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THE ROLE OF COGNITIVE SYSTEMS IN BEHAVIORAL CONTROLS AND
EMOTIONAL ADJUSTMENT IN JUVENILE DELINQUENTS

by

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ABSTRACT

Structured equation modelling was used to test models which related general intelligence; verbal, visuospatial, and attentional skills; and a bias for processing information using right-hemisphere mechanisms to measures of delinquency in a population of 177 adjudicated male and female delinquents. Cognitive measures were estimated by the Wechsler intelligence scales. Personality constructs of social conformity and social confidence, derived from the California Psychological Inventory, served as mediating variables. The verbal model was most convincing and was more parsimonious than a composite model. Verbal skills were associated with greater social conformity and social confidence. Increased social confidence was associated with more serious patterns of delinquency. Direct relationships of general intelligence, verbal, visuospatial, and attentional skills with delinquency and aggressiveness were non-significant. Support was provided for the hypothesis that a right-hemisphere processing bias contributes to more serious delinquency and greater aggressiveness. The role of learning disabilities was examined with a sub-sample of 115 delinquents. A model which attributed delinquency and learning disabilities to cognitive deficits was slightly better than one which attributed delinquency to academic performance. It also provided a better fit than a composite model where academic performance contributed to delinquency. Performance in reading and arithmetic, as measured by the Wide Range Achievement Test, was not significantly associated with measures of delinquency and aggressiveness. Within these models, a right-hemisphere processing bias and reduced attentional skills were associated with greater aggressiveness. No relationship was found between a multivariate constellation of delinquency measures and neuropsychological dysfunction, as measured by an index of variability on the Wechsler intelligence scales. A hypothesized relationship between paranoia and aggressiveness was not supported. No difference was found between groups with varying degrees of lateral asymmetry of cognitive function, as measured by the Wechsler scales, on measures of depression or anxiety. A linear relationship was demonstrated between lateral asymmetry of cognitive functioning and a measure of self acceptance, with those with a non-verbal bias having the

lowest scores. Groups with extreme verbal or performance biases scored highest on a measure of defensiveness, suggesting that they have trouble integrating strong emotional states and rely more on denial.

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DEDICATION

This work is dedicated to my wife, Terry, without whose support and sacrifice it would not have been possible, and to my daughters, Dawn and Tawnya, who also gave up much in the process.

INTRODUCTION

The intent of this research is to examine the relationship of aspects of delinquency to cognitive functions. Of primary concern is the relative importance of verbal and nonverbal cognitive skills in the determination of delinquency. The group with whom the study was conducted is a large sample of adjudicated delinquents. This sample allows for certain relevant hypotheses to be investigated. Because the subjects represent a broad range of delinquents, from individuals diverted from the courts to those who have been incarcerated for lengthy sentences, it is also possible to fruitfully explore features other than delinquency, such as anxiety and depression. Relevant literature will be examined in the fields of delinquency and psychopathy. The relationship of lateral asymmetry of cognitive functioning to psychopathology will be explored in the fields of learning disabilities, temporal lobe epilepsy, depression, schizophrenia, and neurotic states. An effort will be made to relate known brain systems to the phenomena observed.

REVIEW OF THE LITERATURE

Delinquency

Intelligence and Delinquency

The issue of intelligence and its relationship to delinquency has been a controversial area for many years. Several studies have indicated that delinquents tend to score lower overall on tests of intelligence than their peers. Caplan (Caplan, 1965; Caplan and Siebert, 1964) reported that early research on intelligence of delinquents generally produced a mean IQ score that was fifteen to twenty points below that of the general population. Further, the incidence of delinquents classified as mentally deficient was five to ten times greater than that for the general population. There is evidence (Caplan and Siebert, 1964) that delinquents have scored successively higher on intellectual tests over the past few decades, although this may have been an artifact created by changes in the tests most commonly used. Mauser (1974) proposed that delinquents of the modern era are brighter, with mean IQ's that fall in the average range of ability.

It has been argued that differences in intelligence between delinquents and non-delinquents occurred as a result of selection variables which made disadvantaged

youth from lower socio-economic strata more likely to be involved in criminal activities (Simons, 1978). Tarnapol (1969) provided statistics which demonstrate that Negro youths in the United States are more likely to suffer from minimal brain dysfunction because of poorer health care services which contributes to higher infant mortality rates and a greater incidence of premature births. Prentice and Kelly (1963) dismissed a finding of lower IQ scores for delinquents because of the likely inclusion in the studies reviewed of subjects, such as Negroes, who were not included in the normative studies for the test.

Caplan (1965) suggested that, if proper care is taken to consider the various sources of bias, there is little or no difference in intelligence between delinquents and non-delinquents. He found that an eight point difference is consistently reported in the literature, but asserted that this difference is accounted for by differences in social background and testing conditions. Delinquents are more likely to come from a disadvantaged social background; IQ is often assessed under stressful predisposition conditions; and the effects of institutionalization may adversely affect performance.

There is, however, reason to believe that the differences do not relate simply to selection or administration variables. Hirschi and Hindelang (1977)

reviewed the existing research and concluded that delinquents are characterized by lower IQ's than normals. They viewed the effect of IQ as being independent of social class and race and they argued that lower IQ leads to delinquent activities as a result of difficulties in school. Tarnapol (1969) reported that adult arrests and convictions were negatively related to IQ, as measured by Wechsler Full Scale scores. Moffitt et al. (1981) found a significant relationship between delinquency and IQ after partialling out socioeconomic status. Schonfeld et al. (1988) found no significant relationship between environmental disadvantage and conduct disorder when other factors, such as IQ, were considered. Buikhuisen (1987), in reviewing the literature in this area, also concluded that delinquents have lower IQ's.

In explaining the difference in IQ scores, a number of hypotheses have emerged. The differential detection hypothesis proposes that delinquents of lower IQ are more likely to come to the attention of the police and that this biases IQ estimations for delinquents in a downward direction. Moffitt and Silva (1988a) evaluated this hypothesis by means of a longitudinal study in which age cohorts born during a specific period of time were followed up at the age of three and every two years thereafter. Using self-report of delinquent activities and police

statistics, those who were involved in delinquent activities were compared to those who were not. A significant difference of approximately six points in favor of the non-delinquent group was found on all three WISC-R IQ scores: Verbal, Performance, and Full Scale.

Ganzer and Sarason (1973) found that a greater proportion of recidivists came from the group with lower IQ scores. Maskin (1974) reported that female delinquents who successfully graduated from a residential treatment program had higher Full Scale WISC scores than those who were involved in further difficulties. Hays et al. (1978) found that violent juvenile offenders had lower overall IQ scores than did non-violent juvenile offenders. Yeudall et al. (1982) found that delinquents scored lower than controls on all measures of intelligence. Spreen (1981) found, within a mixed sample of neurologically impaired, learning disabled, and normal controls, a nonsignificant trend for subjects of lower I.Q.'s to show a somewhat higher number of the more serious types of offenses. Moffitt and Silva (1988b) stated that a finding of an I.Q. deficit of one half of a standard deviation (approximately eight points) has become well accepted.

The availability of longitudinal data with a group of black males from ages 4, 7, and 17 allowed Schonfeld et al. (1988) to evaluate the relative contribution of IQ,

neurological soft signs, environmental disadvantage, parent psychopathology, and early aggression to the presence of conduct disorders in adolescence. The results of their path analysis were consistent with the view that IQ, parent pathology, and early aggression contributed to the development of a conduct disorder at age 17. Logistic regression analyses suggested that IQ was specifically related to conduct disorder. Deficits in acquired knowledge were linked with conduct disorder, while spatial ability was not. These authors interpreted this as support for the view that deficits affecting psychiatric status reside in the individual's learning environment. It was thought that differences in understanding social cues emerged out of the unfavorable learning contexts that give rise to global deficits in cognitive functioning.

Kandel et al. (1988) compared men at risk for criminal behavior with men who were not at risk and found that the high risk subjects who avoided criminal involvement had considerably higher verbal, performance, and total IQ scores (estimated from four WAIS subtests) than the other three groups. High risk subjects who became seriously criminal had lower IQ scores than cohorts who were not apprehended for crimes. They described high intelligence as a protective factor believed to operate through the rewards of academic success.

This research has been replicated by White et al. (1989) with delinquents. Risk status was determined according to the extent of serious antisocial behavior present in preschool. They found that delinquent boys were significantly more likely to show lower IQ's than non-delinquent boys in both the high and low risk groups. The same finding applied for girls, but the delinquency effect was not as marked in girls as in boys.

In summary, the bulk of evidence, especially from the most carefully controlled studies, suggests that general intelligence tends to be lower among persistent delinquents.

Lateral Asymmetry of Cognitive Performance in Delinquents

The Wechsler intelligence scales allow for a comparison of tests which are thought to measure verbal (or dominant hemisphere) abilities and those which are thought to measure non-verbal (non-dominant hemisphere) skills (Wechsler, 1974, 1981). Unequal performance on these global measures has been thought to indicate either relative impairment of one hemisphere (Reitan, 1955; Klove & Reitan, 1958; Klove, 1959, Matarazzo, 1972) or differential skill in the associated abilities.

Wechsler (1958) suggested three diagnostic signs based on Wechsler-Bellevue subtest scatter which distinguished

sociopaths. The first of these was a relatively higher Performance IQ than Verbal IQ. The second was a good score on the Picture Arrangement subtest because sociopaths "have a good grasp of social situations, but they are inclined to manipulate them to their own advantage in an antisocial way" (p. 177). The third was a low score on the Similarities subtest, indicating poor abstract thinking.

Of the three, the first is the sign which has received the most support from subsequent research (Hays, Solway & Schreiner, 1978; Bernstein & Corsini, 1953; Wiens, Matarazzo & Gaver, 1959; Manne, Kandel & Rosenthal, 1962; Solway et al., 1975; Fisher, 1961; Henning & Levy, 1967; Buikhuisen, 1987), although its diagnostic significance has not always been endorsed (Foster, 1959; Kingsley, 1961). Race may play a role in the presence of this sign as two studies found it absent in samples of Negro juvenile delinquents (Fisher, 1961; Henning & Levy, 1967), although Tarnapol (1969) found that scores thought to reflect right hemisphere functions were significantly higher than those thought to indicate left hemisphere functioning in a predominately Negro, non-white delinquent sample. He also reported that Wechsler Verbal IQ scores were more important than Performance IQ scores in predicting adult arrests and convictions. Manne et al. (1962) found that the frequency of subjects showing the $P > V$ sign was lower with lower IQ

scores. Prentice and Kelly (1963) acknowledged that the $P > V$ sign was present in almost all studies of delinquents, but they felt that it might be more diagnostic of the learning difficulties that are a relatively frequent concomitant of delinquency than of delinquency itself.

Fernald and Wisser (1967) correlated the $P-V$ discrepancy with the degree of acting out, as estimated by ratings of criminal offenses, in males aged 12 to 15 and found a positive but nonsignificant relationship. Recidivists display the $P > V$ sign more frequently (Haynes & Bensch, 1981), but the size of the difference may not be related to recidivism (Bleker, 1983). Recidivists have been found to have a higher mean Performance IQ than non-recidivists (Haynes & Bensch, 1981; Bleker, 1983), although Spellacy and Brown (1984) found that IQ did not predict post-institutional adjustment. Andrew (1974) found that the $P > V$ sign was negatively correlated with I-level ratings of maturity in delinquents. More mature subjects by this classification displayed higher levels of verbal skills. Miller et al. (1980) reported that the relative values of the four Bannatyne (1974) categorizations varied with overall intelligence in an adjudicated delinquent population. The group with IQ's above 90 had mean ranks in the order of Conceptual (Comprehension + Similarities + Vocabulary) $>$ Spatial (Object Assembly + Block Design +

Picture Completion) > Sequential (Digit Span + Coding + Picture Arrangement) > Acquired Knowledge (Information + Arithmetic + Vocabulary), whereas those with IQ's below 90 had ranks in the order of Spatial > Sequential > Conceptual > Acquired Knowledge.

Taylor (1972) examined patients who received temporal lobectomies for severe epilepsy and found that psychopathic disorders were more frequently associated with left hemispheric operations. Cantwell et al. (1980) reported a high rate of conduct disorders among children referred to a speech and hearing clinic for language difficulties, with attention deficit and conduct disorder being the most commonly observed problems. Yeudall (Flor-Henry and Yeudall, 1973; Yeudall and Fromm-Auch, 1979) has used interpretations of a neuropsychological battery to demonstrate that psychopathy is related to dominant and depression to non-dominant fronto-temporal dysfunction. It was found that primary psychopaths exhibited dominant hemisphere dysfunction, while "neurotic" criminals showed non-dominant hemisphere dysfunction (Flor-Henry and Yeudall, 1973). Psychopaths exhibited a decrement of verbal over performance I.Q. scores, while depressed patients scored higher on verbal than performance I.Q. It was emphasized that the neuropsychological deficits are causative of the behavioral deficits, rather than growing

out of patterns of acting out behavior. Psychopaths were seen as being similar to schizophrenics in the type of neuropsychological disorganization that they display (Flor-Henry, 1976).

Yeudall and Fromm-Auch (1979) found that delinquent adolescents were no more likely to display lateral asymmetries in their performance on neuropsychological tests than were controls. This was re-evaluated by Yeudall et al. (1982), who administered an extensive neuropsychological battery to persistent delinquents and compared their performance to a non-delinquent control group. They found a much greater incidence of abnormal neuropsychological profiles among delinquents that reflected a pattern of dysfunction in anterior brain regions. Their overall finding was of greater impairment of the non-dominant than dominant hemisphere, although a sex difference was noted. Females were more likely to show non-dominant dysfunction, while males were as likely to show impairment of dominant as of non-dominant functions. Moffitt and Silva (1988c) found delinquents to score lower than non-delinquents on measures of both verbal and visuo-spatial functions. This finding was interpreted as not supporting Flor-Henry's (1976) theory of specific left-hemisphere dysfunction in antisocial behavior.

Yeudall et al. (1982) found that four of the five WISC-R or WAIS subtests that supplied the greatest weight in the discriminant function that separated delinquent and non-delinquent youths were verbal subtests, namely, Vocabulary, Information, Comprehension, and Arithmetic. Together with Coding, these subtests also produced the lowest mean performance in the sample of delinquents described by Solway et al. (1975). This lends support to the interpretation of Bleker (1983) that poor verbal and cognitive mediation is an important predictor of juvenile delinquency and recidivism.

Supportive evidence for left-hemisphere dysfunction in juvenile delinquents was provided by Fitzhugh (1973) who found a predominance of left-hemisphere signs in this group when compared to an "emotionally disturbed" control group. Hurwitz et al. (1972) suggested that the neuropsychological deficits of delinquent boys were manifested more clearly in tasks of temporal sequencing than in tasks of perceptual restructuring. Berman and Siegal (1976a, 1976b), using the Wechsler tests and Halstead Neuropsychological Battery to compare incarcerated delinquents with a control group, concluded that delinquents as a group had deficits in their ability to comprehend, manipulate, and utilize conceptual material of a verbal nature. A difference between the groups was also noted in perceptual organization, although

this was not as pronounced. The inability to profit from experience and the repeated use of poor judgment was thought to characterize the delinquents' performance in both the Category Test and their overall life style.

Hare (1979) used a hemi-retinal experimental paradigm, presenting three-letter words in the right and left visual fields. Psychopaths, as defined by their scores on the Psychopathy Checklist, did not differ from normals and non-psychopathic criminals in simple recognition of words presented in the right visual field. In a subsequent studies described in Hare and Connolly (1987) more complex stimuli were used. They found that psychopaths processed a task requiring categorization of verbal stimuli more efficiently when it was presented to the right hemisphere. Non-psychopathic criminals performed much as the non-criminal control group. Psychopaths made fewer errors of categorization when words were presented to the left visual field, raising the possibility that they may differ in lateralized control of at least some perceptual-cognitive processes. Nachshon and Denno (1987) argued that these results could be interpreted as indicative of left hemisphere dysfunction rather than as a lack of hemispheric asymmetry.

Hare and McPherson (1984) evaluated the performance of psychopaths, as defined by scores on the Psychopathy

Checklist, on a dichotic-listening test. Although criminals generally did not differ significantly from non-criminals in right-ear advantage, they found a tendency toward reduced asymmetry in psychopaths compared with non-psychopathic criminals. They argued against interpreting these results in terms of neurological dysfunction because psychopaths do not show other bilateral deficits in performance and because the reduced asymmetry was not due to an unusually large decrement in right ear performance. Rather, it grew out of a reduced right ear and augmented left ear performance. The results were more readily interpreted in terms of group differences in hemispheric dominance for language. They suggested that left-hemisphere capacity for verbal processing is reduced and that psychopaths make greater use of right-hemisphere processes and strategies for processing verbal information. Preference for cognitive strategies that rely relatively little on verbal, logical, and sequential operations was thought to contribute to the ineffective role that language plays in the regulation of their behavior.

Tucker (1981) suggested that the poor left hemisphere performance of psychopaths on intellectual tasks suggests that the hypothesized inhibitory and self-regulatory function of verbal and sequential ideation is deficient in these individuals. This might be associated with low

anxiety, which is generally thought to be diagnostic of psychopathy.

Jurkovic and Prentice (1977) found a highly significant correlation between moral maturity, as measured by Kohlberg's structured moral dilemmas, and scores on a vocabulary test in a group of delinquents with a normal control group. They subdivided the category of delinquents according to Quay's (Quay & Parsons, 1971) classification scheme into psychopathic, neurotic, and subcultural delinquents. The psychopathic delinquents displayed lower levels of moral development than the other delinquent groups and normal controls, as well as deficient performance on tasks specifically assessing formal operational thought. The neurotic and subcultural delinquents more closely approximated the level of moral and cognitive development found in the normal controls. Brickman et al. (1984) pointed to the failure of delinquent youths, especially those who are violent, to develop cognitive controls to manage their affects and moods.

There is little controversy about the presence of differential cognitive performance among delinquents that favors non-verbal over verbal intellectual processes. All the studies that have been reviewed have averaged data across all delinquent subjects and have not attempted a cluster analytic approach which categorizes groups of

delinquents who may be quite different. Although group data suggests a trend favoring non-verbal skills, a smaller subgroup could exist which has a reversed pattern of test results.

Frontal Lobe Dysfunction in Delinquents and Psychopaths

Pontius (1974) proposed that delinquency might be related to a maturational lag in myelination of the frontal-lobe system (FLS) that governs executive planning skills. Pontius and Ruttiger (1976) presented a four stage developmental sequence of FLS maturation: Stage I (disjointedness of activity); Stage II (inability to switch the principle of action appropriately); Stage III (planning); and Stage IV (ability to switch the principle of action of an ongoing activity appropriately). They compared the performance of delinquents on the Narratives Test (Pontius, 1974) to an unmatched control group to evaluate their maturational levels. Significantly fewer delinquents had achieved the fourth stage of development, although this result could easily have been due to educational or intellectual factors that were not taken into account (Kandel and Freed, 1989). Pontius and Yudowitz (1980) identified a subgroup of criminals who showed an inability to switch principle of action both on the Narratives Test and on the Trail Making B Test.

Yeudall and Fromm-Auch (1979) found a preponderance of signs of anterior neuropsychological impairment in a number of groups which were characterized by problem behavior, including psychopaths, delinquent adolescents, adolescents with conduct disorders, self mutilators, sex offenders, and violent criminals. Gorenstein (1982) attempted to relate the behavior of psychopaths to features of the frontal lobe syndrome. He found that a group of psychopaths performed less adequately than non-psychopathic psychiatric patients and normal controls on three measures considered to be sensitive to frontal lobe functions: the Wisconsin Card Sorting Test, the Sequential Matching Memory Task, and the Necker Cube. Perseveration and impaired cognitive flexibility were thought to be characteristic of their performance. This study was criticized by Hare (1984) on the basis of classification of subjects. No difference in the performance of the same tests used by Gorenstein (1982) was found between groups of incarcerated criminals classified as high, medium, and low in psychopathy using the Psychopathy Checklist and DSM III criteria for antisocial personality disorder (Hare, 1984). Hare (1984) speculated that the poor results of Gorenstein's subjects may have been because of their drug and alcohol abuse. He emphasized the differences that exist between true psychopaths and frontal lobe patients, in spite of similarities of some aspects of their behavior, and

cautioned organic explanations of this complex behavior. Hoffman et al. (1987) also attempted a replication of Gorenstein's (1982) research using inpatients in an alcohol treatment program and found no differences between subjects classified as high or low in psychopathy on a frontal lobe test battery.

Elliott (1978) highlighted several dissimilarities between individuals suffering prefrontal lesions and classical psychopaths. Elliott notes that the psychopath,

"does not display the apathy, the impairment of memory, or the facetious jocularity which is often seen in the former. The prefrontal case shows bad judgment both in his own affairs and in the affairs of others, whereas the psychopath often demonstrates good judgment in assessing theoretical situations concerning people, but fails in his own practical affairs. Further, whereas the prefrontal case is consistently abnormal, the psychopath may tread the path of virtue and show considerable skill in the management of his affairs for prolonged periods before committing some egregious folly or senseless crime...The capacity of many psychopaths to ingratiate themselves with others and to lie with every appearance of sincerity is not conspicuous in prefrontal cases." (p. 161)

Kandel and Freed (1989) reviewed research which has related criminal behavior to frontal-lobe dysfunction. They pointed out that much of the research has failed to control for obvious confounding factors such as education, socioeconomic status, institutionalization, and drug or alcohol use. They concluded that the existing evidence seems to indicate that frontal-lobe dysfunction is not

related to psychopathy. This is supported by the finding of Virkkunen et al. (1976). In following-up subjects who suffered open head wounds from the Second World War over a period of 30 years, they found that subjects suffering fronto-temporal injuries were no more likely than any other head injury group to commit criminal acts.

In spite of the similarity of features of psychopathy and chronic delinquent behavior to frontal lobe syndromes (Cummings, 1985), the research literature does not generally support the idea that these disorders have a common neurological basis. The importance of the frontal lobes in human behavior (Damasio, 1985) leaves little doubt that there will be frontal lobe involvement in almost all behavioral disorders, but an attempt to apply a localized lesion model does not appear to be appropriate.

Neuropsychological and Neurophysiological Findings

Nevertheless, reports of neuropsychological impairments in delinquent and criminal populations are numerous. Tarnapol (1969) found support for his hypothesis that a significant degree of minimal brain dysfunction would be found in population of disadvantaged delinquents. Berman and Siegal (1976a, 1976b) reported that a group of incarcerated delinquents performed more poorly on nearly all measures of Wechsler's intelligence tests and on all of

the tests of the Halstead Neuropsychological Battery, except for the Tactual Performance Test. Berman (1978) summarized their findings as identifying three distinctive clusters of skills that were most impaired in delinquents: 1) Visual-perceptual; 2) Auditory memory; and 3) Nonverbal concept formation. Skoff and Libon (1987) reported that approximately two-thirds of a group of incarcerated male delinquents aged 15 to 17 were moderately to severely impaired in at least one of four areas of executive planning: 1) mental planning, 2) establishing and maintaining a mental set, 3) shifting set, and 4) mental control. Voorhees (1981) found differences between delinquents and controls on almost all measures derived from the Bender-Gestalt Test and Luria's Neuropsychological Investigation. Those tasks requiring sustained levels of concentration and attention provided the greatest difficulty for the delinquent group. Their performance levels were less affected when sustained attention, symbolic manipulations, and complex abstract abilities were not involved.

Moffitt and Silva (1988b) were able to avoid selection variables that often have biased results by taking data from a longitudinal study in which all children born within a specified period of time were evaluated and those with confirmed delinquency were compared with non-delinquent

cohorts. A neuropsychological battery was administered and the groups were compared by means of MANOVA. Significant differences were found between the delinquent and non-delinquent groups on the multivariate tests. The variables which were found to be significant on subsequent univariate tests were factor analyzed to reveal three significant dimensions: 1. A verbal factor defined by performance on WISC-R subtests of Vocabulary, Information, Similarities, and Arithmetic; 2. A visuospatial-motor integration factor defined by performance on Block Design, the Rey-Osterreith Complex Figure, Grooved Pegboard Speed and Mazes; and 3. A memory factor which included initial registration and delayed recall scores from the Rey Auditory Verbal Learning Test. These factors were significantly correlated with a measure of family adversity (Verbal, -0.25 ; Visuospatial-motor integration, -0.18 ; and Memorization, -0.17). In spite of the correlations, the neuropsychological measures did account for significant variance beyond the family adversity measure in a hierarchical regression analysis. Nonetheless, the authors acknowledged that the percentage of statistical variance in delinquent group membership explained by the neuropsychological measures was small.

Garneski (1960) reported a higher incidence of a particular pattern of unusual EEG recordings involving 14 and 6 per second positive-spiking in delinquents, but

subsequent research by Weiner et al. (1966) that excluded subjects with a history of brain impairments found no difference between delinquents and non-delinquents on any EEG measure. Robbins et al. (1983) found a high incidence of cognitive, perceptual, and perceptual-motor impairments among two groups of non-incarcerated delinquents. An inordinate number of these youths were classified as learning disabled using test data. They noted particular impairments in echoic memory, discrimination of sounds, and speech recognition aspects of auditory perception which implied that the failure of the delinquents to develop adequate verbal skills might be at least partially related to poor auditory perception. Schonfeld et al. (1988), on the other hand, found that the presence of soft signs contributed to variance in IQ, but they were insignificant in determining the presence of a conduct disorder. Hurwitz et al. (1972) reported delays in motor maturity in delinquent boys when compared to a normal control group, although this finding is tempered by the fact that the control group had a significantly higher IQ than the delinquent group.

