.

The TRAILS main effect was unnecessary to analyze because greater time to completion is expected on the Trails B test. The significant interaction also reflects this incomparability between tests.

ANOVA results for Number Of Errors are shown in Table 3. For purposes of clarification, OFFENSE represents violent and nonviolent offenders, and TRAILS is the form (A or B).

Table 3

ANOVA Source Table of Results From 2x2 Analysis for Number Of Errors

	SS	DF	MS	F
BETWEEN BLOCKS/SUBJECTS				
OFFENSE (O)	10.09	1	10.09	7.91*
ERROR	168.36	132	1.28	
WITHIN BLOCKS/SUBJECTS				
TRAILS (T)	90.81	1	90.81	72.43**
O x T	11.70	1	11.70	9.33*
ERROR	165.49	132	1.25	

Note. The (*) means probability to the .001 level. The (**) means probability to the .0001 level.

Significant main effects were found for OFFENSE and TRAILS. A significant interaction was found for OFFENSE x TRAILS. Significance was found at the .001

level for the main effect of OFFENSE. The Violent group made significantly more errors than the Nonviolent group. Post-Hoc statistical analysis of the interaction was done using a Tukey HSD. A significant difference was found between the Violent group on the Trails B and the Nonviolent group on Trails B at the .05 level. The TRAILS main effect again reflects an incomparability between the tests.

Pearson product moment correlation coefficients (*r*) were calculated between the following: time on Trails A; time on Trails B; errors on Trails A; errors on Trails B; and age of the offender. The means, standard deviations, minimum and maximum values for these variables are presented in Table 4.

Table 4

Means, Standard Deviations, Minimum and Maximum Values for Correlated Variables

VARIABLE	MEAN	SD	MIN	MAX
TIME A	30.68	9.77	15.00	55.00
TIME B	80.47	31.07	36.00	240.00
ERRORS A	0.13	0.34	0.00	1.00
ERRORS B	1.30	1.60	0.00	8.00
AGE	31.34	7.19	19.00	59.00

Note: Only 20 subjects out of 134 had records that did not confirm prior drug use. For this reason, history of prior drug use was not correlated with the other variables.

The correlation coefficients for the variables in Table 4 are presented in Table 5 along with the probabilities. The scores are first collapsed across total time to completion, and then across total number of errors.

Table 5.

Correlation Coefficients Between Subject Variables and Time to Completion or Number of Errors

	Time	Time	Age
Variable	_r_	_r_	_r_
ERRORS A	-0.17*	-0.08	-0.06
ERRORS B	0.01	0.46****	0.00
AGE	0.27***	0.23**	1.00

Note. The (*) means probability to the .05 level. The (**) means probability to the .01 level. The (***) means probability to the .001 level. The (****) means probability to the .0001 level.

As these data show, in several instances statistical significance was achieved. Whether or not these results are of any clinical significance will be discussed in Chapter 4.

CHAPTER 4

Discussion

The number of errors on Trails A and the amount of time on Trails A were negatively correlated. As less time was taken on Trails A, more mistakes were made. This is not surprising. On the other hand, the time on Trails B and number of errors on Trails B were positively correlated. That is, the more time the subject took on Trails B, the more mistakes he made. This is also not surprising, as it reflects the difficulty of the test. Age of the subjects and time taken for both tests were positively correlated. This is expected, as the older one gets, the slower one's reaction time. As such, these correlations are obvious and require no further discussion.

The comparison of the Violent and Nonviolent groups revealed statistically significant differences in performance on both tests. The Violent group took significantly more time and made statistically significantly more errors than the Nonviolent group on both Trails A and Trails B.

On Trails A, the Nonviolent group made a mean difference of .03 more errors than the Violent group. On Trails B, the Violent group made a mean difference of .80 more errors than the Nonviolent group. While this led to statistical significance, it is arguable whether these findings are truly clinically significant (Reitan, 1986). The difference of eight-tenths of an error is too small to warrant interpretation on the Trail Making Test. However, with respect to the time to completion, the Violent group took statistically significantly more time to completion on both tests. The difference in time to completion between the Violent and Nonviolent groups of 15.36 seconds on the Trails B test is both statistically significant and of definite clinical significance.

Comparison with the baseline data provided by Reitan's (1986) norms suggests the time to completion for both the Nonviolent group and the Violent group fits within the limits of the normal range, although at the upper end. That is, although the Violent group scored significantly higher, both groups scored within the normal range. Therefore, insofar as the Trail Making Test is concerned, there is no evidence that criminals are impaired.

The range in scores between the Violent and Nonviolent groups may simply reflect a sample bias. There are several ways the sample could have been biased. The subjects were assigned to groups only by the felony crimes for which they had been convicted. This operational definition was convenient because of the documentation of the offense. However, the documentation did not include a comprehensive index of the subject's prior behavior. In other words, if the subject had committed a violent offense and not been convicted of it, he would have been misplaced.

Possible etiology of the poor test performance was not determined by the present study. That is, poor performance on the Trail Making Test may be due to any number of factors: difficulty in overall brain functioning, difficulty in the processing and carrying out of instructions, or intelligence.

Considering the population being tested, where malingering and confabulation are not uncommon, there is little if any index of the veracity of their test performance. Moreover, the parolee population does not accurately reflect the prison population. It is possible that prison inmates would score very differently than parolees, as only a select percentage of prisoners receive parole privileges. Further, only volunteers were used, and this in itself serves as bias.

Perhaps the discrepancy in Trails B scores is not unusual considering the population. While it is possible that among parolees, violent offenders have a higher rate of organicity, it must be kept in mind, that no corroborating evidence (e.g., EEG, CAT scan) was generated as to the presence of brain damage in any of the parolees. While this study does lend support to the biogenic perspective, further investigation is required.

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APPENDICES

APPENDIX A

CONSENT FORM

Please carefully read the following paragraph and sign below if you are in agreement.

The purpose of the present study is to assesss the comparability of three populations. If you choose to participate, you will be asked to complete two trailmaking tests which will require between five and ten minutes in total. All identifying information will be used only to match your tests to certain groups and will be destroyed after all data have been collected and categorized. Your answers will remain confidential. If for any reason during the session you feel uncomfortable, you may discontinue participation.

I (print your name) ______________________________ have read and understand the preceding information and agree to participate in this study.

Signature of Participant/ Date

APPENDIX B

PERMISSION FOR REPRODUCTION

TO: All Graduate Students Who Submit a Thesis or Research Problem/Project as Partial Fulfillment of the Requirements for an Advanced Degree

FROM: Emporia State University Graduate School

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