Hare (Hare, 1970; Hare and Cox, 1978) reported several anomalies of autonomic response in adult psychopaths compared to non-psychopaths, using the Psychopathy Checklist as a criterion. Resting skin conductance is

lower; non-specific fluctuations in skin conductance are fewer; skin conductance responses to intense or aversive stimuli are smaller; skin conductance responses show abnormally slow recovery to baseline levels; and increases in skin conductance responses when a subject is anticipating an aversive stimulus are small while increases in heart rate are larger. Hare and Cox (1978) hypothesized that the psychopath's pattern of heart rate acceleration and small increases in electrodermal activity reflect the operation of an active, efficient coping process, and the inhibition of fear arousal. Consequently, many situations that have great emotional impact for most people are of little consequence to the psychopath because he or she is better able to attenuate aversive inputs and to inhibit anticipatory fear. This process, however, interferes with learning avoidance behavior. Working with adult psychopaths, Ziskind et al. (1977) provided mixed evidence for variations in conditionability of autonomic responses which suggested a deficiency in aversive conditioning. Volavka (1987) showed that theft was more likely to occur among subjects who have a slowing of alpha frequency and interpreted the finding as support for the idea that low cortical arousal might be associated with difficulty in learning law-abiding behavior.

Delinquency and Attention Deficit Disorder

In a follow-up of children averaging 13.3 years of age, who had been identified as hyperactive five years earlier, Weiss et al. (1971) found emotional immaturity, inability to maintain goals, poor self-image, and feelings of hopelessness to be common. As a group, they were differentiated from their peers by greater restlessness, aggressivity, and antisocial acts. Twenty-five percent had a history of acting-out antisocial behavior. These youths had been rated as more aggressive at first evaluation and came from families that were rated as more pathological. Offord et al. (1979) and Walker et al. (1987) found that conduct disorder children with coexisting hyperactivity exhibited more aggressive behavior and a greater variety and severity of antisocial behaviors than delinquents who were not hyperactive. An earlier onset of delinquency was also noted in both studies. Mannuzza et al. (1989) found that children suffering from attention deficit disorder with hyperactivity were at increased risk of being involved in criminal activities. They reported, however, that such children were not uniformly at risk for partaking in criminal activities. Rather, a minority (one-quarter) of these youths developed an anti-social personality disorder, and two-thirds of this group engaged in anti-social

behavior, whereas the hyperactive children without an antisocial personality disorder were often not delinquent.

Satterfield (1987) compared hyperactive children who had been referred for learning and behavioral problems with controls who were matched for age, sex, race, and WISC Full Scale IQ on a follow-up. He subdivided the hyperactive group into those who had been arrested for more than one serious offense and those who had not been arrested even for a minor offense. He found that the rate of antisocial behavior was many times higher among the hyperactive children than in normal control subjects, although it should be noted that these youngsters were already preselected for the presence of behavior problems. Data derived from auditory event-related potentials (AERP), EEG power spectral, and clinical EEG suggested that there might be two distinct groups of hyperactive children. The group involved in multiple arrests was characterized by normal EEG power spectral, AERP measures, and clinical EEG findings. The group free of antisocial activity was characterized by abnormal EEG power spectral values, AERP's, and clinical EEG findings. Although the N2 component of the AERP in the multiple arrests group was not different from normal, it was significantly larger than N2 amplitudes for the non-offender hyperactives. This fact prompted the author to suggest that multiple-offender

hyperactives have low cortical arousal and inhibitory levels compared to non-offender hyperactives, but normal arousal-inhibitory levels compared with normals. It was proposed that a given arousal-inhibitory level, as reflected by N2 amplitude, could at the same time be indicative of a normal level for a normal child and an abnormal arousal level for a hyperactive child. An alternative explanation was that social-environmental factors play a more significant role than brain dysfunction in the genesis of antisocial behavior.

Hare and Cox (1978) suggested that there is some evidence that the hyperactive child syndrome may be characterized by low tonic skin conductance levels and electrodermal hypo-responsiveness. If lowered cortical arousal causes a state where more intense stimuli are required to excite the individual, one would expect antisocial individuals to seek out more intense levels of excitement to achieve normal levels of arousal. Whitehill et al. (1976) evaluated this hypothesis with antisocial preadolescent children and found some support for it.

Moffitt and Silva (1988c) examined the effect of Attention Deficit Disorder on neuropsychological measures and self-reported delinquency across a broad spectrum of adolescents. They found that subjects evidencing both ADD and delinquency were distinct in certain ways from subjects

with only ADD or only delinquency. The ADD delinquents scored significantly below non-ADD delinquents on verbal and visual-integration measures. ADD delinquents performed more poorly than non-delinquents and non-ADD delinquents on measures of verbal memory, and ADD non-delinquents scored significantly better than ADD delinquents on verbal measures.

The research in this area is difficult to interpret. Research studies have differed widely in the type of subjects that have been included. Some have gathered data from incarcerated delinquents from disadvantaged backgrounds while others, such as Moffitt and Silva (1988b, 1988c), have used subjects who are clearly less seriously delinquent. Research designs are often found wanting. It appears to be quite likely that neuropsychological dysfunction is more frequently found in delinquents, but the deficits that are observed vary with the test battery that is administered and they are seldom related to any specific theory of brain function. Most often it seems to be presumed that it is enough to identify the deficits. They may be related to learning disabilities or impulse control but no attempt is made to account for the delinquency of unimpaired individuals or the failure of many learning disabled youngsters to become delinquent (Spren, 1981). The work of Hare (Hare, 1970; Hare and

Cox, 1978) does provide a theoretical basis for observed neurophysiological changes that forms a useful foundation for further research. The attempt to link hyperactivity and attention deficit disorder to the same theory holds some promise. This model relies on a general arousal model which may be understood in relation to subcortical mechanisms. Since it is thought that this pattern of cognitive functioning may be related to learned patterns of thought and emotional control (Hare, 1984), further delineation of the cortical patterns that accompany it may be fruitful.

Factors in Aggression

Elliott (1982) described a dyscontrol syndrome which is related to minimal brain dysfunction and is characterized by sudden, unprovoked episodes of rage. It was proposed that some violent criminal behavior might be caused by subtle neurological impairments which were difficult to localize. A group of patients who experienced episodic rages were described by Bach-y-Rita et al. (1971) and it was observed that they frequently presented a history that was suggestive of minimal brain dysfunction. Elliott (1978) highlighted a number of organic conditions that can contribute to a syndrome of episodic attacks of rage.

Lewis et al. (1979) observed a pattern of major and minor signs of neurological impairment, reduced verbal abilities, physical abuse by family members, and pervasive paranoid ideation to be more common in violent incarcerated delinquents. Pincus et al. (1979) reported finding neurologic abnormalities in 96% of violent and 22% of non-violent incarcerated adolescents. Monroe et al. (1977) found a significant correlation between neurological signs and dyscontrol behavior in a recidivist group of incarcerated aggressive adolescent offenders. Lewis et al. (1987) found that none of their variables indicative of major neurological impairment distinguished delinquents from controls, although indicators of minor neurological impairment did. Ratings of violence were correlated with minor neurological impairment, as well as psychomotor symptoms and family violence. Spellacy (1977, 1978) demonstrated marked differences between violent and non-violent incarcerated adolescents and men on a battery of neuropsychological tests. The non-violent groups performed better on a variety of cognitive, language, perceptual, and psychomotor abilities. The neuropsychological tests were shown to discriminate the groups more effectively than did the MMPI. Krynicki (1978) was able to demonstrate EEG abnormalities and cognitive impairments in a group of violent adolescent offenders that suggested left frontal lobe dysfunction and a pattern of reduced left hemisphere

dominance. Brickman et al. (1984), using the Luria-Nebraska Neuropsychological Battery, found a trend towards more serious impairment in violent delinquents than in those who were non-violent. The only significant differences between the two groups were on the expressive speech and memory scales. They suggested the possibility of temporal lobe dysfunction.

Tartar et al. (1983) pointed out that much of the research relating violence to neuropsychological impairment has used incarcerated populations of subjects with multiple problems. They used a broad-spectrum neuropsychological battery and were unable to find significant differences between delinquents who had committed violent, non-violent, or sexual offenses. When offenses were rated for their degree of violence, however, Wechsler Full Scale IQ and four Wechsler subtests, Information, Similarities, Vocabulary, and Picture Completion, were significantly correlated in a negative direction. Nachshon and Denno (1987) reported that, although delinquents in their sample of Negro youth were no more likely to be left-handed, left-eyed or left-footed than non-delinquents, there was a significant tendency for violent delinquents to show a left-eye preference when compared to other delinquent categories. These authors interpreted this finding to support their contention that violent delinquents were more

likely to demonstrate left-hemisphere dysfunction, a weak argument when one considers the lack of research supporting the notion that eye-dominance can act as a marker of hemispheric dysfunction.

Bach-Y-Rita et al. (1971) observed that a large proportion of patients who displayed episodic rages came from families where violence was a prominent part of the family structure. Tartar et al. (1984) reported that delinquents who had been subjected to physical violence on at least one occasion in their homes were likely to score lower on neuropsychological tests, including Comprehension and Similarities from the WISC-R/WAIS, Wechsler Verbal IQ, and a test of auditory attention span. The authors noted that the cognitive impairments in the abused delinquents were primarily circumscribed to verbal or linguistic processes. As might be expected, more of the abused delinquents committed violent crimes of an assaultive nature. It should be noted that there were numerous other differences in family environment between these two groups which were likely to be as significant as physical abuse. The physically abused group was more likely to have alcoholic fathers, to have alcoholic mothers, to have parents who were engaged in criminal acts, to have been sexually abused, to have parents who were separated or divorced, and to have been placed in a foster home.

Similarly, Lewis et al. (1979), in comparing more violent to less violent delinquents incarcerated in the same institution, noticed that the more violent group was more likely to have been physically abused by adult relatives, often in extreme ways. Lewis et al. (1987) found indicators of abuse and family violence to be highly predictive of delinquency and violence in both a sample of delinquents and a sample of matched controls. Delinquents were more likely to have experienced severe physical abuse; their households were more likely to have been filled with violence among family members, often involving lethal weapons; their mothers were more likely to have been psychiatrically hospitalized; and they were more likely to have been placed outside the home in foster homes, group homes, treatment centres, and in the homes of relatives. Henggeler et al. (1987) found that the families of female delinquents may be especially dysfunctional. White et al. (1989) suggested that girls may be intellectually more resilient to delinquency and that other factors such as family disadvantage or discord may be more important for girls' delinquency. Moffitt and Silva (1988c) found that ADD delinquents came from homes characterized by greater family adversity (low parental education and income, single-parent status, large family size, poor maternal mental health, and poor family social environment) than non-ADD delinquents and non-delinquents.

In a follow-up study of delinquents studied in earlier research (Lewis et al., 1979), Lewis et al. (1989) were able to examine characteristics of adolescent offenders that were predictive of adult offenses. They found that a combination of intrinsic vulnerabilities (i.e., episodic psychotic symptoms, neurological/limbic dysfunction, and cognitive impairment) and family violence interacted to increase the likelihood of adult aggression. They emphasized the importance of family violence and abusiveness as a model of aggressive behavior, but children who are neuropsychiatrically and cognitively intact are better equipped than are multiply handicapped children to choose among alternative styles. The intrinsically vulnerable child was thought to be more likely to react impulsively and unthinkingly when stressed. Lewis et al. (1989) suggested that neuropsychiatrically and cognitively impaired children were less able to modulate the rage engendered by abuse. The possibility was entertained that the more hyperactive and impulsive child might also invite abuse.

The finding that violent delinquents tend to have a fundamentally paranoid perception of others (Lewis et al., 1979) supports a recent theory of aggression. Dodge (1986) emphasized that the attributions about peers' intentions and expectations regarding future peer behavior was

important in the genesis of aggressive behavior. It was found that aggressive boys were more likely to attribute hostile intent to others in ambiguous situations (Dodge, 1980; Dodge and Frame, 1982).

It is reasonable, on the basis of these studies, to query whether instability of family environment could be associated with limited development of verbal and linguistic skills. Reduced verbal abilities, as measured by reading ability and expressive language problems, was found to be associated with a greater incidence of aggression among children who had been abused by Burke et al. (1989). Expressive language delay has also been shown to be associated with problem behaviors in very young children (Caulfield et al., 1989). Interestingly, Caulfield et al. (1989) found that mothers of children with developmental expressive language problems rated their children as less acceptable in their intellectual, physical, and emotional characteristics and they were more likely to use physical methods of discipline than were mothers of a control group.

Huesmann et al. (1987), using longitudinal data stretching over twenty-two years, emphasized the importance of early aggressive behaviors on intellectual development. Their data supported the interpretation that, whereas early intellectual limitations might contribute to the

development of aggressive behavior patterns at age 8, aggression tended to interfere with subsequent intellectual development. Intellectual achievement in middle adulthood was predictable from early aggressive behavior. White et al. (1989) found that preschool anti-social behavior was a good predictor of delinquency in boys but not in girls.

Using a group of aggressive preschool boys as her subjects, Gouze (1987) found that the attention of aggressive boys is more easily captured by aggressive social interactions. They have more difficulty shifting away from such interactions and appear to be more distracted by them. In attempting to resolve conflicts they frequently provide more aggressive solutions.

The importance of the parent-child relationship in the genesis of cognitive controls should not be underestimated. Luria (1961) emphasized that a child's mental activities are conditioned from the beginning by his social relationships with adults. He credited Vygotsky with the idea that,

"all the most important mental activities result from the child's social development, in the course of which there arise new functional systems whose sources are to be sought not in the depths of the mind but in the forms of the child's relationships with the adult world." (p. 16)

Through his mother's instruction the child,

"learns how to formulate his own wishes and intentions independently, first in externalized and then in inner-speech. He thus creates the highest forms of purposive memory and deliberate activity. What he could previously do only with adult help, he is now able to do unassisted. This fact becomes the basic law in a child's development." (p. 17)

The maternal relationship also provides a training ground for mechanisms of emotional regulation. Kopp (1989) provides a description of mechanisms whereby the child, through the relationship with a caregiver, learns to regulate his or her emotions and to ultimately understand reciprocity, acceptability, and people's needs and to think about meanings and values.

The research on aggressive delinquents is also clouded by biases in the subjects who are selected for study. The work of Lewis (Lewis et al., 1979; Lewis et al, 1989) focuses on some of the most violent individuals, as can be seen from the outcome study ten years later. The range of behavior that might be examined in the various studies is very wide and it is not clear whether the findings of many of these studies apply to a broad spectrum of aggressive youths. The importance of the home environment and parental relationships is emphasized by this research and these observations are useful in clarifying the genesis of criminal behavior.

Learning Disabilities and Delinquency

Graham & Kamano (1958) first noted that the PIQ > VIQ pattern occurred in both unsuccessful students and delinquents and they suggested that it is the reading difficulty which contributes to the subtest pattern said to be characteristic of the delinquent. Henning and Levy (1967) found that a ranking of subtest performance patterns was, for Caucasian but not Negro juvenile delinquents, highly correlated with the pattern found in a sample of retarded readers. They interpreted this finding as supporting the idea that a reading disability pattern, rather than sociopathic personality pattern, is what is being seen in the Wechsler subtest pattern.

Mauser (1974) cited many similarities between juvenile delinquents and learning disabled youth: 1) both show a negative self-concept and low frustration tolerance; 2) they are predominantly male; 3) there is evidence of a greater occurrence of minimal brain dysfunction among both groups; 4) a lower than average IQ is common to both; 5) both have difficulty in school beginning in the primary grades; 6) neither seems to have a single cause or cure; and 7) both groups lack positive personality characteristics and have poor self-concepts. Hogenson (1974) viewed reading failure as a source of frustration that could eventually lead to delinquency. He found a

significant correlation between reading underachievement and aggression.

Berman and Siegal (1976b) placed considerable emphasis on the learning problems that were thought to accompany the neuropsychological impairments measured in a delinquent population. They observed that the adaptive deficits were not different from those routinely diagnosed in children with early school learning problems. It was suggested that youngsters who become delinquent are those whose learning disabilities were never diagnosed and who went through the escalating cycle of behaviors leading to delinquency as the only possible response to the continual frustration and humiliation caused by the learning problems. Berman (1978) viewed learning disabilities as being a fundamental cause of delinquency, as did Hirschi and Hindelang (1977).

Rourke (1988a) suggested that learning disabled children,

"(a) are perceived as less pleasant and desirable by parents, teachers, and peers; (b) are the recipients of more negative communication from parents, teachers, and peers; (c) are ignored and rejected more often by teachers; (d) are treated in a notably more punitive and derogatory manner by parents; and (e) are likely to live in families that resemble those of emotionally disturbed children." (p.802)

Meltzer et al. (1986) compared the learning processes of delinquent, learning-disabled, and normal adolescent males. They noted the similarity of style between a subgroup of the delinquents and the learning-disabled

group. Upon close analysis, the delinquents were found to be more severely impaired in their educational skills than the learning-disabled subjects. They concluded that there were three groups among the delinquents: 1) a group who displayed cognitive and educational profiles virtually identical to learning-disabled adolescents; 2) a group of children with behavioral and social problems superimposed on specific learning disability profiles; and 3) a group with learning and cognitive profiles similar to those of average achievers. Moffitt and Silva (1988c) found that ADD delinquents had significantly poorer reading achievement than controls and non-ADD delinquents but not ADD-non-delinquents.

Sprenen (1981) has emphasized the importance of a prospective analysis as opposed to the usual retrospective examination of these relationships. In his view,

"if a researcher uses a well defined group with existing severe problems, he/she is likely to find a stronger relationship to almost any hypothetical precursor than would be found if precursors were defined in a prospective design which, on follow-up, would show how many of the subjects carrying the precursor sign actually develop without delinquency" (p. 793).

When this type of analysis was applied to groups of subjects who were neurologically impaired, sub-clinically impaired, learning disabled without neurological impairment, and normal controls, no significant differences

were apparent in the frequency with which these subjects had come to the attention of the police. The neurologically-impaired groups actually showed fewer offenses numerically and drew fewer penalties than the learning disabled group without indication of neurological impairment. Nonetheless, Spreen (1989) found that aggressive behavior and temper tantrums were most frequent in learning disabled subjects with hard neurological signs.

Virkkunen and Nuutila (1976) investigated the likelihood that a group of 224 retarded readers would commit criminal offenses between the ages of 15 and 20. They found that 12.1% of these did so, which was higher than the incidence for the general population but low enough to cause them to reject the hypothesized sequence of specific reading retardation leading to lack of success in school leading to depression and poor self-esteem leading to the need for self-assertion by resorting to criminal means and adopting psychopathic defenses. Rather, they found that symptoms of hyperactivity contributed to a lack of adaptability and to criminality, supporting the contention that among hyperactive children there is some primary defect which makes them susceptible to criminality. Spreen (1989) rejected the hypothesis that emotional adjustment problems occur primarily as a neurotic response in learning-disabled youth. He thought it reasonable to

view learning disabilities and emotional reactions as having a common neurological basis, although his research did not reveal any consistent relationships.

Rourke (1988a) has suggested that any attempt to describe socio-emotional disturbances in learning disabled children should be cognizant of the fact that the learning disability diagnosis represents a heterogeneous population. Subgroups are likely to differ in patterns of skills that are related to socio-emotional functioning. In an effort to characterize the emotional disorders that accompany learning disabilities, Porter and Rourke (1985) found that their sample clustered into four groups: 1) Learning disabled children who do not have concomitant socio-emotional problems; 2) LD children with marked psychological disturbance reflected by internalized socio-emotional difficulties such as depression and anxiety; 3) LD children with disproportionate and pervasive somatic concerns; and 4) LD children with behavioral disturbance marked by overactivity, distractibility, interpersonal insensitivity, and antisocial behavior. They were unable to find any relationship between personality subtype and measures of cognitive and academic achievement, including Verbal-Performance IQ discrepancy. The results of this study were replicated by Fuerst et al. (1989), although they dropped the category of children with somatic concerns

leaving a normally adjusted group; a group characterized by internalized emotional problems of anxiety, withdrawal, and depression; and a group marked by externalized forms of behavioral difficulties such as hyperactivity, hostility, impulsivity, restlessness, and aggressiveness. They did not report on associated measures of cognitive functioning.

Ozols and Rourke (1985) compared the social responsiveness and judgment of two groups with differing patterns of cognitive performance. One group of children had poor psycholinguistic skills whereas visual-spatial-organizational, tactile-perceptual, psychomotor, and nonverbal problem-solving abilities were well developed. Reading and spelling were poor, but mechanical arithmetic questions were done relatively well. In the other group were children who had problems in visual-spatial-organizational, tactile-perceptual, psychomotor, and nonverbal problem-solving skills, but psycholinguistic abilities were intact. They tended to have significant problems in mechanical arithmetic, although reading recognition and spelling were good. These two groups had been established as functioning quite differently on neuropsychological testing (Rourke and Finlayson, 1973). Learning disabled children with poor psycholinguistic skills had been found to perform as though they had dysfunctional left hemispheres, whereas the group with

visuo-spatial deficits performed as though they had dysfunctional right hemispheres (Rourke and Strang, 1978). Ozols and Rourke (1985) found that individuals in the language-disordered group were more socially responsive, seemed more aware of contextual cues, were more adept at nonverbal responses, and showed more flexibility in their thoughts about emotions. Children in the spatial group were more adept at verbal responses, rarely expressed emotion appropriately through facial expression or voice tone, were more dependent on the examiner for direction, and tended to exhibit stereotyped and restricted emotional responses.

Rourke (1988a) concluded that the pattern of nonverbal learning disability seems to approximate a sufficient condition for the development of some sort of socio-emotional disturbance, whereas the pattern of central processing abilities and deficits exhibited by the psycholinguistically-impaired child does not. For this type of child it was thought that something in addition to psycholinguistic deficiency is necessary for disturbed socio-emotional functioning to occur, such as the various interpersonal difficulties that learning-disability children are vulnerable to.

A syndrome of developmental deficit in right hemisphere skills has been described by several authors

(Weintraub & Mesulam, 1983; Voeller, 1986; Tranel et al., 1987; & Rourke, 1988b) and reviewed by Semrud-Clikemam and Hynd (1990). Neuropsychological profiles are characterized by average to superior verbal functions and poor to severely impaired nonverbal abilities (Weintraub & Mesulam, 1983). Rourke (1988b) has characterized this syndrome as including strengths in auditory perception; repetition of rote material; attention to simple, repetitive verbal material; memory for rote verbal material; phonemic hearing, segmentation, blending, and repetition; receptive language skills; and volume of speech output. Academic performance is characterized by good single-word reading and spelling to dictation (Rourke, 1988b; Weintraub & Mesulam, 1983).

Weaknesses may be evident in tactile and visual perception; visual-spatial-organizational abilities; bilateral psychomotor coordination; dealing with novel stimulus configurations; attention to and memory for tactile and visual input, especially where it is not easily coded verbally; concept-formation, problem-solving, strategy-generation, and hypothesis testing, especially in novel situations; dealing with cause-effect relationships; and "psycholinguistic pragmatics", meaning repetitive, rote use of verbal communication with little appreciation of its appropriateness (Rourke, 1988b). Speech prosody is

disturbed, gesturing in association with speech is absent, social perception is impaired, and the ability to express and interpret affect is poor (Weintraub & Mesulam, 1983; Voeller, 1986). Academic performance is marked by poor reading comprehension, outstanding deficiencies in mechanical arithmetic, and difficulties in subjects involving problem-solving and complex concept-formation (Rourke, 1988b).

This type of individual is thought to be at risk for problems of emotional adjustment which are characterized by such internalized forms of psychopathology as anxiety, withdrawal, isolation, and depression (Rourke, 1988b). Introversion, chronic depression, extreme shyness, and social isolation are commonly reported problems (Weintraub & Mesulam, 1983). They are thought to have extreme difficulties in adapting to novel situations and display significant deficits in social perception, social judgment, and social interaction (Rourke, 1988b). This model presupposes that the socio-emotional difficulties of the nonverbal learning disability sufferer result from interactions between their cognitive assets and deficits with little reference to psychodynamic factors. Rourke (1988b) suggested that these individuals bore a resemblance to the type of immature delinquent described by Quay (1972).

In a retrospective study, Glosser and Koppell (1987) used a number of psychometric signs to differentiate three groups of learning disabled students: a left hemisphere impaired group, a right hemisphere/bilateral impaired group, and a non-lateralized group. They found that children exhibiting selective deficits in left hemisphere functions displayed a high incidence of depressive and anxious symptomatology and had the lowest incidence of aggression and attention disorders. Those with right hemisphere dysfunction were the least predisposed to depression and anxiety and the most likely to present ill-defined somatic complaints. There was no evidence for the hypothesis that learning disabled children with right hemisphere impairments would exhibit higher rates of aggression and disregard for social norms. The non-lateralized group displayed high rates of distractibility, motor activity, aggressiveness, dysphoria, and anxiety.

Hemispheric Asymmetry, Emotion, and Psychopathology

In order to better understand the relationships of various brain systems to the behavioral manifestations that might be associated with strengths or weaknesses in these systems, it will be useful to examine some of the research that has been conducted on the topic of hemispheric asymmetry, emotion, and psychopathology. The question of the lateral representation of the functions of emotional

expression and interpretation has received considerable research attention. There seems little doubt that the right hemisphere is actively involved for the accurate interpretation and expression of emotional stimuli (Tucker, 1981; Campbell, 1982; Bryden & Ley, 1983). The topic of hemispheric asymmetry and emotion has received attention in the study of brain lesions and through the experimental analysis of the perception and expression of emotion. Contributions have also been made through the controlled study of temporal lobe epilepsy, manic-depressive illness, schizophrenia, and neurotic disorders. A variety of techniques have been used, including analysis of EEG and GSR patterns, auditory evoked potentials, hemi-retinal paradigms, dichotic listening techniques, tests of somatosensory sensitivity, the study of lateralized eye movements, and the results of standardized neuropsychological tests. The interpretation of results often requires a leap of faith because little is known about the relationship of such functional signs and the neurological processes that underlie them. When a deficit in some hemispheric function is identified, it is unclear what that deficit means when no structural change can be distinguished. For example, Marin and Tucker (1981) argued that cortical functional changes in psychiatric states may reflect primary changes in the structure and function of subcortical brain systems.

"We will do well to bear in mind that the presence of a syndrome typical of an anatomical lesion does not mean that one is dealing with an anatomical lesion in that location. In fact, there may be no anatomical abnormality at all. In considering the theoretical relevance of neurological diseases to psychiatric disorders it is important to note that although the vast majority of patients with neurological diseases manifest specific sensori-motor or cognitive disturbances, relatively few manifest complex behavioral disturbances such as represented by psychiatric disorders." (pp. 553)

Goldstein (1952) first observed that a catastrophic emotional reaction accompanied aphasia. He attributed this reaction to the patient's recognition of the loss of linguistic capabilities. Denny-Brown et al. (1952) described a case of a right hemisphere lesion who was indifferent to her consequent difficulties and ignored the left side of her body. Hecaen (1962) reported that left hemisphere lesions resulted in a catastrophic emotional reaction, while right hemisphere lesions more frequently lead to indifference reactions. These findings were supported by the phenomena that were observed to accompany the unilateral injection of sodium amytal. Terzian (1964) found that a depressive-catastrophic reaction followed left hemisphere injection, while inappropriate euphoria followed injection of the right. These findings replicated by Perria et al. (1961) who found that the emotional reaction usually took place 4-6 minutes after the injection, often after the subjects' EEG had returned to normal. It was not a universal reaction. It occurred in about one-third of

the injections made on the dominant side and one-half of those made on the non-dominant side. Rossi and Rossadini (1967) observed emotional reactions in forty two percent of their subjects with euphoria being the more common. They described the emotional reactions as follows:

"The depressive type is characterized by a sad attitude of the patient and by his tendency to pessimism; the patient complains of almost everything: his health and the health of his family, his financial conditions, his work, and so on; he is convinced he will soon die and his family will go to ruin; he often starts weeping. The euphoric reaction is characterized at first by a relaxed attitude and then by the extremely optimistic view he takes of everything, by his smiling and making jokes, and by his breaking into actual laughter." (pp. 171)

Although the depressive and euphoric emotional reactions were more common for the dominant and non-dominant hemispheres, respectively, the reverse reaction occurred in 15% of cases for the depressive reaction and in 32% of cases for the euphoric reaction. Clearly, the relationship was not absolute and was further clouded by the fact that Milner (1967) was unable to produce the same phenomena when she carefully rated the moods of the patients. While some of her patients displayed a euphoric or good-humored response to the injections, depressive reactions were rare and neither reaction was consistent with the side of the injection.

Gainotti (1972) found that, in a group of 80 right and 80 left hemisphere brain lesioned subjects, behaviors

denoting a catastrophic reaction or indicating an anxious-depressive orientation of mood occurred statistically more frequently among left brain-damaged patients, while symptoms denoting anosognosia, indifference, or minimization of deficits were found to be significantly more frequent among patients suffering a lesion of the right hemisphere. Ruckdeschel-Hibbard et al. (1986) criticized the conclusions drawn by Gainotti from his data. They argued that he associated left brain-damage with depressive symptomatology when he did not actually find a significant difference in the frequency with which depressive behaviors were observed in right brain-damage and left brain-damage groups.

Deglin & Nikolaenko (1975) used unilateral ECT to alternatively inactivate the cerebral hemispheres. They found that right hemisphere ECT often lead to euphoria, carefreeness, softening of the emotions, and sometimes a temporary hypomaniacal state. Disinhibition, tactlessness, and talkativeness also were observed. After left ECT, the mood of the same patients was depressed with dysphoria, anxiety, hypochondria, uneasiness of the mind, and a diffuse dissatisfaction with the surroundings. The concrete manifestations of the emotional shifts depended upon the psychopathological syndrome. The distress of melancholic patients was intensified; anxiety increased in

patients with an anxious depressive syndrome; and suspicion and tension increased in delirious patients. These shifts in mood persisted for hours, beyond the time that motor and speech activity returned to normal, suggesting that a defect of awareness or anosognosia could not explain the emotional changes. The authors concluded, based upon EEG patterns, that the emotional changes depended not only on inactivation of the hemisphere involved but also upon increased activity of the contralateral thalamocortical systems. Although the mood of depressed patients had been rated by a psychiatrist and a self-report was conducted after unilateral ECT, Halliday et al. (1968) did not report this phenomenon, but experimental support comes from Abrams and Taylor (1979).

Robinson et al. (1984) also found more depressive reactions in left hemisphere stroke patients, and they were able to describe a relationship of depression to the anterior and posterior poles of the brain. Severity of depression was correlated with the distance of the lesion from the frontal pole, negatively for the left hemisphere and positively for the right. Left anterior injury was most likely to produce depression, including both mood and vegetative signs suggestive of an endogenous etiology. Right anterior injury was most often associated with "inappropriate cheerfulness", while none of the left

hemisphere patients displayed this symptom. Depression was also observed in patients with right posterior injury, but the range of scores was lower than the left hemisphere group and the correlation was heavily dependent on two patients with moderate to severe depression.

Tucker et al. (1981) suggested that right hemisphere dysfunction in depression may not represent a chronic neurological condition but some transient process that is related to the depressive affect itself or possibly to changes in arousal that accompanies depression. Hypnotic induction was used to create euphoric and depressive mood states and hemispheric arousal was evaluated by a dichotic listening task. There was little bias between the ears following euphoric mood, but there was a right-ear bias during depressive mood. In order to clarify whether this resulted from under-arousal of the right hemisphere or over-arousal of the left, a second experiment was conducted in which EEG recordings were made after subjects listened to tapes inducing the opposing moods. There was a shift to greater alpha (decreased arousal) in the left frontal region and less alpha in the right frontal region (increased arousal) during depression.

Attempts to evaluate emotional adjustment following brain damage using the MMPI has produced mixed results. Black (1975) found evidence of increased depression,

paranoid ideation, and deviant thinking in a left brain-damaged group, whereas the right brain-damage group had normal profiles. Gasparrini et al. (1978) found the left brain-damage group to be more depressed. Their mean profile was consistent with a diagnosis of major affective disorder. Since the two groups had equivalent cognitive deficits, the authors suggested that the observed depression could not arise as a response to more significant levels of impairment. The right brain-damage group maintained normal profiles. Dikman and Reitan (1974) were unable to find any lateral or anterior/posterior differences on MMPI profiles.

It is important, in this type of self-report inventory, to consider the influence of potential response bias. Bear (1979) found that right temporal lobe epileptics tended to present a "polished" image of themselves on questionnaires.

Ross (1981, 1985) proposed that prosody of speech is impaired by damage to the right hemisphere in a parallel manner to the fashion in which speech is impaired in aphasia. His classification proposed that right frontal damage would lead to a motor aprosodia, which is characterized by flat monotone speech with loss of spontaneous gesturing. Right temporoparietal damage was thought to lead to a sensory aprosodia which entails

excellent affective prosody in speech and active spontaneous gesturing. However, in these patients auditory comprehension of affective prosody, visual comprehension of emotional gesturing, and repetition of affective prosody were thought to be severely impaired. Borod et al. (1985) found stroke patients with right hemisphere brain damage to use facial and intonational channels of communication less frequently than left hemisphere brain-damaged patients and normal controls. Those with right frontal damage were specifically limited in their use of facial expression, while those with right posterior pathology were limited in their use of intonation. The speech of right brain-damaged subjects was less appropriate and more propositional than that of the other two groups, that is, they relied more heavily on the use of words than the use of prosody.

Sackheim et al. (1982) proposed that destructive lesions result in disinhibition of contralateral regions regulating emotional experience, and that the left side of the brain typically subserves positive emotion to a greater extent than the right, whereas the reverse holds true for negative emotion. Thus, the euphoria that may follow damage to the right hemisphere was considered to be a release of left hemisphere functions, while depression following left hemisphere damage related to disinhibition of the right hemisphere. They suggested that emotion

involved an interaction between cortical and subcortical areas, but they did not comment upon the relative roles of these areas with respect to affective experience and display. Their conclusions were based upon observations of cases of pathological laughing and crying, limbic epilepsy, and hemispherectomies. Support for the hypothesis that positive emotions are lateralized to the left and negative emotions to the right hemisphere is provided by Sackheim and Gur (1978) and Ahern and Schwartz (1979). By studying eye movements, Tucker et al. (1977) found that the right hemisphere of subjects placed under stress in an experimental situation was aroused to a greater degree than the left.

It has been suggested that the left hemisphere may serve to inhibit the right hemisphere's emotional responsivity (Bakan, 1969). Tucker (1981) has hypothesized that the left hemisphere's focal and analytic cognition provides the capacity for a more tight-knit modulation of the emotional process. Furthermore, he suggested that anxiety might involve over-activation of the left hemisphere. Tucker et al. (1978) found that college students who reported high anxiety performed more poorly on both a verbal and spatial task with hemi-retinal presentation to the left hemisphere.

Bear and Fedio (1977) evaluated the relationship of personality characteristics to laterality of epileptic foci within a group of temporal lobe epileptics and controls. They found many features to be more evident within the epileptic group. A factor analysis of the questionnaire produced two factors, a severity factor and a qualitative factor. The latter suggested emotive characteristics at one extreme and ideative characteristics at the other. Based on the second factor, the right temporal epileptics were rated more emotive (aggressive, depressed, and emotionally labile) and the left temporal epileptics were more ideative (religiosity, philosophical interest, personal destiny, and hypergraphia).

Although Spreen (1989) was unable to find any clear correspondence between lateralization and type of emotional disorder in a learning disabled population, Sollee and Kindlon (1987) examined children (aged 5 to 16) with clearly lateralized brain lesions and found that dominant hemisphere lesions were associated with externalizing behavior problems, while non-dominant hemisphere lesions were associated with internalizing behavior problems. Specifically, behavior related to physical aggression and loss of control such as fighting and temper tantrums was most characteristic of children with lesions of the dominant hemisphere. Items related to mood disorders as

opposed to vegetative signs of depression characterized the non-dominant hemisphere sample best.

Hemispheric Asymmetry and Psychiatric Disorders

It is useful to examine the behavioral and emotional phenomena that accompany various emotional disorders in order to gain a better appreciation of the types of manifestations which might accompany disturbances of the functioning of either the right or left hemispheres. Theories of hemispheric asymmetry of cognitive function have been proposed in the areas of temporal lobe epilepsy, schizophrenia, affective disorders, and neurotic disorders.

Evidence Drawn from Research with Temporal Lobe Epileptics

Slater and Beard (1963) examined the incidence of schizophrenic reactions in temporal lobe epileptics and came to the conclusion that schizophrenic reactions occur far too often to be related to chance. Characteristic symptoms included delusions of reference or persecution; thought disorders, such as thought-blocking, unfinished answers, disturbed syntax, and neologisms, culminating in "word salad" at the extreme; deficient conceptual thinking and circumstantiality; emotional disturbance, including moods of irritability and aggressiveness, sudden inexplicable feelings of intense fear, and loneliness and bewilderment; and disturbances of volition with a loss of

desire to do things. The incidence of schizophrenic reaction in temporal lobe epilepsy has been questioned (Small et al., 1966), but has generally found support in the research literature (McKenna et al., 1985; Pond, 1974; Pritchard et al., 1980; Shukla et al., 1979; and Sherwin et al., 1982).

Flor-Henry (1969a, 1969b) concluded that temporal lobe epilepsy of the dominant hemisphere predisposes patients to psychotic, schizophrenic-like symptoms, while epilepsy of the non-dominant hemisphere is associated with manic-depressive reactions, although his samples were small (Marin and Tucker, 1981). Sherwin et al. (1982) confirmed Flor-Henry's hypothesis that patients with left-sided temporal epileptogenic lesions have a special risk for the development of a schizophrenic-like psychosis. They suggested that such lesions are especially disruptive of the patient's thought processes. Pritchard et al. (1980) also found the incidence of psychopathology to be highest in patients with left foci. Bear (1979) described right temporal lobe epileptics as more overtly emotive: aggressive, depressed, and emotionally labile. Patients with left temporal foci developed an introspective, ideational pattern of behavioral traits.

The finding of laterality effects in temporal lobe epilepsy has not always been supported. Strauss et al.

(1982) examined ictal fear responses and found no differences between those with left versus right foci, although those with left foci reported more interictal fear of social and sexual situations. Shukla and Katiyar (1980) examined psychiatric diagnosis and the side of temporal EEG focus in 62 temporal epileptics and concluded that neurotics had right foci significantly more frequently, but no such laterality effect was noted for any other diagnostic groups. They concluded that the development of psychosis depends upon the severity of the epileptogenic lesion rather than on the side involved.

In conclusion, there is some evidence that left hemisphere dysfunction arising from epileptogenic lesions may result in disturbances of thinking, while similar dysfunction of the right hemisphere produces emotional lability and manic-depressive disorders.

Evidence Regarding Laterality from Studies of Schizophrenia

Three major theories of lateral asymmetry of brain function have been put forward in an attempt to account for the unusual mental phenomena associated with schizophrenia. The first to be extended was the theory of left hemisphere dysfunction. Subsequent theories have proposed left hemisphere overactivation and defective interhemispheric transfer of information.

Left Hemisphere Dysfunction

Kleist (1960) observed that the disturbances of language and of comprehension of abstract thoughts in schizophrenia bore a resemblance to impairments found in focal brain lesions of the left temporal lobe. Drawing upon his work with temporal lobe epileptics, Flor-Henry (1969b, 1976) suggested that schizophrenics suffer predominantly from disorganization in the dominant orbital frontal-temporal regions, while manic-depressive syndromes reflect disorganization of the non-dominant anterior limbic structures. Taylor et al. (1979) found schizophrenics to make more dominant temporal/temporoparietal errors than depressed patients on an aphasia screening test. Gruzelier (1979) reviewed the available literature and concluded that there was considerable research support for these hypotheses, as well as for the view that callosal transmission deficits might also be a factor.

Flor-Henry and Yeudall (1979) used the Halstead-Reitan Battery to evaluate the left hemisphere dysfunction hypothesis and interpreted the relative weakness of the schizophrenic group on Ideomotor Apraxia, Seashore Speech Sounds, Oral Word Fluency, and Trail Making B as implicating dominant parietal, temporal, and frontal systems. Taylor et al. (1981) found schizophrenics to be more impaired in dominant hemisphere functions than

patients with affective disorders, but the pattern of deficits also involved the non-dominant hemisphere. Taylor and Abrams (1984) also found a relative weakness on dominant fronto-temporal functions (as measured by a variety of neurological and neuropsychological indicators) among schizophrenics. Colbourne and Lishman (1979) demonstrated a tendency for right-handed male schizophrenics not to show the usual right ear and visual field (left hemisphere) advantage for alphanumeric stimuli, but they noted that poor lateralization is also characteristic of groups such as dyslexics, poor readers and language-disordered children, and minimally brain-damaged individuals.

Merrin (1981) reviewed the evidence related to the theory of hemispheric asymmetry in schizophrenia and drew several conclusions: 1) Studies of psychiatric sequelae of left-sided trauma suggest that schizophrenic symptoms are possible but are not generally associated with such brain disease; 2) Consistent support is not provided for the suggestion that left temporal lobe epileptic foci are associated with schizophreniform psychoses; 3) Neuropsychological test results do not routinely support a pattern of dominant hemisphere difficulties; 4) Schizophrenics perform in an anomalous fashion on visual hemi-field tasks, but many research design problems make

the results difficult to interpret; 5) Left hemisphere impairment is suggested when auditory threshold or discrimination tasks are used; 6) Dichotic listening studies are consistent with frequent anomalous cerebral functional organization but not left-sided impairment; and 7) An apparently diminished responsivity in left-sided skin conductance in schizophrenics may reflect ipsilateral limbic disorder.

Attempts have been made to evaluate this hypothesis using dichotic listening and hemiretinal research paradigms and the results have been inconclusive (Marin & Tucker, 1981; Walker & McGuire, 1982). On verbal and nonverbal dichotic listening tests, Yozawitz et al. (1979) found that schizophrenics did not show the expected left hemisphere impairment. Walker & McGuire (1982) suggest that there is evidence that they process stimuli directed to the left hemisphere more slowly since they respond less rapidly to stimulation when it is presented to the right sensory field. Losonczy et al. (1986) found that the most chronically ill, Kraepelinian patients showed larger ventricles in the left hemisphere than in the right, but this was not true of less chronic patients. It is possible that the variable results of hemi-cortical studies might be confounded by the relative presence of such patients in the sample.

In conclusion, some evidence has been advanced in support of schizophrenia as a disease which impairs left hemisphere functions. This theory supports the view proposed in temporal lobe epilepsy research that dysfunction of the left hemisphere produces symptoms of thought disorder. In other words, disturbances in the verbal regulation of behavior could be expected to occur. But the notion that schizophrenia would occur exclusively as a result of left hemisphere pathology is challenged by many other findings in the field. A recent study by Shenton et al. (1989) found reduced P300 auditory evoked potential amplitudes to typically occur over the left temporal region in schizophrenics, but some patients showed a pattern of reduced right temporal responses. A comparison of two subjects of each type suggested that those with right temporal deficits exhibited more positive symptoms, more thought disorder, a poorer clinical response to neuroleptics, poorer premorbid functioning, a more diffuse pattern of cognitive deficits on a neuropsychological testing battery, and an earlier age of onset than the subjects showing a left temporal P300 deficit. There were no differences between the two groups on negative symptom ratings. It was felt, based upon CT scans, that the right temporal group might have had more frontal lobe involvement than the left temporal patients.

Left Hemisphere Overactivation

Gur (1979) went beyond the theory that schizophrenics have a deficit in left hemisphere functions to suggest that they also overactivate their defective hemisphere. Citing evidence that schizophrenics display lateral eye movements suggestive of left hemispheric activation regardless of whether questions were verbal or spatial in nature (Gur, 1978), Gur (1979) presented schizophrenics and controls with tasks that called upon sequential and simultaneous processing skills. It was found that schizophrenics performed more slowly on the task which called for simultaneous analysis. No differences were noted between paranoid and non-paranoid or acute and chronic patients. Depressed patients performed equally quickly on both conditions, suggesting that this was not a general phenomenon of emotional disturbance. It was concluded that schizophrenics have a dysfunctional left hemisphere, fail to shift processing to the right hemisphere (as might be done by brain-injured patients), and overactivate the dysfunctional hemisphere.

Walker and McGuire (1982) extended this interpretation. They noted that a priming stimulus can increase hemispheric arousal contralateral to the sensory field where the stimulus occurs. When the stimulus is of a similar nature to the task that will be subsequently

performed, it serves to enhance performance. However, priming can result in dominance by the hemisphere that is least efficient in subserving the required functions. Further, when a concurrent task requires more complex cognitive activity or greater memory capacity it may contribute to performance decrements for other tasks subserved by that hemisphere. There is a similarity between the performance of schizophrenics and normals whose left hemisphere processes are overactivated. When left hemisphere processes are strained, incoming information is processed more slowly, as has been observed with schizophrenics.

Left hemisphere overactivation could result in deficits that are characteristic of schizophrenic's cognitive deficits (Walker & McGuire, 1982). It would interfere with the linguistic capacities of the left hemisphere, producing difficulty with verbal tasks. It might also lead to the misapplication of linguistic, analytic, or sequential strategies to right hemisphere tasks and thus lower performance on a variety of visuospatial measures. The overarousal of the left hemisphere would also lead to slowed processing and longer response latencies to stimuli in the right sensory hemifield. Magaro and Chamrad (1983) reported that paranoid patients exhibited a deficit in recognizing faces

presented to the left visual field (right hemisphere) but not to the right. In bilateral presentations, they preferred left-hemisphere to right-hemisphere processing. Non-paranoid patients appeared to rely more on right hemisphere processing at the expense of left.

These findings may be important in understanding the cognition of individuals suffering from impairment of the left hemisphere, whether this is a result of brain trauma or a developmental disorder of brain functioning. Requirements to analyze information verbally might result in confused thinking or consistent misinterpretations of events and situations. Inadequate verbal regulation is likely to lead socially inappropriate behavior.

Defective Interhemispheric Transfer

Rosenthal and Bigelow (1972) reported structural changes in the form of enlargement of the corpus callosum of schizophrenics. Beaumont and Dimond (1973) demonstrated deficiencies in the interhemispheric transfer of information by having subjects say whether stimuli presented to both visual fields were the same or different and comparing this to performance on a task which required the comparison of stimuli presented to the same visual field. Schizophrenics performed more poorly on the inter-hemisphere task but were equivalent to controls on the

intra-hemisphere comparison. Green (1978) used a complex task in which subjects were taught haptic recognition of different shapes through feedback to the hand performing the task or the opposite hand and then were tested for transfer to the opposite hand. Schizophrenics performed more poorly than controls in using opposite hand feedback and on the transfer task. Carr (1980) also found schizophrenics to have difficulty performing tasks that required inter-manual comparisons and, presumably, efficient transfer of haptic information across the corpus callosum. Walker et al. (1981) interpreted the apparently contradictory findings of a right hemisphere superiority of schizophrenics for both a verbal and spatial task reported by Gur (1978) and a left hemisphere superiority of schizophrenics for recall of digits presented unilaterally cited by Lerner et al. (1977) as being most parsimoniously accounted for by the hypothesis of defective interhemispheric transfer.

The two hemispheres of the normal brain work interactively in processing information, with each providing its contribution in the aspects of the information that it is most suited to deal with (Galin, 1974; Kinsbourne, 1974). If one hemisphere is malfunctioning, this should show up in asymmetrical patterns of electrodermal activity in autonomic responses.

Acute schizophrenics do show autonomic response patterns which would be consistent with an overly aroused left hemisphere, while chronic schizophrenics show an overly aroused right hemisphere (Gruzelier, 1973; Gruzelier and Venables, 1973 & 1974). Thus, the acute patients have an extremely active problem-solving orientation that produces high levels of information overload. The overaroused and consequently impaired left hemisphere no longer provides sequential, linguistic, rational structure for the analogical and semantically loose conceptualizations of the right hemisphere (Tucker, 1981). The chronic stage may result from a shift from the inadequately functioning left hemisphere to predominant right hemisphere activity (Shimkunas, 1978). Since the right hemisphere specializes in perceptual and emotional activity, it could become more concerned with processing internally-generated than external stimuli. Shimkunas (1978) suggested that both overinclusion and concreteness could be understood in terms of diminished efficiency of the interhemispherical transmission and analysis of the physical properties of objects, on the one hand (a right hemisphere task), and the recognition of similarities between objects, on the other (a left hemisphere task).

Walker and McGuire (1982) argued that callosal defects would result in exaggerated performance asymmetries,

particularly where left ear or visual field input must be transferred from the right to the left hemisphere for processing. The bilateral performance deficits noted in studies are not of the extent that would be expected by such a defect. Schizophrenics do not display unusual decrements in response accuracy with linguistic stimuli presented to the LVF. These observations argue against the defective interhemispheric transfer hypothesis as a primary feature of schizophrenic pathology. Nonetheless, it draws our attention to the types of disturbed thinking that may be possible if interhemispheric transfer of information is impaired.

Evidence from Studies of Affective Disorders

Flor-Henry (1969) proposed that epileptic foci in patients with manic-depressive features were lateralized to the non-dominant hemisphere. This received some support from Gruzelier and Venables (1973) who found a pattern of arousability of GSR responses which suggested an asymmetry of response amplitude that might have been caused by impaired right hemisphere processing. Unilateral right ECT was initially used to avoid the verbal memory problems of ECT to the left hemisphere. Halliday et al. (1968) found better recovery from depression using unilateral than bilateral ECT. Unilateral ECT to the right hemisphere was especially effective. Subsequent studies have found

unilateral right ECT as effective as bilateral ECT and more effective than unilateral left ECT in treating the actual mood disorder (Cronin et al., 1970; Cohen et al., 1974), especially in cases of endogenous depression. Flor-Henry and Yeudall (Flor-Henry, 1976 & 1983; Flor-Henry & Yeudall, 1973 & 1979) suggested that patients diagnosed with affective disorders tend to score lower on nonverbal than verbal subtests of the WAIS. Specifically, their performance on a battery of neuropsychological tests reflected asymmetrical pattern of fronto-temporal dysfunction, with the right hemisphere more impaired than the left. This finding of right hemisphere dysfunction was replicated by Goldstein et al. (1977) with a heterogeneous group of patients who had previously not responded to treatment, including ECT. Following ECT, cognitive performance improved, revealing a more pronounced pattern of right hemisphere deficit. Kronfol et al. (1978) also reported right hemisphere dysfunction in depressed patients. They found improvement in right hemisphere cognitive skills after several unilateral right hemisphere ECT treatments. Those receiving left hemisphere ECT showed decline in verbal skills. Brumback and Staton (1982) proposed that learning disabilities, attention deficit disorders, and major childhood depressive disorders were all associated with dysfunction of the right cerebral hemisphere. They suggested that right hemisphere learning

disability may be etiologically linked with childhood endogenous depressive illness, whereas the symptoms of a left hemisphere learning disability could be exacerbated by such depression (Brumback and Staton, 1983). Support for this suggestion is found in a case report by Ternes et al. (1987). They found that an 11-year old boy with symptoms of right hemisphere dysfunction, including frequent right temporal spikes on EEG examination, responded to treatment with carbamazepine with an increase in Performance IQ and alleviation of interpersonal problems and affective difficulties.

Taylor et al. (1975) found no hemispheric asymmetries in the performance of a group of depressed patients on the Aphasia Screening Test. This was replicated by Taylor et al. (1979) who found no deficiency in non-dominant skills in depression using the same instrument. In a subsequent study, (Taylor et al., 1981) a pattern of right hemisphere deficits was observed. Yozawitz et al. (1979) evaluated hemispheric asymmetry in affective and schizophrenic patients using dichotic listening procedures. They found the affective group to show evidence of right hemisphere impairment that was significantly different from normals. Although they could not be differentiated from schizophrenics on a verbal or nonverbal test, the combined scores of the tests lead to a statistical difference in the

direction of greater right hemisphere impairment for the affective group. Bruder & Yozawitz (1979) reported that the asymmetry noted was more likely to be present in bipolar depressives than unipolar depressives. They noted that auditory perceptual asymmetries were negatively correlated with symptom ratings. Suicidal tendencies, insomnia, loss of interest, somatic anxiety, and scores on the Hamilton Depression Scale were negatively correlated with the presence of asymmetrical performance.

This is in contrast to the results of Robinson et al. (1984) who found depression to be most prominent in left anterior stroke patients. Although an indifference reaction has most commonly been associated with right hemisphere brain-damage, Ruckdeschel-Hibbard et al. (1986) concluded that the most prevalent finding in the literature is one of depression, rather than indifference, in most right brain-damaged patients. The appearance of indifference was thought to be associated with prosodic deficits which impair the patient's ability to comprehend and communicate affect. Self-report and clinical ratings suggested that both right and left brain-damaged groups may be equally depressed.

Richards and Ruff (1989) proposed that neuropsychological findings with depressed patients may be affected by poor motivation. In spite of special

incentives to enhance motivation during testing, there was no difference between the motivated and unmotivated groups. They found that the depressed patients performed poorly on some tests of visuospatial attention and learning while verbal measures were intact. In spite of this, they were reluctant to interpret their findings as supportive of the theory of right hemisphere dysfunction in depression. They suggested that the motivational components of depression might be thought of as a confound that affects visuospatial and verbal tasks differentially if one considers the greater novelty of visuospatial tasks. They neglect, however, to account for the fact that such a factor would be expected to elevate rather than depress scores on these tests.

D'Elia & Perris (1973) found a reduced ratio of EEG activity in the left hemisphere relative to the right in a group of depressed psychiatric patients. The involvement of the left hemisphere was proportional to the degree of depression. Abrams and Taylor (1979) found a preponderance of right hemisphere abnormalities in EEG's of patients with affective disorders among those patients who displayed abnormal EEG's (24% of the sample). Perris et al. (1978) compared EEG patterns of psychiatric patients with high and low anxiety and depression scores and found an increase in activity over the left hemisphere in the high anxiety and

depression group and an increase over the right hemisphere in the low group. There was little hemispheric differentiation in EEG activity between the hemispheres when high retardation score and low retardation score groups were compared. The implication may be that the ideational components of depression involve an activation of the left hemisphere. However, the primary mood disturbance of depression may not be lateralized. Perris and Monakhov (1979) suggested that a certain degree of hemispheric specialization occurs in the formation of depressive mood and of depressive ideas. Right hemisphere activation on EEG analysis was associated with the former and left hemisphere activation with the latter.

Tucker (1981) concluded that right hemisphere dysfunction has been observed fairly consistently in patients with affective disorders, but rather than indicating a chronic disorder, this poor right hemisphere capacity may be a transient phenomenon associated with the depressive affect itself. Campbell (1982) found evidence to support the conclusion that depressed mood reduces right hemisphere lateralization on performance of tasks that depend upon right hemisphere processes.

Tucker (1981) reviewed research which suggested that neurotransmitter mediated arousal-systems may be lateralized in their effects. Serotonin and norepinephrine

may be particularly important to the arousal of the right hemisphere, while dopaminergic arousal may specifically support left hemisphere arousal. Although the affective component of depression may relate to right hemisphere dysfunction, the ideative element is more closely related to left hemisphere activity (Tucker, 1981). Marin and Tucker (1981), on the other hand, concluded that no characteristic pattern of hemispheric function has emerged from the study of affective disorders.

Regional cerebral blood flow (rCBF) studies have focused attention on the same areas that were associated with depression in stroke patients by Robinson (1984). Gur et al. (1984) found that depressed patients showed relative left hemisphere overactivation during resting baseline measures. The finding that depressed men had the same flow in anterior regions for both verbal and spatial tasks while for controls, spatial tasks created a higher flow in the right hemisphere was interpreted as being consistent with right hemisphere dysfunction in depression. Uytendhoef et al. (1983) identified a left frontal hypervascularisation and a right posterior hypovascularisation in patients with a major depressive disorder when compared to subjects with bipolar or minor depressions and normal controls.

Based upon their review of neuropathological studies of secondary affective disorders, Jeste et al. (1988) found

depression to be associated with left fronto-temporal and right parieto-occipital lesions, and mania with right fronto-temporal and left parieto-occipital lesions.

That mania may represent an over-activation of the right hemisphere is suggested by a case cited by Tucker (1981) which was originally described by Kushnir, Gordon & Heifetz (1980). This was a manic-depressive patient whose performance on a gestalt recognition test during a manic phase was better than during depression. Her pattern of errors changed, with a preponderance of errors from overly global judgments during the manic phase, followed by a constricted and detail-oriented tendency to overanalyze the stimulus as depression set in.

A case cited by Robinson (1976) suggests that overactivation of both left and right cortical or subcortical structures may be involved in mania. This patient was a 45 year old, right-handed male who suffered a right hemiparesis and a non-fluent dysphasia secondary to a left convexity meningioma. Four or five years after removal of the tumor, he developed a manic state. During the mania, there was significant improvement both in speech and in use of the right extremities. Although the content of the speech was paranoid and psychotic, there was a marked return to prosody and rhythm. Non-fluency was replaced with fluency and more normal use was made of

grammatical forms. Treatment of the mania with chlorpromazine was effective in reducing the mania, but the non-fluent dysphasia and right hemiparesis returned. By administering and discontinuing the medications, it was possible to demonstrate control over the phenomenon. Robinson interpreted this case as evidence for the role of the limbic system in human speech.

Evidence from Studies of Neurotic Disorders

Kenyon (1964) found unilateral left symptoms in 65 percent of a primary hypochondriasis group and in 80 percent of a group where the diagnosis of hypochondriasis was secondary to some other disorder, usually depression. Stern (1977) tested the hypothesis that lateralization of such symptoms to the left side of the body might be because this provided the least inconvenience to the patient, but he found that the predominance of left-sided symptoms occurred as often in left-handed as right-handed individuals.

Galin (1974) noted the similarity between some of the behavior of commissurotomy patients and features of unconscious processes as conceptualized in psychoanalytic theory, especially repression. He proposed that, being blocked from expression, the right hemisphere may express itself through channels which are not under control of the

left hemisphere. Thus, he suggested that hysterical or hypochondriacal conditions might show evidence of expression of the right hemisphere. Galin et al. (1977) found that in sixty-three percent of hypochondriacal patients the physical disability was lateralized to the left which was marginally significant. The relationship was dependent more on female than male subjects.

The term "alexithymia" was introduced by Sifneos (1972, 1973) and elaborated upon by Taylor (1984) to describe a condition involving difficulty recognizing and verbalizing feelings, a reduced capacity for fantasy, a tendency to report physical symptoms rather than feelings, and concrete patterns of speech and thought. A neuropsychological model for alexithymia has been proposed (Buchanan et al., 1980; Hoppe and Bogen, 1977; Shipko, 1982; TenHouten et al., 1986) in which it is proposed that alexithymia reflects a disconnection between the emotional processing functions of the right hemisphere and the verbal processes of the left hemisphere. This could occur as a result of a commissurotomy (Hoppe and Bogen, 1977) or be more functional in nature (Hoppe, 1977). Zeitlin et al. (1989) carried out an evaluation of interhemispheric transfer on a finger localization task and compared this to evidence of alexithymia drawn from a self-report questionnaire. They were able to support the notion of

alexithymia being associated with interhemispheric transfer deficits.

Smokler and Shervin (1979) compared obsessive-compulsive patterns of thought and behavior to a left hemisphere style of cognitive processing. They were seen as: 1) having a strong tendency to repress disturbing affects; 2) tending to treat everything in an ideational way; and 3) favoring a logico-deductive approach to problem-solving. Hysterics were viewed as favoring a right hemisphere style of processing. They were viewed as: 1) having a strong tendency to repress disturbing ideas; 2) subject to emotional lability; and 3) favoring a concrete, stimulus-bound approach to problems. When lateral eye movements were studied in groups of students classified as hysterical or obsessive-compulsive, support was found for the hypothesis that these two groups preferentially activate the right and left hemisphere, respectively.

Two Brain Systems

Several authors have discussed an integrated right hemisphere system which operates in selective attention and which appears to have significant links with the limbic system. Heilman et al. (1978) found that when stimuli are applied to a limb ipsilateral to a damaged cerebral hemisphere, patients with right hemisphere lesions and

unilateral neglect show smaller GSR than do aphasic patients or normal controls. They proposed that unilateral neglect is an attention-arousal defect caused by dysfunction in a cortico-limbic-recticular loop. The cortex (inferior parietal lobule) was thought to be responsible for stimulus analysis (identifying significant or novel stimuli) and recticular formation-mediated arousal. Heilman et al. (1985) emphasized the importance of the inferior parietal lobule in cortical arousal because of its intermediate position in a number of processes. Although unimodal association cortices project to the nucleus reticularis thalami (which in turn projects to the mesencephalic reticular activation system) and are capable of stimulating cortical arousal, they gate only one sensory modality. Mesulam (1985b) reported that, in the monkey, the inferior parietal lobule receives input from reticular areas (intralaminar thalamus, nucleus locus coeruleus, brainstem raphe), limbic centres (cingulate cortex, retrosplenial cortex, nucleus basalis), and sensory tissue (high order association cortex, pulvinar medialis nucleus of the thalamus, lateroposterior nucleus of the thalamus). Multimodal convergence areas, especially the inferior parietal lobule, have a more general action on the nucleus reticularis and may also project directly to the mesencephalic reticular formation, which may induce a general state of arousal because of diffuse multisynaptic

connections to the cortex (Heilman et al., 1985). Ablation of these areas of the cortex that produce electrocortical and behavioral arousal was thought to be capable of causing bilateral hypoarousal (Heilman et al., 1978). Bilateral arousal defects were seen in patients with unilateral neglect from right hemisphere lesions.

Heilman et al. (1985) proposed that cells in the right hemisphere are more likely to have bilateral receptive fields than cells in the left hemisphere. Consequently, cells in the left hemisphere would be activated predominantly by novel or significant stimuli in the right hemispace, but cells in the right hemisphere would be activated by novel or significant stimuli in either visual field. Mesulam (1985b) also concluded that the right hemisphere is dominant for the process of directed sensory attention.

The relative importance of the right hemisphere in processing novel stimuli is emphasized in the model proposed by Goldberg and Costa (1981). It suggested that the right hemisphere is adapted to processing multisensory input and functions to analyze unfamiliar situations and new stimulus configurations. The left hemisphere, on the other hand, operates to systematize and order sensory input, seeking patterns that can be used in rapid processing of information.

Bear (1983) hypothesized that there are two separate, complementary corticovisual systems with independent limbic connections: 1) the ventral or temporofrontal system and 2) the dorsal or parietofrontal system. These systems were thought to operate predominantly in the right hemisphere because of the specialization of the left hemisphere for language and the multisensory associations necessary to support language in the dominant angular gyrus.

The ventral or temporal visuolimbic pathway is a foveal system which recognizes objects by multiple attributes. Projections to the inferotemporal visual cortex and temporolimbic structures assist appropriate drive response and new stimulus-response learning. In addition to projections from the amygdala and hippocampus, a major limbic-motor association is the orbital frontal cortex which is strongly connected to the rostral temporal lobe by the uncinate fasciculus. This system was thought to be important in the acquisition and storage of visuo-emotional associations. Lesions in this system would selectively prevent access to previously learned emotional associations, including acquired social restraints. In terms of emotional function, these intramodal sensorilimbic connections may allow for a more immediate or powerful affective reaction to stimuli. The decoding of emotional

signals would be most effectively accomplished by this system (Bear, 1983).

The dorsal or parietal visuolimbic route involves polysynaptic projections from the striate cortex to the inferior parietal lobule. There is a unique limbic input from the cingulate gyrus with reciprocal connections from the inferior parietal lobule back to the cingulate gyrus. The inferior parietal lobule was thought to be involved in the detection and spatial localization of drive-relevant stimuli. In addition to having efferent pathways from the inferior parietal lobule to reticular activating nuclei, locus ceruleus, and frontal eye fields, the dorsal limbic structures may preferentially project to the dorsolateral prefrontal cortex. This system is proposed to mediate emotional arousal and rapid selective orientation to stimuli that are pertinent to drive. Lesions within this system might interfere with surveillance, orientation, and emotional arousal. The deficits would include neglect, apathy, or abulia. An independent dorsal limbic system in the right hemisphere would allow for superior emotional surveillance, through scanning in multiple modalities for drive-relevant stimuli, and would enhance incidental learning (Bear, 1983).

The model outlined by Mesulam (1985a) suggested that the heteromodal cortex (inferior parietal lobule, anterior

orbitofrontal area and dorsolateral frontal convexity of the prefrontal region, and posterior ventral temporal lobe) provides an integrative connection between limbic and paralimbic and unimodal areas. As such, it functions to mediate between the drives and instincts of the organism, on the one hand, and sensory input and manipulation of the extrapersonal world on the other. Extensive input from paralimbic areas allows mood and drive to influence the manner in which the self and the world are experienced and also to permit thought and experience to influence mood. The right hemisphere was thought to play a primary role in the mediation of emotion and the paralinguistic aspects of communication. He noted that the inferior parietal lobule of the monkey has been shown to contain neurons that are responsive not only to sensory aspects of events in the extrapersonal space but also to their motivational relevance. He suggested that, if such neurons exist in the human brain, an increase in their activity could correspond to a state of heightened attentiveness.

Secondly, there is the brain system that governs verbal communication. Luria (1961) suggested that it is through speech that the child becomes capable of actively modifying the environment that influences him, altering the relative strength of the stimuli acting upon him, and adapting his behavior to the modified influences. He

described experiments that emphasized the importance of speech in the child's attempts to orient himself to problems and to limit impulsive responding.

"At first, such speech is mainly an accompaniment to the child's practical activities or coincides with them: but later on it begins to precede them, the child inhibiting his direct attempts until he has verbally formulated what it is he means to do." (p. 34)

Gradually this speech becomes silent and becomes abbreviated internal speech which is an invariable part of the thought process.

"New functional systems, including inward speech as an essential component, are thus formed. These systems are socially generated, structurally speech-borne and by nature volitional." (p.35)

Luria emphasized that speech forms "second signalling-system links" that abstract and systematize the signals acting on the organism and inhibit its direct-impulse reactions. Thus, a verbal generalization system forms which determines the formation and non-formation of new S-R links without the usual stimulus-bound learning through external reinforcement. Luria (1961) cited experimental results indicating that having a child verbalize instructions resulted in a high degree of control over motor responses so that impulsive responding was markedly reduced.

Luria (1961) suggested that initially the regulatory mechanism of speech operates through the non-specific, impulse aspect of the child's speech (speech serves as a signal for action). As the child develops,

"the regulatory function is steadily transferring from the impulse side of speech to the analytic system of elective significative connections" (propositional mechanisms) "which are produced by speech. Moreover...it shifts from the external to the internal speech of the child." (p.92)

It has been assumed that this system plays an important role in the organization of emotional behavior (Deglin & Nikolaenko, 1975) and in behavioral control, particularly by cognitive behavior modification theorists (Meichenbaum & Goodman, 1969; Meichenbaum, 1976). Riklan and Levita (1964, 1965) found that problems of emotionality and impulse control followed left but not right thalamic lesions. Since these lesions were likely to inhibit left hemisphere functioning, it is reasonable to conclude that the left hemisphere is important in impulse control. In fact, Caulfield et al. (1989) have found that problem behaviors such as crying, screaming, hitting, and throwing toys occurred at a higher rate among a group of two-year-old children with expressive language delay than among normal controls. These children also engaged in a higher rate of nonverbal communication.

Gazzaniga (1985) has suggested a modular interpretation of neuropsychological functioning wherein the control of behavior may fall in the realm of different functional systems at different times. Within this model, it is entirely likely that the functional systems employed in the face of different stimulus complexes will vary and also that individuals will vary with respect to their preferred utilization of functional systems in dealing with the same stimulus complex. Although Gazzaniga did not provide a clear definition of what constitutes a functional system, his research highlighted the differences between verbal and nonverbal modules of problem solving in conjunction with left or right hemisphere processing of tasks in split-brain patients (Gazzaniga, 1970). He described an interpretive module, which appears to be closely linked with speech centres. It provides a running commentary and attempts to rationalize the behavior which is produced.

The concept of an interpretive module may resolve some of the apparent disagreement between the outcome of the sodium amylobarbitone (Terzian, 1964; Perria et al., 1961; Rossi and Rosadini, 1967) and unilateral brain injury experiments (Goldstein, 1952; Gainotti, 1972) which relate a depressive response to left hemisphere dysfunction and the result of research with depressed subjects which

implicate right hemisphere dysfunction (Flor-Henry, 1976 & 1983; Flor-Henry & Yeudall, 1973 & 1979; Tucker, 1981; Campbell, 1982). The interpretive module may serve as an orienting mechanism for some individuals, that is, they may use verbal mediation to continually review the status of various problem situations in their lives and to orient themselves to respond to these situations. Serafetinides et al. (1965) equated consciousness with the function of the cerebral hemisphere dominant for speech. The disabling of this system, such as might occur in aphasia or sodium amylbarbitone injection, could leave them feeling vulnerable and out of control of their lives. This might produce the type of catastrophic reaction that has been described. The euphoric reaction may occur in these individuals because a reduction in the capacity to perceive threat in the immediate situation, consequent to a disabling of the nonverbal system of orientation to the environment, will put them more at ease. It might also occur in individuals who rely heavily on a predominantly nonverbal mode of orientation. Such a mode might be primarily concerned with present stimulus configurations, marked by lower levels of anxiety and limited concern for more distant circumstances, such as has been proposed to characterize psychopaths and hysterics (Tucker, 1981). This type of individual might experience a euphoric reaction to impairment of the right hemisphere since the

inclination to recognize threat in the immediate environment is reduced. Others who utilize a more balanced approach, using both verbal mediation and nonverbal sensitivity to threat, may not experience any emotional reaction because of the compensatory response of the other functional system.

Hughlings Jackson (1932) emphasized the difference between propositional speech and emotional utterances in aphasia. Propositional speech involves the use of words for the deliberate communication of a message, while emotional utterances involve the use of words in the expression of an existing emotional state. It has been commonly observed in aphasic patients that emotional utterances may be relatively intact, while propositional speech shows deficits (Buck & Duffy, 1980).

Robinson (1976) suggested that human speech depends upon two systems rather than one. One is phylogenetically older and is located in the limbic system. It is bilaterally represented without hemispheric dominance; is closely related to emotional, motivational, and autonomic factors; and is able only to transmit signals low in information content. The second is neocortical and lateralized, usually to the left hemisphere. This system was thought to arise from new neocortical association areas and has greater independence from emotional factors. It

was thought to be capable of carrying dense and precise informational loads and to have relegated the old system to a subordinate role.

Lamendella (1977) suggested that speech and communication functions that involve appetitive, affective, and signal communication are processed through subsystems of the limbic complex, whereas propositional speech is processed in the cortex of the dominant hemisphere and serves as an inhibitory mechanism on emotional expression. He emphasized the important role of the limbic system in communication in stating,

"...the so-called extralinguistic and nonverbal aspects of communication aren't mere window-dressing that accompany sentences optionally but a fundamental ingredient of the process by which people decode and encode messages. Many propositional and symbolic components of communicative interactions are not expressed by linguistic means but rather by way of conventionalized manual gestures, body movements, facial expressions, and prosodic elements beyond phonology...The obvious candidate for the level of brain activity likely to be responsible for the bulk of non-propositional human communication is the limbic system...its range of functional responsibilities is quite large and includes major segments of our social and communicative behavior." (pp. 158-159) "With the development of propositionally based symbolic activity by neocortical systems, new types of verbal and nonverbal non-limbic communication appear, leading eventually to language and speech. However, limbic level communication patterns do not disappear at this point. The limbic communication systems continue to serve their special functional roles in concert with both higher and lower levels of neural organization. Speech is normally embedded within a matrix of behavior patterns regulated by the limbic system. In decoding a speaker's message, the addressee consciously attends to these non-linguistic behaviors in order to extract the entire message." (p. 206)

Propositional communication supplants and inhibits limbic functions as neopallial systems develop and carry out the basic limbic functions out at a higher level, but

"the limbic system is demonstrably involved in the control of multimodal behavior sequences that serve as signs for particular internal motivational states of fear, alarm, surprise, rage, and so on...Behavior patterns that are output automatically in particular motivational states constitute the overwhelming majority of messages in the communication repertoires of nonhuman primates and are easily observable in human behavior. Limbic structures are also implicated in the production and recognition of a second class of messages, those regulating social interaction that involves territorial concerns, expressions of dominance, mother-infant and male-female, and friendly, submissive or aggressive displays." (p. 183)

Buck and Duffy (1980) found that patients who were more severely affected in symbolic communication (aphasics) tended to be more facially and gesturally expressive. They speculated that the left hemisphere might exert an inhibitory influence over spontaneous nonverbal expression. Damage to the left hemisphere would decrease inhibition and allow for greater nonverbal communication. Low expressiveness of patients with right hemisphere lesions was seen as suggesting that expression might be mediated in part by the right hemisphere. Their research suggested that the message that arises spontaneously from the emotional state of the patient is not disrupted and may even be facilitated by left hemisphere brain damage, but it was disrupted by right hemisphere damage. The expression

of emotion was believed to occur directly in a natural or conditioned relationship with an current emotional state and not from an intent to communicate.

The importance of verbal mediation of behavior in delinquent adolescents was emphasized by McWhinnie (1969). He suggested that the quality of language usage of delinquents differed markedly from that of psychoneurotic delinquents. The form and content of their thinking was described as being predominantly concrete and they showed only a limited capacity for the formulation and communication of abstract concepts. He suggested that the delinquent lacks the linguistic apparatus to formulate and to communicate understandably about such abstract concepts as personal morality, social responsibility, and awareness of guilt. Psychoneurotic adolescents were described as more able to communicate about abstract feelings such as guilt, inadequacy, and hopelessness and abstract concepts such as immorality and responsibility. This was attributed to the pattern of verbal communication in the families and social groups of delinquents. It was suggested that delinquents whose language is restricted and concrete are likely to have grown up in a family where the pattern of communication was limited and concrete, allowing limited opportunities for elaborated verbal learning. The nature of their upbringing was seen as retarding their development

of thought and moral judgment at the level of the concrete. Baker and Sarbin (1956) suggested that delinquents were socially retarded due to an arrest of perceptual-cognitive development that leads to a relative inability to form complex concepts, including such socially-derived concepts as self and roles.

Guerra and Slaby (1989) investigated the role of individual subjective evaluations, in addition to skills in generating solutions and consequences, in mediating aggressive behavior in young children. They found that aggressive boys at two grade levels (grades 2-3 and 5-6) were more likely to define interpersonal problems in such a way that the other was perceived as a hostilely motivated adversary. Although they were just as likely to choose a non-hostile, nonaggressive solution, they had fewer alternative solutions to fall back on and their second best solution to the problem situation was less effective than nonaggressive boys. The aggressive children foresaw fewer consequences to their aggression and showed less concern about the impact of consequences.

Interaction of Functional Systems

Galin (1974) suggested several models by which the two hemispheres might be integrated: 1) in alteration according to situational demands; 2) the dominant hemisphere may use

subsystems of the other hemisphere while inhibiting the rest; 3) one hemisphere dominates overt behavior, but can only disconnect rather than totally inhibit the other hemisphere; and 4) the two hemispheres are fully active and integrated with each other.

One factor that might contribute to preference for a cognitive mode is the relative superiority of a subject's skill in that mode. Galin (1974) suggested that cerebral dominance is normally determined by which hemisphere is able to solve the problem first and gain access to output channels. He noted that, as the left hemisphere develops its language capacity in the second and third year of life, it gains a great advantage over the right hemisphere in manipulating its environment and securing reinforcements. Galin and Ornstein (1974) differentiated ceramicists and lawyers using the Word-Shape Sorting Test, which allows subjects to select from two equally appropriate methods of classification. Ceramicists were more likely to sort by shape and lawyers by word. Arndt and Berger (1978) were able to demonstrate that sculptors did better on spatial-holistic tests, whereas lawyers did better on verbal-analytic tests. It seems quite likely that children with language-related learning disabilities would be more likely to prefer a spatial-holistic mode of processing.

Geschwind and Galaburda (1985) have speculated about reasons for observed sex differences in neuropsychological research, including the apparent superiority of women in language-related skills and of men on visuospatial tasks and the predominance of men among cases of autism, dyslexia, stuttering, and other developmental disorders. They hypothesized that testosterone acts upon the developing fetus to slow the rate of growth of the left hemisphere. This favors the growth of the right hemisphere in men since "...a neuronal system that develops quickly, or whose axons grow more rapidly comes to predominate over slower competing systems." (p. 434) The slowing of the growth of the left hemisphere leaves it vulnerable to forces which might impair normal development over a longer period of time. This would account for the increased incidence of developmental disorders in males. It also suggests that males may be more prone to a right-hemisphere information processing style.

Of interest are the comments of Marin and Tucker (1981) who emphasized that inter-hemispheric differences within psychiatric categories may involve more than merely the type of information that is processed most effectively. It may be as or more important to consider the processes that are involved, that is, the specific strategies that are used to respond to problems. Priming effects could

also play an important role in determining the type of processing that takes place. Tucker (1981) observed that individuals who are more emotionally responsive show a preference for right hemisphere processing.

Since the right hemisphere has an advantage in interpreting stimulus characteristics that enable one to judge emotion (Campbell, 1982), living in a chaotic family environment where there are many interpersonal conflicts and open displays of emotion could prime an individual to preferentially use a right hemisphere processing style. In such circumstances individuals might come to prefer to process visual information mainly through the right hemisphere in response to an environment that demands a high degree of attention to affective information and where affective cues play a preeminent role as conditioned stimuli for aversive events. Myslobodsky and Rattok (1977) have suggested that the right hemisphere processes information in a diffuse or undifferentiated manner which is well-suited to the mediation of emotion-laden, fight-or-flight behavior. Preference for right-hemisphere processing might be especially likely if the right-hemisphere is specialized for the processing of negatively-charged emotional stimuli (Wexler, 1980).

Buikhuisen (1987) has advanced a theory of delinquency that focuses on presumed right-hemisphere deficits. He

suggests that the social learning process in early childhood is predominantly reduced to avoidance learning. In order to be able to discover the relation between their behavior and the reaction of the environment, children must be able to recognize the emotional contents of a message received and to be able to experience negative emotions. It is suggested that the cognitive deficits (impaired information processing, impaired vision, and capacity for sustained concentration and attention) of delinquents impair their capacities for avoidance learning. The repeated failures of these children to learn to adhere to rules is thought to result in escalating conflict at home and later, at school. Eventually, in response to the frustrated response of parents, these children may come to feel rejected, which has an impact on self-esteem and personality development. The child responds to the conflict by adopting behavior patterns such as avoidance that reduce autonomic arousal and lead to emotional flattening. Failures at school lead to frustration, truancy, and a lack of attachment to the system. Although the steps of this model are plausible, it is based upon a number of questionable assumptions. It assumes that the cognitive deficits displayed by delinquents are those mediated by the right hemisphere, when the bulk of the research literature points to left-hemisphere impairment as being of more consequence. Furthermore, it assumes that

the child enters into a benign family environment which only becomes coercive in response to the child's deviant behavior. This does not hold up in the face of the type of family environments described by Lewis (Lewis et al., 1979; Lewis et al., 1987).

Waber (1976) suggested that rate of maturity was a factor in patterns of cognitive strengths. Early maturers scored better on verbal than spatial tasks, and late maturers scored better on spatial than verbal tasks.

Relationship of Personality Traits to Cognitive Variables

If different behavioral traits can be predicted as a result of strengths or weaknesses in these systems, then variations in personality traits, especially as they relate to behavioral controls should be measurable. Turner and Horn (1976) found that personality, as measured by responses to the MMPI, is most related in males and females to verbal abilities and is related only inconsistently to performance abilities. The verbal subtests of the WAIS which loaded on Cohen's (1957) Verbal Comprehension factor were most related to personality characteristics as measured by MMPI items, while subtests in Cohen's Memory factor (Arithmetic and Digit Span) were rather independent of personality factors. Of the subtests in Cohen's

Perceptual factor only Block Design showed any consistent relationship with personality items.

Eysenck (1964) suggested that people differ in terms of their conditionability. He suggested that criminals were slower to develop conditioned responses than others and consequently they did not acquire socialized standards of behavior as readily. He proposed that extraversion is a personality factor which is correlated with conditionability. Using the 16PF test, Turner, Willerman, and Horn (1976) investigated the relationship of the second-order factors Extraversion, Anxiety, Cortertia, and Temperamental Independence to performance on the WAIS in a population of prospective adoptive parents. Extraversion and Anxiety were found to have weak relationships with WAIS subtests. For males Cortertia correlated with Arithmetic, Comprehension, all of the Performance subtests except Digit Symbol, and the three overall IQ scores. For females the Cortertia factor was weakly correlated with WAIS subtests.

The second order factors of Cortertia and Temperamental Independence were thought of by Cattell (1971) as being "ability factor stimulators." Cortertia is characterized by cheerfulness, alertness, and a readiness to handle problems at a cognitive level. This might be thought of in terms of the selective attention and cortical

arousal functions that were attributed to the right cerebral hemisphere (Mesulam, 1985a; Bear, 1983).

If the relationships that have been reviewed in this paper between cognitive functioning and personality characteristic and emotional states have validity, they should be measurable by means of self-report questionnaires. Conversely, personality features that are portentous of criminal and antisocial activity may be predictable, to some extent, from cognitive variables.

METHOD

Conclusions drawn from literature review

Although delinquency is a phenomenon that has multiple determinants, several researchers have suggested that it is associated with neuropsychological dysfunction (Moffitt and Silva, 1988b; Yeudall et al., 1982; Berman and Siegal, 1976a; Skoff and Libon, 1987; Voorhees, 1981 Robbins et al., 1983; Lewis et al., 1979, 1989; Pincus et al., 1979; Monroe et al., 1977; Spellacy, 1977, 1978; Krynicki, 1978; Brickman et al., 1984; Tartar et al., 1983). An indication of lateral asymmetry of performance of cognitive tasks in delinquents and criminals has been the observation of greater verbal than performance IQ on the Wechsler scales (Hays, Solway & Schreiner, 1978; Bernstein & Corsini, 1953; Wiens, Matarazzo & Gaver, 1959; Manne, Kandel & Rosenthal, 1962; Solway et al., 1975; Fisher, 1961; Henning & Levy, 1967; Buikhuisen, 1987). Researchers have identified specific areas of cognitive deficit that can be summarized as follows:

1. That delinquency is associated with a generalized cognitive deficit as is reflected in a lowered overall I.Q. score (Hirschi & Hindelang, 1977;

Tarnapol, 1969; Moffitt et al., 1981, Moffitt & Silva, 1988a, 1988b; Schonfeld et al., 1988; Buikhuisen, 1987; Yeudall et al., 1982).

2. That delinquency may be associated with deficits in specific aspects of cognitive functioning. Verbal (Bleker, 1983; Solway et al., 1975; Yeudall et al., 1982; Fitzhugh, 1973; Berman & Siegal, 1976a, 1976b; Brickman et al., 1984; Hare & McPherson, 1984; Tucker, 1981; McWhinnie, 1969; Moffitt & Silva, 1988b, 1988c; Quay, 1987), nonverbal (Flor-Henry & Yeudall, 1973; Yeudall et al., 1982; Moffitt and Silva, 1988b, 1988c; Berman, 1978), and attentional (Voorhees, 1981; Hare & Cox, 1978; Walker et al., 1987; Satterfield, 1987; Moffitt & Silva, 1988c) skills have been identified as being specifically associated with delinquency.
3. That delinquency is associated with learning disabilities and the resultant frustration that grows out of failure in school (Graham & Kamano, 1958; Henning & Levy, 1967; Prentice & Kelly, 1963; Mauser, 1974; Hogenson, 1974; Berman, 1978; Berman & Siegal, 1976b; Robbins et al., 1983; Meltzer et al., 1986)

This research has generally lacked specificity in terms of the deficits that are being proposed and seldom is any attempt made to rationalize the relationship of these deficits to delinquency. Biases in the selection of subjects seems to be a significant factor in the results that are found in any particular study.

Aggression has been more specifically linked to signs of neurological abnormalities than non-aggressive delinquency (Pincus et al., 1979; Elliott, 1982; Bach-y-Rita et al., 1971; Lewis et al., 1979, 1987, 1989; Spellacy, 1977, 1978; Krynicki, 1978; Brickman et al., 1984). Violent delinquents tend to come from families that are dysfunctional (Bach-y-Rita et al., 1971; Lewis et al., 1979, 1987, 1989) and family adversity may contribute to poor performance on neuropsychological tests (Tartar et al., 1984; Moffitt and Silva, 1988c). Aggressive behavior has been associated with paranoid ideation (Lewis et al., 1979) and the tendency to attribute hostile intent to others (Dodge, 1980; Dodge and Frame, 1982).

Investigations of emotion and brain function also suggest patterns of lateral asymmetry that may be of significance in understanding the relationship between cognitive deficits and behavioral disorders. It has been suggested that the disordered thought found in schizophrenia and the schizophrenic-like psychoses of

temporal lobe epilepsy results from dysfunction of the left-hemisphere (Flor-Henry, 1969a, 1969b; Sherwin et al., 1982; Pritchard et al., 1980; Kleist, 1960; Flor-Henry and Yeudall, 1979; Taylor and Abrams, 1984), although these findings are not substantiated by other researchers (Marin and Tucker, 1981; Walker and McGuire, 1982; Yozawitz et al., 1979; Merrin, 1981). Left hemisphere over-activation (Gur, 1978, 1979; Walker and McGuire, 1982; Magaro and Chamrad, 1983) and defective interhemispheric transfer (Rosenthal and Bigelow, 1972; Beaumont and Dimond, 1973; Green, 1978; Carr, 1980; Walker et al., 1981; Walker and McGuire, 1982) have been proposed as being the primary neurological pattern in schizophrenia. None of the research conclusively supports any one of these three theories and the theories themselves fail to account for the complexity of the disorder and the many other brain areas that appear to be involved (Cleghorn, 1988; Patterson, 1987).

Research relating emotional state to laterality of lesion (Goldstein, 1952; Denny-Brown et al., 1952; Hecaen, 1962; Terzian, 1964; Perria et al., 1961; Rossi and Rossadini, 1967; Gainotti, 1972; Robinson et al., 1984; Black, 1975; Gasparrini et al., 1978; Sackheim et al., 1982) suggests that depressive features may be related to deficits in dominant hemisphere skills or relative

preference for non-dominant over dominant hemisphere processing of information. Thus, the P>V sign should be positively associated with depression. This is contrasted with clinical research which relates symptoms of anxiety and depression to right hemisphere deficits (Flor-Henry, 1969, 1976, 1983; Flor-Henry and Yeudall, 1976, 1983; Gruzelier and Venables, 1973; Goldstein et al., 1977; Kronfol et al., 1978; Abrams and Taylor, 1979; Brumback and Staton, 1982, 1983; Campbell, 1982; Yozawitz et al., 1979; Rourke, 1988b, Sollee and Kindlon, 1987). No satisfactory theory has been proposed which accounts for this apparent contradiction. Kluger and Goldberg (1990) reviewed studies which have related lateralized and diffuse brain damage to affective disorders. They suggested that subjects with bilateral/diffuse brain damage are likely to resemble patients with right hemisphere brain damage in their cognitive profiles. Furthermore, they concluded that the test profile for the groups with affective disorder were significantly closer to the bilateral/diffuse than to the right-hemisphere-damaged profile. To date, studies have been carried out exclusively with clinical populations and have focused on patients with significant brain lesions or diagnosed mood disorders. Self report measures across a broader range of the population have not been used.

Tucker (1981) has suggested that anxiety may involve an over-activation of the left hemisphere. The experimental findings of Tucker et al. (1978) add some experimental support for this hypothesis. Galin (1974) has suggested that relative strengths in left or right hemisphere cognitive processes would lead to different patterns of neurotic adjustment. Hysteria was thought to be associated with a right hemisphere bias, whereas obsessive-compulsive disorders were related to left hemisphere biases. Both disorders entail extensive use of repression, whether of thought or affect. Research on alexithymia (Buchanan et al., 1980; Hoppe, 1977; Hoppe and Bogen, 1977; TenHouten et al., 1986; Zeitlin et al., 1989) suggests that a strong laterality bias in favor of either verbal or nonverbal cognitive processes might be associated with poor awareness of feelings due to interhemispheric transfer deficits. This poor awareness of feelings might appear clinically to resemble repression and denial of feelings.

The literature review suggests lateral asymmetry of cognitive functioning may have consequences for both behavioral controls and indicators of emotional distress. As an alternative to the association of delinquency directly with cognitive deficits, the model which follows is proposed. It is founded in neuropsychological theory

and speculates about a specific sequence of cognitive development that predisposes youths to delinquency and may underlie the phenomenon of psychopathy in adults.

The precipitating factor to this sequence of development is the exposure of the young child to a family environment which is both highly emotional and chaotic. This is apt to include a lack of nurturance and support, limited verbal stimulation and training, and family conflict involving much expressed emotion and unpredictable and/or aggressive behavior on the part of parenting figures. As a result of this type of environment, it is hypothesized that the affected child becomes primed to process information through limbic and right hemisphere structures specialized for perception and expression of emotion, such as the systems described by Bear (1983), Heilman et al. (1985), and Mesulam (1985b). Essentially, the child's environment makes sensitivity to and processing of emotional information a first priority, and the neurological pathways associated with this task become the primary route by which most stimuli are first analyzed. Tucker (1981) has noted that individuals who are more emotionally responsive tend to preferentially use a right-hemisphere processing style. Support for this suggestion is also provided by Hare and McPherson (1984) who found

that psychopaths may process verbal information more readily with their right hemispheres.

Because the environment is chaotic and not easily predicted and because verbal stimulation is lacking, the child tends not to use verbal mediation as a primary tool in information processing. Responses to environmental stimuli tend, therefore, to be short-sighted, self-gratifying, and based upon the emotional valences of situations. Since verbal mediation is a secondary mechanism for information processing, it tends to be used to justify what actions have been committed rather than for planning and guidance of behavior. In this respect, it is similar to the description of the interpretive module proposed by Gazzaniga (1970). In this report, he indicated that split-brain subjects tended to verbalize rationalizations for behavior engendered by right-hemisphere processing which justified the behavior, often in bizarre ways.

Thus, the discrepancy between verbal and nonverbal processing skills, as reflected in the P>V sign, will be a significant marker of this style of processing, and it will be characterized by a lack of internalized values and standards of behavior that might protect against involvement in criminal acts, as well as by a deficiency in insight and planning. In the absence of pro-social values,

strengths in visuospatial skills may be positively associated with delinquency since these abilities might facilitate risk-taking due to improved judgment about the visuospatial demands of criminal actions.

This model differs from the verbal deficit theory in that it proposes that the expediency of the limbic/right-hemisphere processing route interferes with the development of verbal mediation skills, whereas the verbal deficit model suggests that these skills are under-learned due to a reduced ability of the delinquent associated with specific learning disabilities, neuropsychological dysfunction, environmental deprivation, or other factors.

As discussed earlier, verbal mediation or an interpretive module (Gazzaniga, 1970) plays an important role in analyzing and evaluating behavior. A reliance of right-hemisphere cognitive processing would limit such activity and the anxiety which is likely to be stimulated by such internalizing processes (Tucker, 1981). The lack of verbal mediation of behavior in social situations might have a deleterious effect upon social skills, although increased self-confidence, accompanied by a more extroverted personality style (Eysenck, 1947) might ensue. The extent of family adversity may also play a role in the development of social and self-confidence. The affected

individual is likely to present as having limited insight into his feelings and behavior.

Hypotheses

Based upon the literature review, the following hypotheses have been developed:

1. That delinquency is associated with lower intelligence and concomitant personality variables. Lower intelligence will be causally associated with higher levels of delinquency both directly and indirectly through limitations in the development of social values and social competence;
2. That delinquency is a product of deficits in verbal skills and personality variables correlated with verbal intelligence. Reduced verbal abilities, relative to the normal population, will place the individual at greater risk of delinquency directly and through limitations in the development of social values and social competence;
3. That delinquency occurs as a result of visuospatial skill deficits, relative to the general population. This relationship could be direct or through the intervening variable of social confidence;

4. That delinquency grows out of deficits in attentional skills, compared with the normal population. This relationship may be direct, as a result of impulsivity, but it is also associated with personality variables. Variations in social values and a reduction in social competence could be expected to accompany attention deficit disorder;
5. That delinquency results from an information processing bias wherein delinquent children come to preferentially process information through limbic and right-hemisphere channels and verbal mediation is consequently reduced. The relationship of this processing bias with delinquency would be expected to be direct and through reduced development of social values. This information processing bias could also be expected to have the effect of reducing socialization skills, which would, in turn, contribute to delinquency;
6. That delinquency is associated with learning disabilities and grows out of the frustration of school failure. Cognitive deficits and social values are important only insofar as they contribute to school achievement and do not play a direct role in delinquency;

7. That indicators of neuropsychological deficit will be positively associated with measures of criminal offenses, especially those of a more violent or aggressive nature;
8. That there will be a positive relationship between paranoid or intolerant attitudes, as measured by personality testing, and aggressive criminal offenses;
9. That there will be a relationship between indications of lateral asymmetry of cognitive processing and measures of depression. Three possible relationships are suggested by the literature review: a) that depression will be positively associated with a dominant hemisphere bias, b) that depression will be positively associated with a non-dominant hemisphere bias, and c) that depression will be associated with either lateral bias and a quadratic relationship will be observed;
10. That indicators of anxiety should be associated with enhanced verbal information processing;
11. That indicators of denial and repression in the personality measures will be associated with

lateral asymmetry of information processing in a quadratic manner;

Testing the Hypotheses

The Sample

The subjects for this research were 177 adjudicated delinquent youths ranging in age from 13 to 19 years. Males and females were both included in the sample. These were youths who had been evaluated through the Victoria office of Juvenile Services to the Courts and came from a number of lower Vancouver Island communities. Juvenile Services to the Courts provides consultation services to probation officers and Family Court judges under the Young Offenders Act.

The youths included in the sample represented a range of severity of delinquency from cases which have been diverted from the courts to youth who receive lengthy sentences. Existing records were reviewed and all youths who had been administered a particular combination of tests were included. Psychological assessments conducted through Juvenile Services to the Court often involve an intellectual appraisal (usually with the Wechsler scales), an objective personality assessment, and an academic evaluation. Testing was conducted by five registered psychologists. The personality test used varies from case

to case, at the discretion of the psychologist. The cases selected for this research are those evaluated with the California Psychological Inventory, the most commonly used test, where an intellectual assessment was also done. Academic testing is not available in all cases.

Hypotheses 1 through 5.

Tests used.

The California Psychological Inventory was administered to all subjects in the study. Where reading level was thought to present a barrier to completion of the test, it was read to the participant. The CPI is a widely used test of personality designed by Harrison Gough (1975). LeUnes et al. (1980) listed it as one of the three most popular tests in personality research with adolescents. Its prominence as a clinical instrument arises from the extensive investigations that have evaluated the performance of various clinical populations on its individual scales.

The method of construction differs from that of many personality inventories in that no effort has been made to construct the scale according to factor analytic procedures or to have the constructs of the test conform to dimensions of personality that are commonly identified in such

studies. Rather, it is an inventory that is intended to measure "folk concepts" (Gough, 1965) which are,

"...variables used for the description and analysis of personality in everyday life and social interaction. It is theorized that such folk concepts, viewed as emergents from interpersonal behavior, have a kind of intermediate meaningfulness and universal relevance which enhance their attractiveness as diagnostic concepts." (p. 295)

This approach has been soundly criticized by Eysenck (1985) for its refusal to accept the "discipline" of factor analysis and bring the CPI into line with what is generally known about dimensions of personality.

Gough has relied upon "empirical technique" (Gough, 1975) which places greater emphasis upon criterion validity than it does upon construct validity. His intention was to be able to forecast all major aspects of social behavior either through prediction from a single scale or from a combination of scales (Gough, 1975). A precautionary note in interpreting the meaningfulness of correlations between a scale and criterion measures which are represented by extreme groups was provided by Cronbach (1959) and re-emphasized by Dicken (1961). Both of these authors noted that such correlations do not represent the typical range of subjects on the criterion measure and, where groups from both extremes are used, the correlations are exaggerated.

The California Psychological Inventory has been widely used to forecast delinquency and criminality (Laufer et al., 1982) and certain scales have been found to be especially useful. The Socialization scale was originally called the Delinquency scale and showed predictive value in identifying youth who were likely to commit criminal acts (Dinitz et al., 1962). The Responsibility scale was originally developed to assess factors determining political participation (Gough et al., 1952) and was thought to measure concern for social and moral issues, emphasis on duties and self discipline, conventionality, poise, and personal security. These two scales have been shown to be consistently the lowest scores in profiles of criminals in many different studies (Laufer et al., 1982). A fine distinction is made between the three major scales of the CPI that fall under the general category of measures of socialization, maturity, responsibility, and intrapersonal structuring of values, namely the responsibility, socialization, and self-control scales. Gough (1965) suggested that each of these scales is,

"...addressed to a different facet of the value complex: responsibility emphasizes the degree to which values and controls are conceptualized and understood; socialization emphasizes the degree to which they are internalized and made operational in the life of the individual; and self-control stresses the degree to which the individual espouses such regulatory dispositions." (p. 296)

The significant correlations between these three scales (Gough, 1975) indicates that this goal has not been achieved, but these three scales should provide a global measure of social reasoning and judgment.

A considerable body of validation research has been conducted with the Dominance scale as a measure of ascendant behavior and the inclination to assume leadership roles in group situations and with the Sociability scale as a measure of outgoingness and social participation (Megargee, 1977). The Self Acceptance scale has been intended to,

"...identify individuals who would manifest a comfortable and imperturbable sense of personal worth, and who would be seen as secure and sure of themselves..." (Gough, 1968 from Megargee, 1977).

Of particular interest is a study by Lazarus et al. (1962) in which individuals with high scores on this scale displayed significantly less autonomic disturbance in the face of stressful stimuli.

Megargee (1977) reported that numerous factor analyses of the CPI have consistently produced a factor structure with five significant factors. The first of these is referred to as Intrapersonal Values and Social Conformity. The scales which load most highly on this factor are Well-Being, Responsibility, Self Control, Good Impression, and

Achievement by Conformity, with Socialization often loading highly as well.

The second factor that commonly appears is thought (Megargee, 1977) to reflect social poise, ascendancy, self-assurance, and interpersonal adequacy. The Dominance, Capacity for Status, Sociability, Social Presence, and Self Acceptance scales most often load highly on this factor. A factor analysis of the CPI scales was carried out in order to confirm the factor structure for this particular sample.

The outcome can be seen in Tables 1-3. The rotated factor loadings suggest that the first factor does represent intrapersonal values and social conformity and that it might reasonably be represented by the Responsibility, Socialization, Self Control, Achievement by Conformity, and Good Impression scales. These scales have reasonable face validity in measuring internalized verbal controls over behavior.

The factor analysis (Tables 1-3) defined a second factor that is best represented by the Dominance, Sociability, Self Acceptance, Capacity for Status, and Social Presence scales. This would appear to conform to Megargee's (1977) reports of a factor representing social poise, ascendancy, self-assurance, and interpersonal adequacy and will be referred to as Social Confidence.

To maintain a degree of simplicity within the models, only the first two factors were used. Factors 3, 4, and 5 are all considerably smaller than factors 1 and 2 (Megargee, 1977) and did not represent personality variables which have been traditionally associated with delinquency.

Table 1. Factor Analysis of CPI Scales Communalities and Eigenvalues (n=176)

<u>Scale</u> <u>Var.</u>	<u>Communality</u>		<u>Factor</u>	<u>Eigenvalue</u>	<u>Pct. of</u>
DO	.77924	*	1	7.68420	40.4
CS	.78231	*	2	2.59016	13.6
SY	.81763	*	3	1.97048	10.4
SP	.76937	*	4	1.26494	6.7
SA	.72920	*	5	1.01424	5.3
WB	.85153	*			
RE	.70391	*			
SO	.65166	*			
SC	.84328	*			
CM	.72733	*			
AC	.80715	*			
AI	.83703	*			
IE	.78240	*			
PY	.56484	*			
TO	.83451	*			
GI	.76093	*			
FX	.77727	*			
FE	.75619	*			
ANX	.79822	*			

Table 2. Factor Analysis of CPI Scales Unrotated Factor Loadings (n=176)

Scale	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
DO	.524	-.336	-.342	.459	-.254
CS	.724	-.232	.171	.338	.106
SY	.701	-.480	-.220	.206	.075
SP	.583	-.627	-.022	-.187	.008
SA	.421	-.682	-.198	.174	.129
WB	.827	.067	-.093	-.385	-.083
RE	.590	.430	-.316	.243	.110
SO	.540	.476	-.347	-.068	-.087
SC	.645	.619	.151	-.053	-.136
CM	.252	.030	-.618	-.393	.354
AC	.832	.195	-.205	.120	-.142
AI	.763	-.006	.465	-.024	.197
IE	.835	-.181	.029	-.083	.212
PY	.549	-.010	.401	-.060	-.314
TO	.865	.125	.226	-.119	.077
GI	.633	.400	.173	.349	-.219
FX	.349	-.113	.732	-.112	.308
FE	.048	.524	-.108	.307	.611
ANX	-.727	-.016	.231	.441	.147

Table 3. Factor Analysis of CPI Scales Varimax Rotated
Factor Loadings (n=176)

Scale	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
DO	.341	.785	-.173	-.087	-.094
CS	.322	.632	.463	-.094	.078
SY	.190	.840	.187	.196	-.033
SP	-.045	.647	.354	.324	-.344
SA	-.148	.817	.114	.151	-.065
WB	.562	.231	.369	.530	-.254
RE	.597	.214	-.009	.185	.370
SO	.719	.020	-.065	.347	.098
SC	.834	-.162	.337	.083	.031
CM	.072	.128	-.150	.803	.198
AC	.765	.399	.148	.202	-.005
AI	.361	.258	.798	.052	.019
IE	.338	.514	.528	.353	.005
PY	.406	.132	.474	-.121	-.380
TO	.568	.243	.630	.233	-.038
GI	.781	.148	.253	-.249	.065
FX	-.066	.008	.873	-.102	.010
FE	.206	-.137	.049	.045	.831
ANX	-.497	-.226	-.208	-.596	.319

Criminal records for each individual were obtained from the Ministry of the Attorney-General, which maintains a computer-based record system of criminal charges, convictions, and penalties imposed. It also allows for a summary of the status of the offender during the time that they are supervised by the probation services. Two measures will be derived from these records:

- 1) Delinquency Seriousness. Because subjects vary in age, simply using number of offenses does not take into account the relative opportunities for committing offenses. Under the Young Offenders Act individuals under the age of twelve cannot be charged. In view of these restrictions, the months during which subjects have been eligible to be charged with offenses have been tabulated in the following way: Twelve years have been subtracted from the age of each subject, as have the months during which subjects have been in custody or on remand status since opportunities for offenses are greatly reduced during such times. Further, because periods of probation are generally accompanied by restrictions which are designed to prevent further offenses, the periods of time during the subjects are on probation have been arbitrarily divided by two in the cumulative total.

(It should be noted that records of criminal offenses were obtained at a different time than the assessment was conducted, in some cases as many as four years later. Since the Ministry of the Attorney-General records are continuous into adulthood, records for youths who have surpassed the age of 17 include adult offenses.) Next, the total number of charges that have been brought against a subject were divided by the number of years during which charges could be laid (number of months divided by 12). This provides an estimate of Offenses Per Year. Values ranging from 1 to 6 were assigned to each offense according to the format described in Table 4. The total of these values for all offenses for each subject were summed (Total Aggressiveness) and this was divided by the total number of offenses, producing an estimate of the average aggressiveness of each offense. The Delinquency Seriousness variable is the product of the number of offenses per year times the average aggressiveness of each offense.

2. Most Aggressive Offence. The highest value that is assigned from Table 4 will serve as a variable referred to as Most Aggressive Offence.

Table 4. Rating System for Aggressiveness of Offenses.

1. General misconduct
 - Breach of probation
 - Shoplifting
 - Escaping custody
 - False pretenses
 - Fraud
 - Disobeying court
 - Impaired driving
 - Possession of drugs
 - Failure to appear
 - Causing a public disturbance
 - Possession of stolen property
 - Breach of Motor Vehicles Act
 - Breach of Government Liquor Act
 - Theft under \$1000 (\$200 on older records)
 2. Property crimes without victim confrontation
 - Breaking and entering
 - Taking a motor vehicle without owner's consent
 - Mischief - Willful damage
 - Theft over \$1000 (\$200 on older records)
 - Trafficking in drugs
 3. Crimes with victim confrontation or dangerous behavior
 - Robbery
 - Dangerous operation of a motor vehicle
 4. Aggressive behavior without a weapon
 - Obstruction/resisting a police officer
 - Intimidation
 - Assault
 - Sexual assault
 - Assault of a police officer
 - Arson
 - Gross indecency
 5. Aggressive behavior with a weapon
 - Armed robbery
 - Use and possession of a firearm (weapon)
 - Pointing a firearm
 6. Assault causing harm
 - Assault with a weapon causing harm
 - Kidnapping
 - Sexual assault with a weapon
 - Aggravated assault
-

The Wechsler scales (WISC-R and WAIS-R) are widely accepted and well-researched measures of intellectual

functioning (Guertin et al., 1962; Guertin et al., 1966; Matarazzo, 1972; Kaufman, 1979). Subjects in this study were all administered either the WISC-R or WAIS-R (Wechsler, 1974, 1981). Test administration was by a registered psychologist and made use of modifications designed to meet the cultural differences of a Canadian population (Vernon, 1977).

Factor analytic studies of the Wechsler scales have generally shown them to measure three basic factors: 1) verbal comprehension, 2) perceptual organization, and 3) freedom from distractibility (Cohen, 1957; Cohen, 1959; Kaufman, 1979; Sattler, 1982). Groupings of test scores into factor scores was first recommended by Bannatyne (1971) and continues to be a useful practice (Kaufman, 1979).

Statistical analysis

The aforementioned hypotheses were tested by means of structured equation models. Structured equation modelling, of which LISREL is the most well-known variant, allows for simultaneous tests of the adequacy of specified models in accounting for the significant relationships in the original covariance matrix, the comparison of nested models in terms of their relative sufficiency (Hayduk, 1987), and evaluation of the significance of individual parameters

within the models. The statistical analyses were carried out by means of the EzPath program (Steiger, 1989).

Multiple indicators which correspond to Bannatyne's (1974) classifications of Wechsler subtests were used to describe three exogenous latent variables. The Information, Similarities, Vocabulary, and Comprehension were multiple indicators of verbal skills (ξ_1); Picture Completion, Picture Arrangement, Block Design, and Object Assembly were taken as indicators of visuospatial abilities (ξ_2); and Arithmetic, Digit Span, Coding (Digit Symbol), and Block Design constituted the multiple indicators of freedom from distractibility or attentional skills (ξ_3). Block Design was included with indicators of attentional skills in order to balance the number of subtests used to determine each of the exogenous latent variables. In a factor analysis of the Wechsler subtests for this sample (Table 5) it was the subtest which had the third highest loading on the third factor for the rotated and unrotated solutions.

Concepts derived from the California Psychological Inventory form the endogenous variables which serve a mediating role between the exogenous intellectual variables and the endogenous criminal offense indicators. The Responsibility, Socialization, Self Control, Achievement by

Table 5. Prinicipal Components Analysis of Wechsler Subtests (n=177)

	<u>Eigenvalue</u>	<u>Percent of Variance</u>
Factor 1	4.16122	37.8
Factor 2	1.23848	11.3
Factor 3	1.18198	10.7

Factor Matrix

<u>Subtest</u>	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>
Information	.72653	-.15307	-.19305
Similarities	.72571	-.20851	-.09720
Arithmetic	.62448	-.03656	.44102
Vocabulary	.71552	-.34411	-.29969
Comprehension	.70626	-.27020	-.26785
Digit Span	.55997	-.26752	.18448
Pict. Comp.	.52278	.53946	-.22344
Pict. Arr.	.55270	.21398	-.31223
Block Des.	.64712	.41078	.37423
Obj. Ass.	.54708	.55237	.14350
Coding	.30914	-.31079	.66115

Varimax Rotated Factor Matrix

<u>Subtest</u>	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>
Information	.70838	.25009	.15555
Similarities	.68722	.20585	.25483
Arithmetic	.27629	.31521	.64041
Vocabulary	.83767	.07903	.11070
Comprehension	.78197	.13772	.11452
Digit Span	.45492	.07703	.45417
Pict. Comp.	.25515	.72714	-.14286
Pict. Arr.	.46777	.46459	-.11875
Block Des.	.12212	.70376	.46622
Obj. Ass.	.09259	.76294	.18530
Coding	.05345	-.07730	.78733

Conformity, and Good Impression scales were used as multiple indicators of an endogenous latent variable that is labelled Values and Conformity. The Dominance,

Sociability, Social Presence, Capacity for Status, and Self Acceptance scales of the CPI were used as multiple indicators of an endogenous latent variable referred to as Social Confidence.

The two criminal offense variables noted earlier, namely Delinquency Seriousness and Most Aggressive Offense, provided indicators of antisocial behavior in the models.

Criteria for rejecting the hypotheses.

Structured equation models are outlined below which conform to each of the hypotheses. Models which are more restricted versions (i.e., are nested models) of more complex models can be compared with the more complex model to determine its relative adequacy. A method for comparing nested causal models has been described by Hayduk (1987). This method was used, where possible, to compare models relating specific cognitive deficits to the incidence of criminal offenses. The adequacy of each model was considered and the significance of parameters within each model were tested to evaluate the relationship between cognitive factors, personality variables, and criminal offenses. Hayduk (1987) indicated that T-scores may be calculated by dividing the value of the parameter by its estimated standard error. An absolute value of more than two standard errors is considered adequate to allow for a

Bonferroni-type adjustment to the alpha level for multiple comparisons in determining parameter significance.

The Chi-square statistic is often used as a measure of overall model fit. Normally, a model is rejected if the Chi-square statistic is significant beyond the .05 level. Steiger (1989) pointed out, however, that the usefulness of the Chi-square test depends upon the statistical power in a particular testing situation. When statistical power is high, the Chi-square will almost certainly reject the model. For this reason, the Chi-square should be thought of as an "accept-support" test and should not be relied upon exclusively in determining model fit. Other fit indices generated by the EzPath program (Steiger, 1989) are of help. The Steiger-Lind RMS Index is a root mean square standardized residual index which has been adjusted for model complexity. Values of this index below .10 indicate a reasonably good fit, while values below .05 indicate an excellent fit (Steiger, 1989). The Adjusted Population Gamma Index can be thought of as a coefficient of model determination adjusted for model complexity. Values above .90 indicate a good fit; values above .95 suggest an excellent fit (Steiger, 1989). Confidence intervals are provided for this index which provide an indication of the statistical power of testing situation.

Since it is unlikely that any one of the hypotheses will be adequate on its own, the comparison of nested models will be of interest in clarifying the relative importance of particular deficits. Hayduk (1987) suggested that,

"...the difference between two Chi-squares is also distributed as a Chi-square with degrees of freedom equal to the difference between the degrees of freedom for the two models." (p. 164)

The models associated with the second, third, and fourth hypotheses will be compared with a comprehensive model, with the expectation that the verbal deficit model will be the most adequate of these. Linear redundancies in the data make it impossible to evaluate the first and fifth hypotheses as nested models of the other cognitive skills. While the models proposed for these hypotheses do not permit a direct comparison with the other cognitive deficit models, an evaluation of specific parameters should give some indication of the importance of the relationships under study.

Hypothesis 6.

Tests used.

The Wide Range Achievement Test - Revised (Jastak & Wilkinson, 1984) was administered to many, but not all, of the subjects in the study. The Reading, Spelling, and

Arithmetic subtests were sometimes all used, or some combination of these subtests was sometimes used. Reading scores are available on 122 subjects and arithmetic on 115. In 115 cases, the reading and arithmetic scores were obtained from the same subjects. This prompted the decision to evaluate the learning disabilities hypothesis (model) last, using a smaller subject pool. With the reduction in sample size, it was desirable to reduce the number of variables in the analysis. The elements of the models associated with the verbal, attention deficit, and differential processing theories were retained to serve as the basis for a model which emphasizes cognitive deficits as the primary determinant of both learning problems and delinquency, while a second model emphasized learning deficits and school failure as the primary cause of delinquency.

Two exogenous latent concepts (verbal skills and attention) were estimated from multiple variables as in the previous models. Verbal skills were estimated by the Information, Similarities, Vocabulary, and Comprehension subtests of the Wechsler scales, while attentional skills were measured by the Arithmetic, Digit Span, and Coding subtests of the Wechsler scales. The visuospatial and general intelligence concepts were not included since it was expected that they will not play a substantial role in

the occurrence of delinquency. The processing bias concept was estimated by the difference between Performance IQ and Verbal IQ on the Wechsler scales. The social confidence concept was dropped on the assumption that it is not as important as the values and conformity concept, which was estimated by the Responsibility, Socialization, Self Control, Achievement by Conformity, and Good Impression scales of the California Psychological Inventory. The two delinquency measures remained unaltered. Reading and arithmetic skills were estimated by subtests of the Wide Range Achievement Test - Revised.

Statistical analysis.

Structured equation modelling using the EzPath program (Steiger, 1989) was used to evaluate this hypothesis. A model emphasizing cognitive deficits and processing bias as the cause of both delinquency and learning problems is outlined below. An alternative model emphasizes learning problems as the primary factor contributing to delinquency. An evaluation of the overall adequacy of these models and a comparison of their relative adequacy was carried out in the same manner as was outlined for Hypotheses 1 to 5.

Criteria for rejecting the hypothesis.

The Chi-square statistic, the Steiger-Lind RMS Index, the Adjusted Population Gamma Index, and the significance

of individual parameters have been considered in determining the significance of each of the models.

Hypothesis 7.

Tests used.

There are many limitations in attempting to estimate neuropsychological dysfunction using only the Wechsler scales. Such a task calls for the use of a comprehensive neuropsychological battery (Lezak, 1983). However, a gross estimate of neuropsychological impairment may be possible.

Russell (1979) has described three patterns of brain damage as they are seen on WAIS profiles within brain-injured adults. The first is a general reduction in the level of performance on all the subtests of the WAIS when compared with a control group. The second is a pattern that is seen in both diffuse brain-injury patients and those suffering right-hemisphere damage. In this pattern the verbal subtests tend to be minimally impaired, with Arithmetic being somewhat more affected, while the performance subtests are lowered, except for Picture Completion. The third pattern is that which occurs with left hemisphere cases. In it Block Design, Object Assembly, and Picture Arrangement are somewhat higher than the Verbal subtests, but the difference was not great. Holroyd (1968) found this pattern to be associated with

speech, hearing, and/or reading problems in children but not with brain damage diagnoses or psychiatric diagnoses.

Uzzell et al. (1979) demonstrated that differences between Verbal and Performance subtests were capable of lateralizing brain damage in acute patients. Support for interpreting the discrepancy between Verbal and Performance IQ as an indicator of unilateral hemispheric dysfunction in a learning disability population comes from the findings of Rourke and Strang (1978).

Bishop and Butterworth (1980) found a weak association between presumptive evidence of perinatal brain damage and large discrepancies between Verbal and Performance I.Q. scores. They concluded that there was little justification for regarding a large Verbal/Performance discrepancy as indicative of actual or minimal brain damage. Moffitt and Silva (1987) found that Verbal/Performance discrepancies are not very reliable over time, although the fact that they prorated IQ estimates from four subtests in each category would be expected to lower reliability estimates.

Thus, discrepancies between the IQ indices of the Wechsler scales must be interpreted with caution. An improvement upon prediction of neuropsychological dysfunction might be made by including subtest variability estimates. Lezak (1983) recommended subtest analysis in

the determination of neurological impairment, although, in adults,

"...pattern analysis applies best to patients with recent or ongoing brain changes and is less effective in identifying organic disorders in psychiatrically disturbed patients." (p. 253)

Greater variability in subtest results is thought to be more indicative of neuropsychological impairment. Lezak (1983) viewed Digit Symbol as the subtest which is consistently more sensitive to brain damage than any other WAIS subtest. Its score is likely to be depressed even when damage is minimal and tends to be affected regardless of the locus of the lesion (Lezak, 1983).

In view of these considerations, a Wechsler Variability Index was calculated for each subject by summing the absolute value of the difference between Verbal and Performance IQ, the sum of the absolute values of the deviations of the subtests around the mean of all the subtests (in scaled score points), and the discrepancy of Coding and Digit Symbol from the overall scaled score mean of all the subtests.

Criminal offenses were measured by means of the variables Offenses per Year, Total Aggressiveness, and Most Aggressive that were outlined earlier.

Statistical analysis.

The Wechsler Variability Index served as the dependent variable and the three criminal offense variables acted as independent variables in a Multiple Regression analysis where the three variables were entered simultaneously into the equation. These relationships were evaluated for the entire sample and for a sub-sample of youths who had been incarcerated.

Hypothesis 8.

Tests used.

The California Psychological Inventory shares many items in common with the Minnesota Multiphasic Personality Inventory. The common items are listed by Megargee (1977). Rodgers (1966) developed formulas which allow MMPI profiles to be estimated from the CPI responses. Relatively good correlations with the MMPI can be generated using this procedure. A pilot study was carried out at Juvenile Services to the Courts with 21 subjects who were administered both the CPI and the full MMPI. This research showed the following correlations which are presented in Table 6.

Projected MMPI values used non-K-corrected age adjusted norms which have been recommended for use with

adolescents by Marks et al. (1974). The results of the

Table 6. Correlations Between Projected and Actual MMPI Scale Scores (n=21).

<u>Scale</u>	<u>Correlation</u>
Lie	0.62*
F	0.68**
K	0.45
Hypochondriasis	0.70**
Depression	0.67**
Hysteria	0.69**
Psychopathic Deviance	0.53*
Masculinity/Femininity	0.33
Paranoia	0.47
Psychasthenia	0.73**
Schizophrenia	0.83**
Mania	0.68**
Social Introversion	0.56*

1-tailed significance: * (.01) ** (.001)

Paranoia scale of the projected MMPI and the Tolerance scale of the CPI were of particular interest in this hypothesis. The criminal offense variables noted earlier (Offenses per Year, Total Aggressiveness, and Most Aggressive) were also be used.

Statistical analysis.

A canonical correlation analysis was carried out with the personality variables, on the one hand, being correlated with criminal offense characteristics, on the other. It was expected that one significant canonical dimension would be evident that related paranoia, on the one hand, to aggressiveness, on the other.

Hypothesis 9.

Tests used.

Dependent measures were the Depression scale of the projected MMPI and the Well-Being scale of the CPI.

Statistical analysis.

Individuals who demonstrated marked discrepancies in the direction of either right or left hemisphere processing were of particular interest in the analysis. The sample was divided into four groups on the basis of Verbal/Performance discrepancy on the Wechsler scales. Because delinquents have a tendency to score higher on Performance than verbal tests, the divisions between the groups were at the mean Performance IQ minus Verbal IQ discrepancy for the entire group, as well as at the mean plus and minus 15 scaled score points. This served to balance the numbers in the groups and made some adjustment for the P>V bias. A MANOVA was carried out which placed particular emphasis on single degree of freedom tests which compared the extreme groups with each other, the extreme groups with the moderate groups (quadratic effect), and the groups which are divided by the mean P-V score (linear effect). The first test provided an evaluation of the question of laterality of brain function and depression. The second test allowed for the possibility that either

lateral bias may be associated with depression. The third test allowed for an evaluation of the lateral bias and depression relationship across a broader range of subjects to determine if there tends to be an association between lateral bias and depression in a general population of delinquents. Lastly, multiple regression analyses were conducted which held the Depression and Well-Being scales as the dependent variables and the subtests of the Wechsler scales as the independent variables to evaluate more specific relationships between cognitive variables and depression.

Hypothesis 10.

Tests used.

The dependent variables were the Anxiety scale of the CPI and the F and Pt scales of the projected MMPI. These variables were selected as the best available indicators of anxiety among the personality variables.

Statistical analysis.

This hypothesis was tested by means of a MANOVA which made use of the same group divisions as were noted for the previous hypothesis. The single degree of freedom tests that were of particular interest was that which compared the extreme Verbal>Performance group to the means of the

other groups, that which compared the groups which were divided by the mean P-V score, and that which tested for a linear relationship across the four groups. Exploratory multiple regressions were carried out using the Anxiety, F and Pt scales as dependent variables and the subtests of the Wechsler scales as independent variables.

Hypothesis 11.

Tests used.

The best measures of repression and denial in the personality measures were the Hysteria and K scales of the projected MMPI, although Self Acceptance might capture the same qualities on the CPI.

Statistical analysis.

This hypothesis was tested by use of a MANOVA which compared the subjects divided into four groups according to their P-V scores, using the same criteria that have been outlined earlier. Specific attention was paid to the quadratic effect across the groups, although a linear effect and a comparison of extreme groups were also carried out. Multiple regression analyses was carried out using the Hysteria, K, and Self Acceptance scales as dependent variables and the subtests of the Wechsler scales as independent variables.

RESULTS

Sample Statistics

The sample consisted of 177 youths of whom 143 were boys and 34 were girls. Group and sex means for age, Full Scale IQ, Verbal IQ, Performance IQ, and Performance IQ minus Verbal IQ are presented in Table 7. The boys ranged

Table 7. Sample Statistics (age and IQ) by Group and Sex.

<u>Variable by Group</u>	<u>Mean</u>	<u>St. Dev.</u>
Age (Months)		
Group (n=177)	186.37	15.57
Males (n=143)	186.87	15.57
Females (n=34)	184.26	15.62
Full Scale IQ		
Group (n=177)	99.45	12.39
Males (n=143)	99.67	12.38
Females (n=34)	98.53	12.58
Verbal IQ		
Group (n=177)	96.51	12.80
Males (n=143)	96.79	12.63
Females (n=34)	95.32	13.61
Performance IQ		
Group (n=177)	103.09	12.60
Males (n=143)	103.17	12.88
Females (n=34)	102.74	11.51
PIQ-VIQ		
Group (n=177)	6.58	11.84
Males (n=143)	6.38	12.11
Females (n=34)	7.41	10.75

in age from 12 years 5 months to 19 years 5 months, with an average age of 15 years 6.87 months ($sd=15.57$ months). The girls ranged in age from 12 years 11 months to 18 years 1 month, with an average age of 15 years 4.26 months ($sd=15.62$ months). The age difference between the sexes was not significant ($t=0.88$, $df=175$, two-tailed $prob.=.383$). Average age of the total sample was 15 years 6.37 months ($sd=15.57$ months).

Full scale Wechsler IQ ranged from 72 to 139. The average IQ of 99.45 ($sd=12.39$) falls very close to the normative sample for the tests (Wechsler, 1974, 1981) and runs counter to the suggestion that delinquents tend to have lower intelligence than non-delinquent youths. Holmes (1980) has presented data on children at 7.5, 9.5, and 11.5 years of age that suggests that children living in British Columbia score higher on the WISC-R than the normative sample. This trend, however, is most marked for the younger age groups. If the trend noted in her data were to continue to age 15, it is unlikely that there would be any significant departure from the test norms.

Boys Full Scale IQ scores ranged from 7 to 139, while girls ranged from 74 to 123. The difference between the Full Scale IQ scores of the sexes was not significant ($t=0.48$, $df=175$, two-tailed $prob.=.63$).

The Performance-Verbal IQ discrepancy was in line with that reported in the literature on delinquency where a difference of seven points in favor of Performance IQ is generally expected. Verbal IQ scores ranged from 67 to 136, while Performance IQ scores ranged from 69 to 139. The PIQ-VIQ discrepancy ranged from -27 to 40. This was relatively uniform across the sexes. The differences between males and females in mean Verbal IQ ($t=.60$, $df=175$, two-tailed $prob.=.55$), mean Performance IQ ($t=.18$, $df=175$, two-tailed $prob.=.86$), and average PIQ-VIQ discrepancies ($t=.45$, $df=175$, two-tailed $prob.=.65$) were not statistically significant. Thus, in terms of primary characteristics, male and female delinquents in the sample were not significantly different.

The means for the Wechsler scale subtests, including breakdowns for males and females, can be seen in Table 8. The table contains the probabilities that the means of the respective subtests differ from the normative (population) mean of 10.00 (Wechsler, 1974). Using a two-tailed probability, Arithmetic and Similarities are the only subtests which do not significantly deviate from the normative value, suggesting that the cognitive profile of delinquents is different in several respects. The profile of subtests is presented in Figure 1.

Some interesting differences in the performance of males and females by be observed on the Wechsler subtests.

Table 8. Wechsler subtest means and their comparison with normative values.

<u>Variable by Group</u>	<u>Mean</u>	<u>St. Dev.</u>	<u>St. Err.</u>	<u>Prob.(2 tl)</u>
Information (n=177)	8.61	2.64	.20	.001
Males (n=143)	8.79	2.62	.22	.001
Females (n=34)	7.82	2.62	.45	.001
Similarities (n=177)	10.31	3.02	.23	.180
Males (n=143)	10.24	3.05	.26	.358
Females (n=34)	10.62	2.92	.50	.214
Arithmetic (n=177)	9.92	3.02	.23	.726
Males (n=143)	9.94	3.06	.26	.818
Females (n=34)	9.79	2.69	.46	.638
Vocabulary (n=177)	9.35	2.37	.18	.001
Males (n=143)	9.46	2.41	.20	.006
Females (n=34)	8.88	2.18	.37	.002
Comprehension (n=177)	9.38	3.01	.23	.008
Males (n=143)	9.37	2.91	.24	.008
Females (n=34)	9.44	3.47	.60	.352
Digit Span (n=177)	9.23	2.62	.20	.001
Males (n=143)	9.14	2.71	.23	.001
Females (n=34)	9.59	2.23	.38	.280
Pict. Comp. (n=177)	10.53	2.59	.19	.006
Males (n=143)	10.67	2.57	.21	.002
Females (n=34)	9.91	2.64	.45	.842
Pict. Arr. (n=177)	10.89	2.74	.21	.001
Males (n=143)	11.01	2.83	.24	.001
Females (n=34)	10.35	2.28	.39	.368
Block Design (n=177)	10.79	2.84	.21	.001
Males (n=143)	10.81	3.01	.25	.002
Females (n=34)	10.67	2.04	.35	.056
Object Assembly	11.06	3.15	.24	.001
Males (n=143)	11.12	3.15	.26	.001
Females (n=34)	10.68	3.19	.55	.214
Coding (n=177)	9.25	2.64	.20	.001
Males (n=143)	8.93	2.55	.21	.001
Females (n=34)	10.59	2.60	.45	.190

Figure 2 presents the cognitive profiles of the sexes.

Fig. 1. Mean Wechsler Profile

Total Sample (n=177)

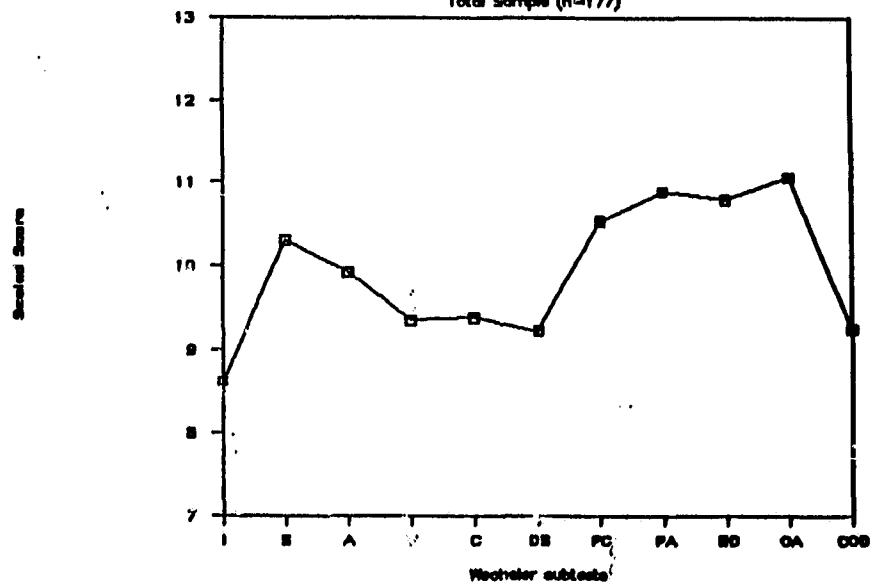
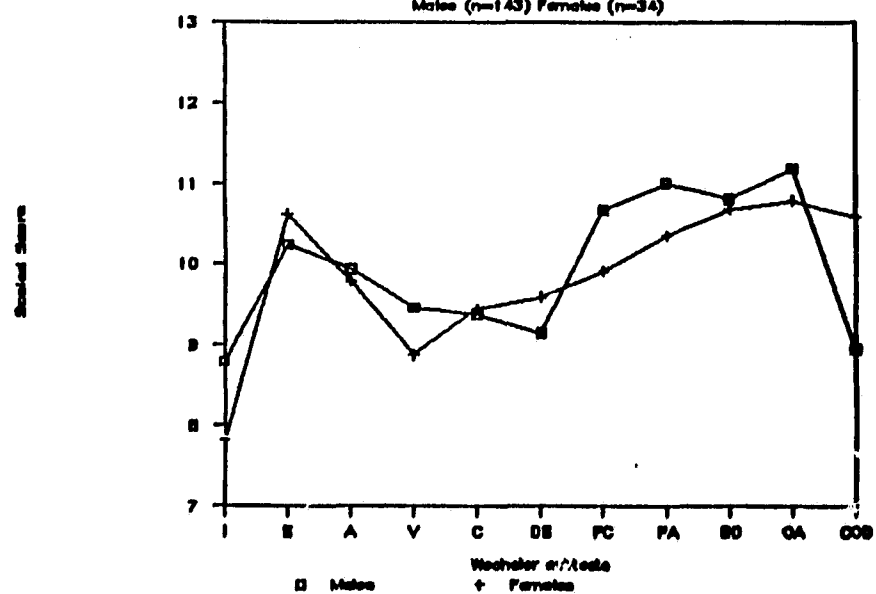


Fig. 2. Mean Wechsler Profile by Sex

Males (n=143) Females (n=34)



Surprisingly, females, as a group, scored lower than males on the Information and Vocabulary subtests, while markedly exceeding the performance of males on the Coding subtest. Males surpassed females on Picture Arrangement and Picture Completion. The means of the subtests for females tended to fall closer to the normative values for the subtests than did the males. Significant departures from the normative values were only seen on the Information and Vocabulary subtests for females, with their performance on the Block Design subtest approaching significance. Males, on the other hand, differed significantly from the normative sample on every subtest except Similarities and Arithmetic.

In order to evaluate the statistical significance of

Table 9. Homogeneity of Variance Tests for MANOVA
Comparison of Wechsler Subtests by Sex.

<u>Variable</u>	<u>Bartlett-Box F(1,26986)</u>	<u>Probability</u>
Information	.00002	.996
Similarities	.09184	.762
Arithmetic	.81315	.367
Vocabulary	.47026	.493
Comprehension	1.74674	.186
Digit Span	1.81508	.178
Pict. Completion	.04741	.828
Pict. Arrangement	2.21629	.137
Block Design	6.76435	.009
Object Assembly	.00895	.925
Coding	.01341	.908

Box's M = 60.6999

F with (66,11778) df = .80384 p = .865

these differences, a MANOVA was carried out using sex as the independent variable and the Wechsler subtests as dependent variables. As can be seen in Table 9, a violation of the homogeneity of variance assumption for the Block Design subtest is indicated suggesting that the results must be interpreted with some caution. Furthermore, the sample size for females is small, so their data is likely to be unstable.

Table 10. MANOVA Comparing Wechsler Subtests by Sex.

Multivariate Test of Significance (S=1, M=4 1/2, N=81 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.87386	2.16528	11.00	165.00	.019

Univariate F-Tests with (1,175) DF

<u>Var.</u>	<u>Hypo. SS</u>	<u>Error SS</u>	<u>Hypo. MS</u>	<u>Error MS</u>	<u>F</u>	<u>Sig.</u>
Inf	25.66891	1204.64747	25.66891	6.88370	3.72894	.055
Sim	3.96411	1601.94550	3.96411	9.15397	.43305	.511
Ari	.61754	1569.11127	.61754	8.96635	.06887	.793
Voc	9.21461	979.06787	9.21461	5.59467	1.64703	.201
Com	.13671	1597.73900	.13671	9.12994	.01497	.903
DSP	5.52236	1203.43809	5.52236	6.87679	.80304	.371
PC	15.84785	1166.28774	15.84785	6.66450	2.37795	.125
PA	12.00338	1305.73673	12.00338	7.46135	1.60874	.206
BD	.49853	1423.34327	.49853	8.13339	.06129	.805
OA	2.89718	1742.53784	2.89718	9.95736	.29096	.590
Cod	74.89046	1148.66886	74.89046	6.56382	11.40958	.001

The multivariate Wilk's Lambda from Table 10 was significant. This permits an interpretation of the

differences in performance between the sexes on the subtests. Coding is the only subtest upon which males and females were significantly different, although the result for the Information subtest approaches significance.

One might conclude that the female delinquents in this sample were more similar to the normative Wechsler population than were the males. The females tended to score lower than the normative sample only on tests which involve long-term memory and/or environmental stimulation. The males, on the other hand, appeared to be quite different than the normative sample. They generally exceeded normative performance on tasks which called for visuo-spatial skills, while falling below the norms on tests which require verbal and attentional skills. These conclusions, however, must be viewed with caution. Significance tests are highly sensitive to sample size, so that males are, a priori, likely to appear statistically more different than females.

Academic achievement testing was not conducted with all subjects. The means and standard deviations are presented in Table 11. The sample means differ significantly from normative values for the test (Jastak & Wilkinson, 1984) in all three areas of academic achievement, although sex differences clearly play a role in the discrepancies. Male subjects scored below the test

Table 11. Academic Achievement Test Results (WRAT-R Scaled Scores)

<u>Variable by Group</u>	<u>Mean</u>	<u>St. Dev.</u>	<u>St. Err.</u>	<u>Prob.(2 tl)</u>
WRAT Reading (n=122)	9.35	2.72	.25	.010
Males (n=101)	9.22	2.70	.27	.004
Females (n=21)	10.00	2.79	.61	.999
WRAT Spelling (n=92)	8.32	2.86	.30	.001
Males (n=74)	8.03	2.82	.33	.001
Females (n=18)	9.50	2.79	.66	.448
WRAT Arith. (n=115)	7.72	3.16	.29	.001
Males (n=95)	7.72	3.26	.33	.001
Females (n=20)	7.75	2.67	.60	.001

norms in all three academic areas, while females differed from the normative sample only in Arithmetic. Males and females did not differ significantly from each other on the Reading ($t=1.20$, $df=120$, two-tailed probability=.232) and Arithmetic ($t=.04$, $df=113$, two-tailed probability=.96) but a significant difference was observed between them in Spelling ($t=1.99$, $df=90$, two-tailed probability=.049) with females performing better than males. These results would suggest that, on the average, the male delinquents would conform more closely to the Group 1 pattern of learning disability (deficient in reading, spelling, and arithmetic), as described by Rourke and Finlayson (1978) and Rourke and Strang (1978). Female delinquents appear to conform more closely to the Group 3 pattern (reading and spelling at or above average with arithmetic deficient), although their mean Wechsler profile does not correspond to

that which might be expected from individuals with this type of learning disability pattern.

The results of the CPI scales are presented in Table 12. The data from four of the scales was unavailable for one female. No attempt has been made to compare these results to normative samples since adolescent norms are not available for the test and adult norms have been used (Gough, 1975). These means have been profiled in Figure 3. The low points in the profile suggest a fair degree of emotional distress, difficulties in incorporating the usual

Table 12. Means and Standard Deviations of CPI Scales.

<u>Variable</u>	<u>Sample Mean</u>	<u>Sample SD</u>	<u>Male Mean</u>	<u>Male SD</u>	<u>Female Mean</u>	<u>Female SD</u>
Dominance	38.33	9.45	38.38	9.64	38.15	8.75
Cap. Status	35.53	10.69	35.15	9.73	37.15	14.08
Sociability	42.79	10.37	42.79	9.94	42.76	12.19
Soc. Presence	50.00	10.64	50.11	10.25	49.53	12.29
Self Accept.	50.01	10.02	49.84	9.78	50.71	11.10
Well Being	23.23	15.93	23.85	15.62	20.62	17.14
Responsibil.	21.90	11.46	22.32	11.30	20.12	12.11
Socializat.	26.78	10.39	28.03	10.00	21.50	10.47
Self Control	33.58	10.13	33.76	9.94	32.79	10.99
Tolerance	31.67	10.97	31.92	10.18	30.58	14.03*
Good Impress.	36.89	9.93	37.03	9.96	36.24	9.93*
Communality	33.64	17.05	33.65	17.48	33.62	15.35
Ach. Conform.	25.86	11.98	26.66	11.63	22.50	12.97
Ach. Independ.	38.95	10.70	38.78	10.16	39.71	12.88
Intell. Effic.	26.40	12.83	25.78	12.45	29.00	14.23
Psychol. Mind.	44.47	10.00	44.48	10.00	44.47	10.16
Flexibility	53.28	11.56	53.06	11.19	54.21	13.22*
Femininity	47.35	7.93	48.07	7.46	44.24	9.21*

Sample n=177 Males=143 Females=34

*Sample n=176 Males=143 Females=33

values and standards of society, impulsivity, problems in accepting direction from authority figures, and a relative disinterest in or inefficiency in learning.

The profiles for males and females are presented in Figure 4. The general configuration of the profiles appears to be virtually identical. A MANOVA was carried out to evaluate their statistical similarity. The tests for homogeneity of variance in Table 13 suggested that

Table 13. Homogeneity of Variance Tests for MANOVA
Comparing Males and Females on CPI Scales.

<u>Variable</u>	<u>Bartlett-Box F(1,25491)</u>	<u>Probability</u>
Dominance	.48509	.486
Cap. for Status	7.61931	.006
Sociability	1.82605	.177
Soc. Presence	1.86475	.172
Self Acceptance	1.06592	.302
Well Being	.45030	.502
Responsibility	.26484	.607
Socialization	.10722	.743
Self Control	.70346	.402
Tolerance	6.04311	.014
Good Impression	.00024	.988
Communality	.66700	.414
Achiev. by Conf.	.78891	.375
Achiev. by Ind.	3.63451	.057
Intell. Efficiency	.47609	.490
Psychol. Mindedness	.03832	.845
Flexibility	1.54486	.214
Femininity	2.50678	.114

Box's M = 249.77246

F with (171, 10660) df = 249.77246 p = .096

there are some significant differences in variance and the

Fig. 3. Mean CPI Profile

Total Sample (n=177)

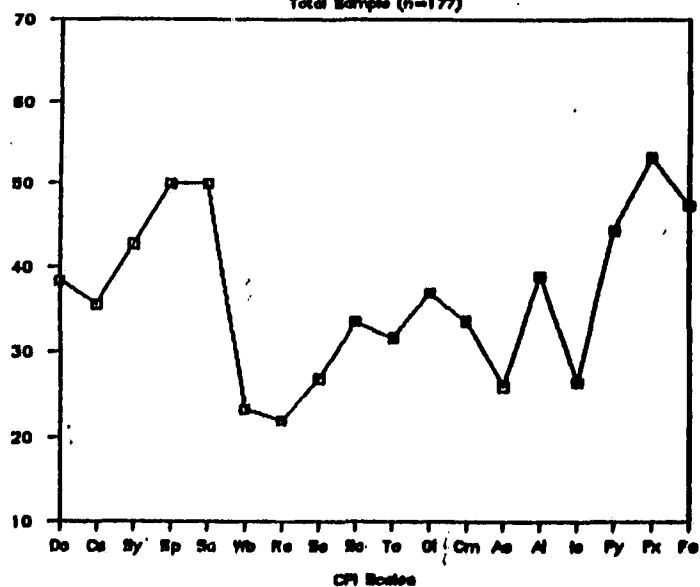
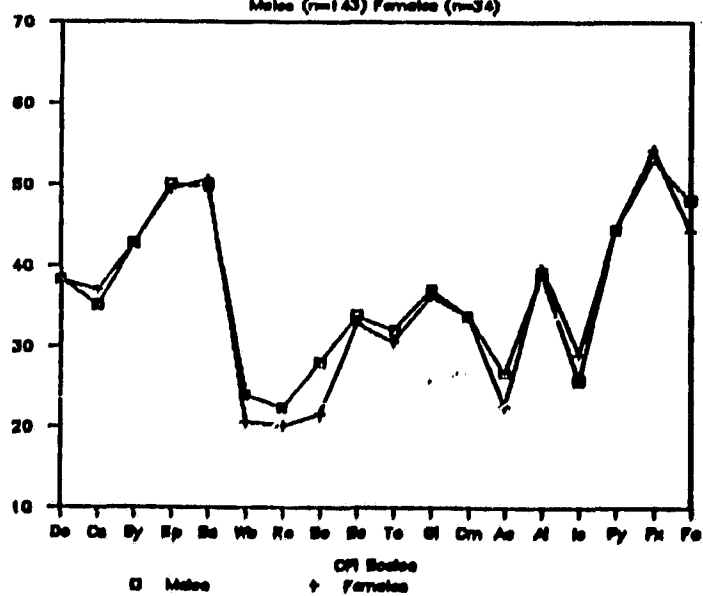


Fig. 4. Mean CPI Profile by Sex

Males (n=143) Females (n=34)



results must therefore be interpreted with some caution. The Capacity for Status and Tolerance scales do not have homogeneous variances and the value for Achievement via Independence approaches significance.

In spite of the apparent similarity of the CPI

Table 14. MANOVA Comparison of CPI Scales by Sex.

Multivariate Test of Significance (S=1, M=8, N=77 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.78627	2.37087	18.00	157.00	.002

Univariate F-Tests with (1,174) DF

<u>Var.</u>	<u>Hypo. SS</u>	<u>Error SS</u>	<u>Hypo. MS</u>	<u>Error MS</u>	<u>F</u>	<u>Sig.</u>
Do	.05828	15637.6690	.05828	89.87166	.00065	.980
Cs	174.36422	19646.8858	174.36422	112.91314	1.54423	.216
Sy	7.90924	18577.0396	7.90924	106.76460	.07408	.786
Sp	1.45688	19765.7249	1.45688	113.59612	.01283	.910
Sa	25.69930	17640.2098	25.69930	101.38052	.25349	.615
Wb	195.69945	44028.1585	195.69945	253.03539	.77341	.380
Re	93.47334	22851.3846	93.47334	131.32980	.71175	.400
So	1036.26005	17715.7343	1036.26005	101.81456	10.17792	.002
Sc	30.42672	18018.8858	30.42672	103.55681	.29382	.508
To	48.67191	21010.2145	48.67191	120.74836	.40309	.526
Gi	16.84149	17254.8858	16.84149	99.16601	.16983	.681
Cm	.50714	51146.0326	.50714	293.94272	.00173	.967
Ac	422.02855	24718.8578	422.02855	142.06240	2.97073	.087
Ai	27.44114	20130.3543	27.44114	115.69169	.23719	.627
Ie	431.50364	27988.3543	431.50364	160.85261	2.68260	.103
Py	.69362	17565.3007	.69362	100.95000	.00687	.934
Fx	35.40924	23363.9487	35.40924	134.27557	.26371	.608
Fe	392.79779	10619.3613	392.79779	61.03081	6.43606	.012

profiles for males and females, the multivariate Wilk's Lambda for the MANOVA comparison is significant (Table 14),

allowing for an interpretation of the subtest differences. The univariate tests indicate that females scored significantly lower than males on the Socialization and Femininity scales. The Achievement by Conformity scale approached significance, with females scoring lower.

The impression created by the comparisons of males and females across cognitive, academic achievement, and personality variables is that females more closely conform to the cognitive profile of the normative sample for the tests, are less likely to have difficulties in language skills, and are somewhat more rebellious and antisocial in their values. This would imply that the background to their delinquent behavior may have more to do with family conflicts, whereas, for males, delinquent behavior may be more closely associated with learning disabilities or other cognitive dysfunction in addition to socio-emotional variables. White et al. (1989) have reached a similar conclusion.

The means and standard deviations of the projected MMPI scales are presented in Table 15. The Masculinity/Femininity scale is not included in this table because it is normed differently for males and females.

A number of variables were recorded from criminal records. The number of charges that had been brought

Table 15. Means of Projected MMPI Scale T-Scores.

<u>Variable</u>	<u>Mean</u>	<u>Standard Deviation</u>
L	49.78	8.97
F	56.11	9.34
K	49.53	7.02
Hypochondriasis	66.51	13.38
Depression	62.77	11.35
Hysteria	66.90	12.11
Psychopathic Dev.	71.01	10.47
Paranoia	56.49	5.58
Psychasthenia	60.43	11.11
Schizophrenia	63.07	10.96
Mania	54.96	7.35
Social Introversion	45.47	10.52

against an individual were recorded, whether these charges lead to a prosecution or not. This number was divided by the number of months of adolescence divided by twelve (where the number of months were calculated as has been described earlier) to produce a variable labelled offenses per year.

Sentencing variables were recorded in the following manner. The records available from the Ministry of Corrections did not always make it clear when sentences were concurrent and when they were consecutive. When multiple offenses were cleared through the courts on the same occasion and the same sentence was applied to each of the charges, it was assumed that these sentences were concurrent and they were only added into the totals once. When sentences were given on separate dates, unless it was

clearly indicated that the sentences were concurrent, they were treated as though they were consecutive sentences and added into the totals separately. The reasoning for handling it in this manner was to reflect the seriousness with which the court viewed each offense or group of offenses. It was felt that when offenses were dealt with in a group, the judge would have made a decision on sentencing that would have considered the offenses as one package. Although these sentencing variables are not used in subsequent calculations, they provide some indication of the range and extent of patterns of contact with the Juvenile authorities.

This information, together with data on age of first offense and aggressiveness, collected in the manner proposed earlier, is presented in Table 16.

Table 16. Means and Standard Deviations of Criminal Offense Variables for Total Sample (n=177)

<u>Variable</u>	<u>Mean</u>	<u>St. Dev.</u>	<u>Minimum</u>	<u>Maximum</u>
Charges	5.84	6.01	1	30
Off. per Yr.	1.49	1.84	.10	10.29
1st Off. Age (mths.)	180.03	17.11	128	232
Comm. Service Hrs.	60.12	88.07	0	500
Probation (mths.)	24.91	17.73	0	84
Days in Detention	141.17	315.78	0	3046
Aggression Total	10.27	9.74	1	47
Most Agg. Aggressive Off.	3.03	1.60	1	6

The information on criminal offenses reveals that there was a broad range of criminal behavior represented in the sample, confirming that the sample is representative of a wide range of seriousness of delinquency. The number of charges ranged from 1 to 30 and the days in custody ranged from 0 to 3046. (This maximum figure was accumulated by a youth who, shortly after turning 18 years of age, was sentenced for serious offenses as a adult).

The age of first offense averaged almost exactly 15 years, with a range from 10 years 8 months to 19 years 4 months. In the latter case, the individual was charged with sexual offenses that he had committed as a juvenile. Because all other offenses had been recorded as occurring on the date that the matter was dealt with in court, this offense was recorded as occurring at this age for the sake of consistency. The charge laid against the youth at 10 years old occurred prior to the implementation of the Young Offenders Act which now prohibits youths from being charged under the age of 12.

Table 17 presents a comparison of the respective means and standard deviations for males and females, as well as t-values and two-tailed probability estimates of the differences between the means.

These results indicate that males significantly exceed

Table 17. Means of Criminal Offense Variables by Sex
(Males=143, Females=34).

<u>Variable</u>	<u>Males</u>		<u>Females</u>		<u>t</u>	<u>2-tail Prob.</u>
	<u>Mean</u>	<u>St. Dev.</u>	<u>Mean</u>	<u>St. Dev.</u>		
Charges	6.34	6.33	3.76	3.85	2.27	.025
Off. per Yr.	1.62	1.95	0.94	1.08	1.97	.050
1st Off. Age	179.74	17.51	181.24	15.52	.46	.649
Com. Ser. Hrs.	66.65	93.71	32.62	51.16	2.27	.025
Prob. (mths.)	27.23	17.79	15.15	13.90	3.70	.000
Days in Det.	167.66	344.31	29.76	76.70	2.32	.022
Agg. Total	11.22	10.22	6.29	6.08	2.70	.008
Most Agg. Off.	3.16	1.52	2.47	1.81	2.29	.023

females on every measure, except for the age at which the first offense is committed.

Testing the Hypotheses

Hypothesis 1

The basic measurement model to be used in testing the hypothesis is presented in Figure 5. An exogenous latent concept of General Intelligence is defined by the manifest variables of the Wechsler subtests. The parameter value of the Vocabulary subtest was fixed at -1.000 in order to provide a uniform standard of measurement between the latent concepts in the model. The negative value was used because an initial analysis with this parameter set at 1.000 produced negative parameter values for all other Wechsler subtests loading on the latent exogenous variable of general intelligence. The negative value for Vocabulary was, therefore, consistent with the other subtests. In defining the endogenous concept of Values and Conformity, the parameter for the Self Control scale was fixed at 1.000 and the parameter for the Sociability scale was fixed at 1.000 for the endogenous concept of Social Confidence. The indices of model fit for this model are presented in Table 18.

The model proposed to account for the hypothesis that delinquency is associated with a general lowering of intellectual functioning is diagrammed in Figure 6. It

Figure 5. Measurement parameters for general intelligence model.

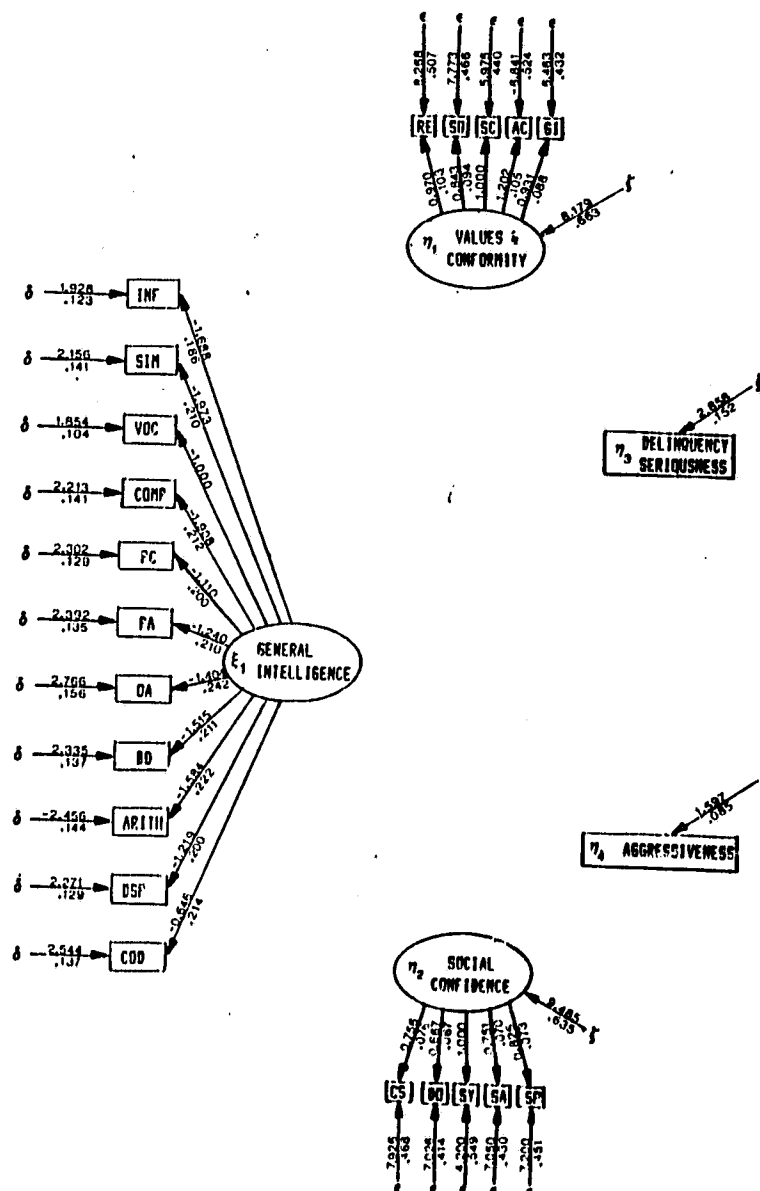


Figure 6. General intelligence model.

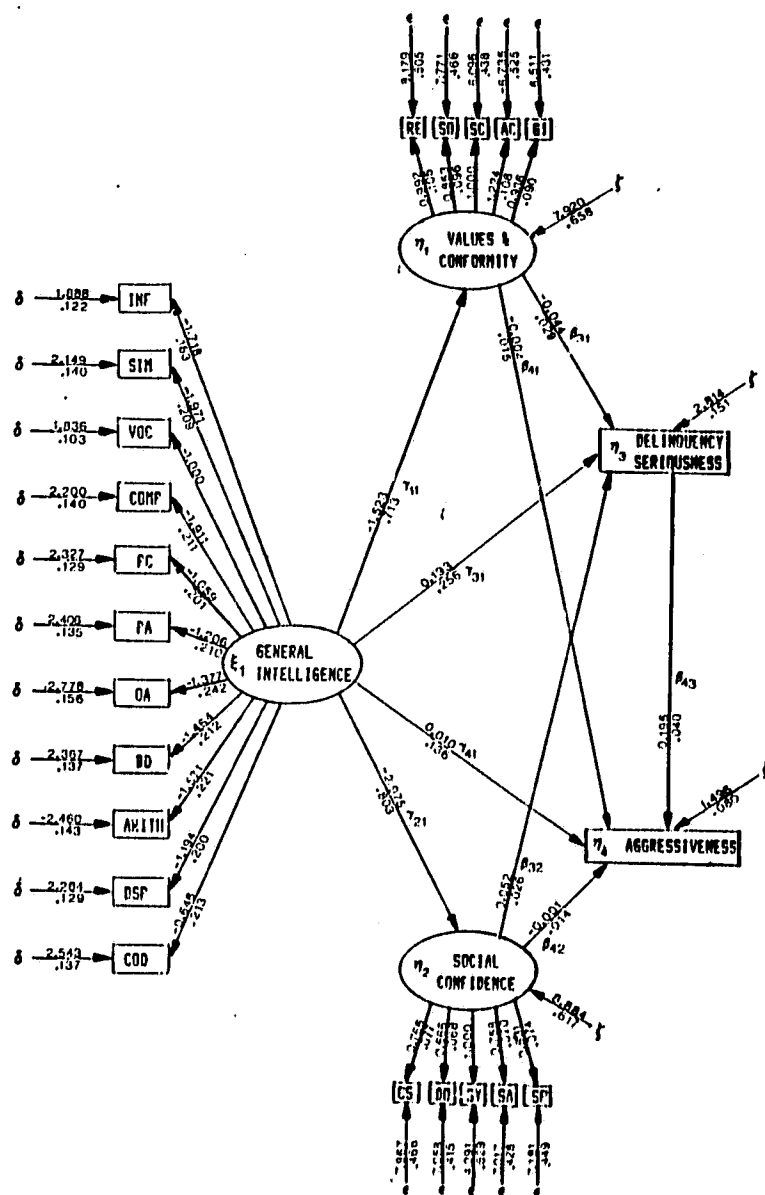


Table 18. Indices of Fit for General Intelligence Measurement Model.

Sample size	= 177
Degrees of Freedom	= 233
Chi-square	= 651.5441
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .1015
S-L ARMSI Confidence Intervals	= .0923, .1107
Adjusted Population Gamma Index	= .7953
APGI Confidence Intervals	= .7645, .8256

proposes that intelligence will have a direct effect upon both seriousness of delinquency and aggressiveness (parameters τ_{31} and τ_{41} are free), as well as indirect effects through its contribution to the formation of values and social conformity and the establishment of social confidence (parameters τ_{11} and τ_{21} are free) which are, in turn, presumed to contribute to delinquency (parameters β_{31} , β_{41} , β_{32} , and β_{42} are free). The numbers above each parameter line indicate the parameter value and the numbers below the line represent the standard error.

The fit indices for this model are presented in Table

Table 19. Indices of Fit for General Intelligence Model.

Sample size	= 177
Degrees of Freedom	= 224
Chi-square	= 604.1611
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0959
S-L ARMSI Confidence Intervals	= .0863, .1053
Adjusted Population Gamma Index	= .8129
APGI Confidence Intervals	= .7812, .8438

19. The difference of 47.383 between the Chi-square of the measurement model and the theory-based model is significant beyond the .001 level for 9 degrees of freedom. The theory-based model provides a significant improvement over the measurement model alone. The Chi-square for the hypothesis model is significant, suggesting that model fit is not significant. Although there is no standard by which this may be determined, the confidence intervals for the other indices are relatively narrow, suggesting that other indices should be consulted. The Steiger-Lind Adjusted RMS Index proposes that the model is a good fit to the data, while the Adjusted Population Gamma Index indicates only a fair fit.

The T-scores of the parameters within the model are presented in Table 20. The parameters linking the Wechsler subtests with the concept of general intelligence are all negative. This concept might, therefore, be more appropriately thought of as intellectual deficit. Its direct relationships with measures of delinquency are weak. It cannot be asserted that the direct relationship of general intelligence with seriousness of delinquency or aggressiveness are significantly different than zero. It does appear, however, that there are indirect pathways by which intellectual deficit contributes to the presence of delinquency. The contribution of general intelligence both

to the formation of values and social conformity and to social confidence is significant. Higher intelligence is associated with pro-social values and increased social conformity, as well as with greater social confidence. The parameter implying a causal relationship between less pro-social values and reduced conformity and seriousness of delinquency is of reasonable magnitude, but it does achieve a level that is significant statistically. The parameter connecting social confidence concept to seriousness of delinquency is statistically significant. It suggests, however, that increased social confidence is likely to lead to greater delinquency. This indirect route, therefore, indicates that higher intelligence may be associated with greater delinquency through its contribution to the personality variable of social confidence.

Neither of the personality variables appear to make any real contribution to the aggressiveness of the

Table 20. T-scores for General Intelligence Model.

<u>Parameter</u>	<u>T-score</u>
τ_{11}	-2.14 *
τ_{21}	-3.70 *
τ_{31}	0.75
τ_{41}	0.07
β_{31}	-1.52
β_{41}	-0.27
β_{32}	2.00 *
β_{42}	-0.07
β_{43}	4.88 *

delinquent.

Hypothesis 2

This hypothesis suggests that delinquency is a result of deficits in verbal skills. Figure 7 presents the measurement model for the verbal, spatial, and attention models. The exogenous concepts are not considered to be independent factors, and the relationships between them are indicated by the lines that connect them. The coefficients associated with these relationships are represented by the Greek letter phi (ϕ) which is subscripted to represent the appropriate exogenous variables. The fit indices for this measurement model are presented in Table 21.

Table 21. Indices of Fit for Verbal, Spatial, and Attention Measurement Model.

Sample size	= 177
Degrees of Freedom	= 231
Chi-square	= 601.8508
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0946
S-L ARMSI Confidence Intervals	= .0852, .1039
Adjusted Population Gamma Index	= .8179
APGI Confidence Intervals	= .7870, .8480

The model which proposes that verbal skills are the primary cognitive determinant of delinquency can be seen in

Figure 7. Measurement parameters for cognitive deficits models.

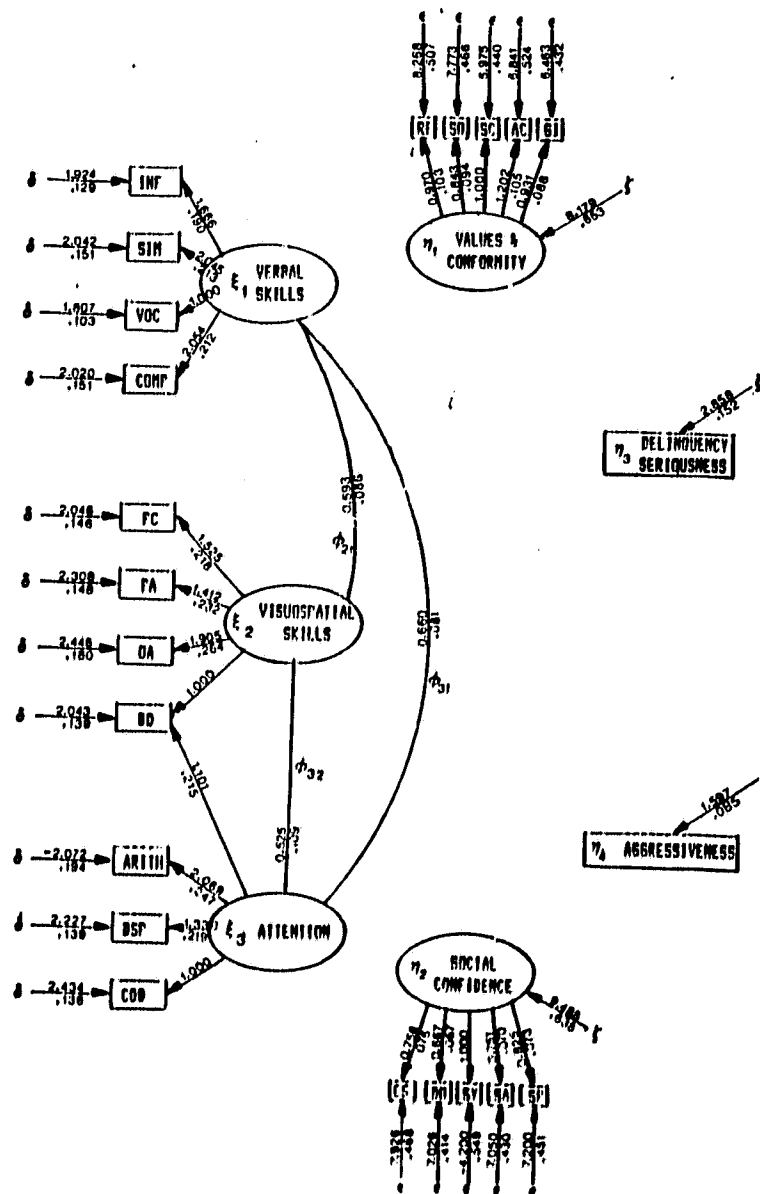


Figure 8. Verbal skills model.

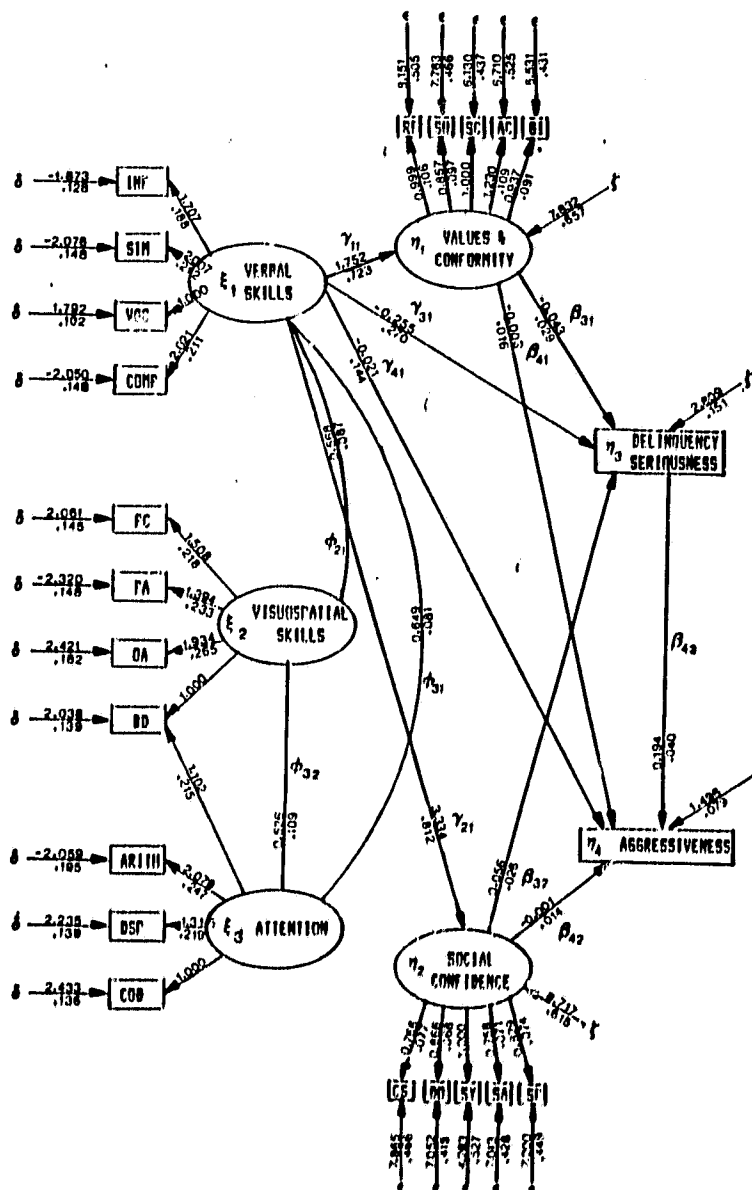


Figure 8. Within this model, verbal skills would be expected to contribute to the development of values and conformity through strengths in memory and reasoning, and social confidence would be facilitated by the individual's capacity for understanding social expectations and ease in social communication. Thus, parameters τ_{11} and τ_{21} would remain free for estimation. The development of pro-social values and conformity and increased social confidence would be expected to have an impact upon the commission of criminal offenses. Thus, parameters β_{31} , β_{41} , β_{32} , and β_{42} will remain free. A direct relationship between verbal intelligence and criminal offenses could also be expected and this is allowed for by leaving the parameters τ_{31} and τ_{41} free. The fit indices for this model are available in Table 22.

Table 22. Indices of Fit for Verbal Model.

Sample size	= 177
Degrees of Freedom	= 222
Chi-square	= 548.6286
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0874
S-L ARMSI Confidence Intervals	= .0776, .0971
Adjusted Population Gamma Index	= .8401
APGI Confidence Intervals	= .8086, .8706

The difference of 53.22 with 9 degrees of freedom between the Chi-square of the measurement model and the Chi-square of the verbal model is significant beyond the

.001 level. The confidence intervals for the Steiger-Lind Adjusted RMS Index and the Adjusted Population Gamma Index are quite narrow, suggesting the Chi-square is not the best index of model fit. The value of .0874 for the Steiger-Lind Adjusted RMS Index indicates a good fit, while the Adjusted Population Gamma Index of .8401 suggests a fair fit.

The T-scores for the model parameters can be seen in Table 23. The parameters which link the verbal skills concept with the personality concepts of values and conformity and social confidence could be considered to be significantly different than zero. The magnitude of the T-scores exceed the values for the parameters linking general intelligence with these same personality constructs. The direct relationships of verbal skills with delinquency are non-significant, but the indirect route of verbal skills contributing to social confidence and increased social confidence leading to more serious delinquency is statistically different than zero. It is also in a positive direction, implying that enhanced verbal skills might actually lead to greater delinquency through this route. The relationship between the values and conformity personality concept and seriousness of delinquency does not reach a level that might be considered to be statistically

significant. Neither of the personality constructs appear to make any contribution to aggressiveness.

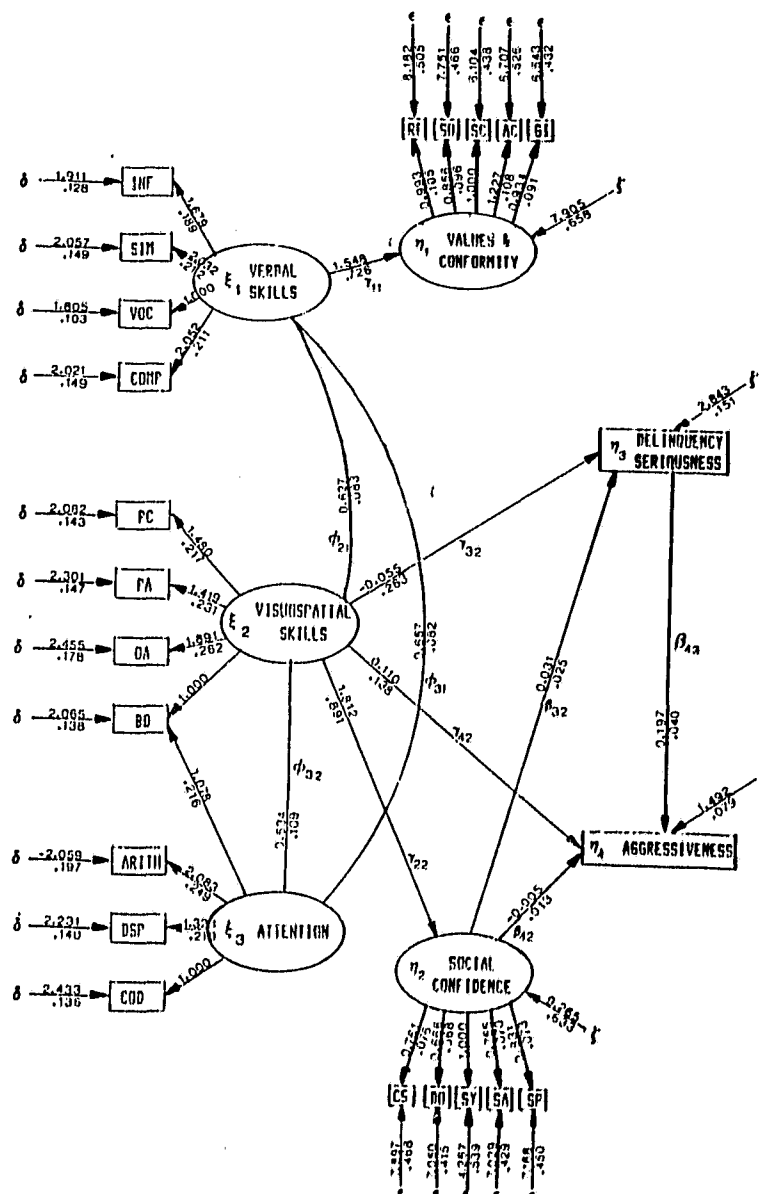
Table 23. T-scores for Verbal Model.

<u>Parameter</u>	<u>T-score</u>
τ_{11}	2.42 *
τ_{21}	4.11 *
τ_{31}	-0.94
τ_{41}	-0.15
β_{31}	-1.48
β_{41}	-0.19
β_{32}	2.00 *
β_{42}	-0.07
β_{43}	4.85 *

Hypothesis 3

This hypothesis suggests that delinquency arises out of visuospatial deficits. The model associated with it is displayed in Figure 9. Within this model a relationship is allowed between verbal skills and the development of values and social conformity by leaving parameter τ_{11} free. If visuospatial skills were the only cognitive factor contributing to delinquency, however, no relationship would be expected between values and conformity and criminal offenses. Thus, the parameters β_{31} and β_{41} are fixed at zero. Research with nonverbal learning disabilities (Weintraub & Mesulam, 1983; Voeller, 1986; Tranel et al., 1987; & Rourke, 1988b) suggests that a relationship between

Figure 9. Visuospatial skills model.



visuospatial skills and social confidence should be allowed for. Visuospatial deficits seem to be related more to social skills deficits and symptoms of anxiety and depression than to acting-out behavior. Strengths in visuospatial skills might be conducive to delinquency since they would facilitate many of the visuospatial judgments required for successful delinquency. In order to account for these relationships, parameters τ_{22} , τ_{32} , and τ_{42} are free for estimation.

The indices of model fit are found in Table 24. The improvement over the measurement of 34.8915 points in the Chi-square at 7 degrees of freedom is significant beyond the .00 level. The visuospatial and verbal models cannot be considered to be nested models and they cannot, therefore, be directly compared. In general, however, the visuospatial model does not appear to be as adequate as the verbal model in accounting for the significant relationships between the variables. The visuospatial model has a Chi-square which is 18.33 points higher than the verbal model. The Steiger-Lind Adjusted RMS Index indicates a good fit, but this is also larger than the same index for the verbal model. The Adjusted Population Gamma Index indicates a fair fit but poorer than the verbal model.

The T-scores for the visuospatial model are seen in

Table 24. Indices of Fit for Visuospatial Model.

Sample size	= 177
Degrees of Freedom	= 224
Chi-square	= 566.9593
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0903
S-L ARMSI Confidence Intervals	= .0806, .0998
Adjusted Population Gamma Index	= .8312
APGI Confidence Intervals	= .7997, .8617

Table 25. The significant relationship between verbal skills and values and conformity is confirmed in this model and a significant positive relationship between visuospatial skills and social confidence is indicated. None of the relationships with measures of delinquency or aggressiveness are found to be significantly different than zero, even the relationship between social confidence and delinquency seriousness which was significant in the verbal and general intelligence models. Of interest is the fact that the relationship between visuospatial skills and

Table 25. T-scores for Visuospatial Model.

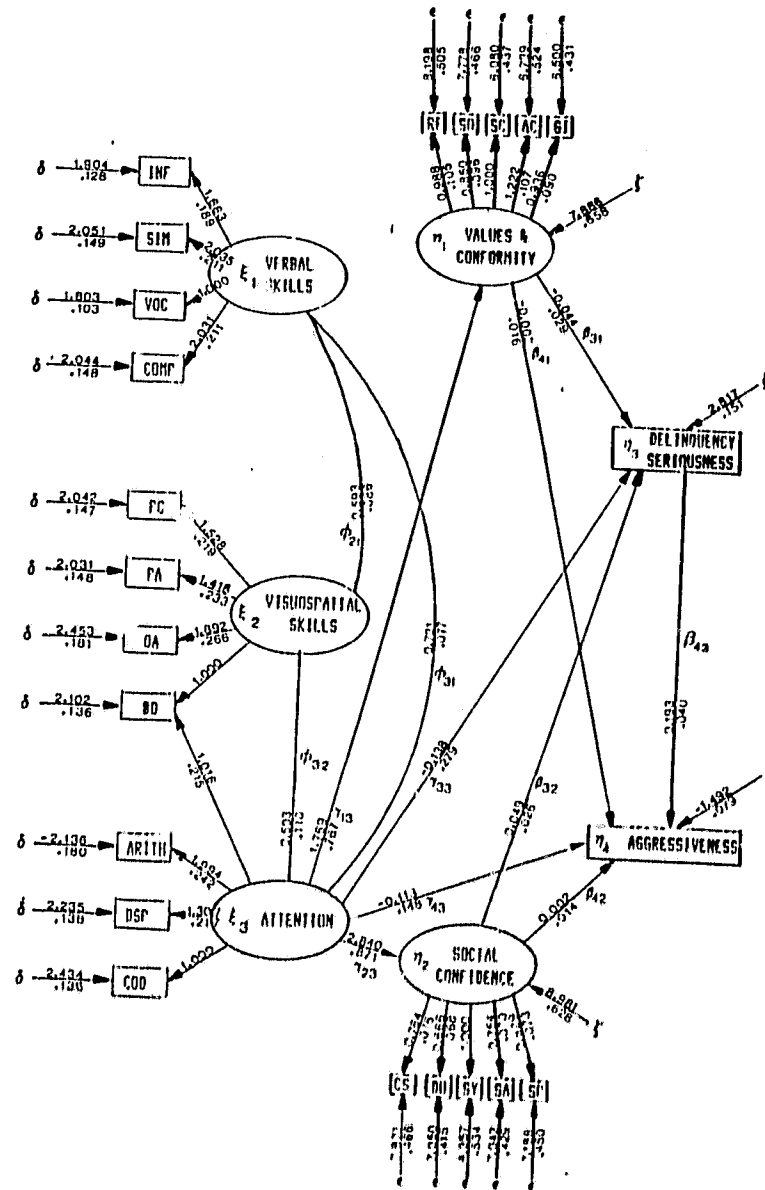
<u>Parameter</u>	<u>T-score</u>
τ_{11}	2.13 *
τ_{22}	2.03 *
τ_{32}	-0.21
τ_{42}	0.80
β_{32}	1.24
β_{42}	-0.38
β_{43}	4.93 *

aggressiveness is in a positive direction, even though it is not significant.

Hypothesis 4

The model associated with deficits in attentional skills can be seen in Figure 10. It is presumed that attention deficit is likely to have a bearing on the personality variables of values and conformity and social confidence. The impulsivity that often accompanies attention deficit could be expected to lead to a rejection of pro-social values which require consideration of the needs of others. Attentional skills are expected to facilitate social confidence by contributing to the interpersonal communication attributes that facilitate relationships. Parameters τ_{13} and τ_{23} are left free to account for these relationships. The research that has related attention deficit to aggressiveness (Walker et al., 1987; Moffitt and Silva, 1988c; and Lewis et al., 1989; Satterfield, 1987) suggests that a relationship between attentional skills and aggressiveness may be of particular interest. The parameters τ_{33} and τ_{43} are free to estimate the contribution of attention deficit to actual criminal offenses. The relationships between personality variables and delinquency are estimated by leaving parameters β_{31} , β_{41} , β_{32} , and β_{42} free.

Figure 10. Attentional skills model.



The fit indices for this model are presented in Table 26. The difference of 42.2376 from the Chi-square of the

Table 26. Indices of Fit for Attention Model.

Sample size	= 177
Degrees of Freedom	= 222
Chi-square	= 559.6132
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0894
S-L ARMSI Confidence Intervals	= .0796, .0990
Adjusted Population Gamma Index	= .8340
APGI Confidence Intervals	= .8023, .8646

measurement model at 9 degrees of freedom indicates that this is an improvement which is significant beyond the .001 level. Although a direct comparison with the verbal and visuospatial models is not possible, it would appear that the verbal model may be a better fit to the data, while the visuospatial model is less adequate than the attention model. The verbal model has a Chi-square which is 10.9846 points lower with the same number of degrees of freedom. The Chi-square value of the attention model is 7.3461 points lower. The Steiger-Lind Adjusted RMS Indexes of .0874, .0894, and .0903 and the Adjusted Population Gamma Indexes of .8401, .8340, and .8312 for the verbal, attention, and visuospatial models, respectively, also support this contention. The fit indices for the attention model are seen in Table 26.

The T-scores for the parameters of the attention model are presented in Table 27. The relationship between

attentional skills and the personality variables of values and conformity and social confidence are significantly different from zero and are in a positive direction. However, none of the relationships with measures of delinquency can be considered to be significantly different from zero.

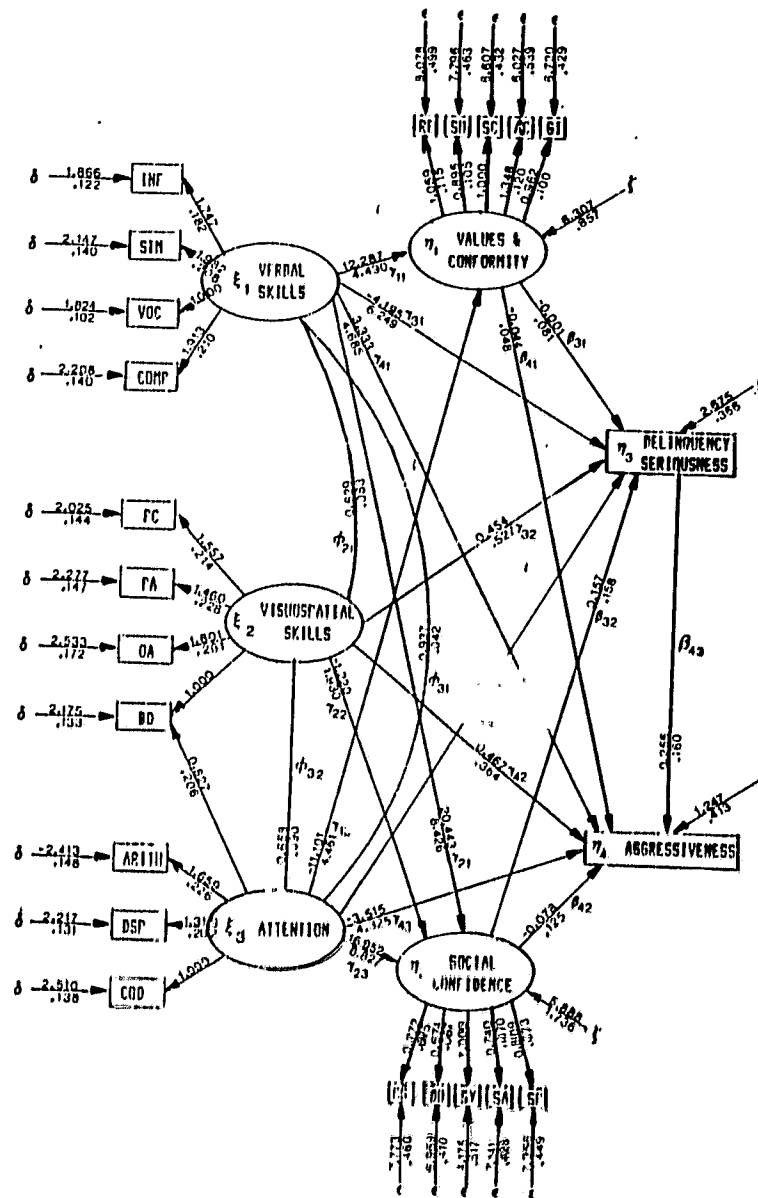
Table 27. T-scores for Attention Model.

<u>Parameter</u>	<u>T-score</u>
τ_{13}	2.31 *
τ_{23}	3.26 *
τ_{33}	-0.49
τ_{43}	-0.76
β_{31}	-1.52
β_{41}	-0.13
β_{32}	1.88
β_{42}	0.14
β_{43}	4.83 *

Composite of Verbal, Visuospatial, and Attention Models

A composite of the verbal, visuospatial, and attention models is presented in Figure 11. It includes the parameters that have been tested in each of the three models. Each of those models can be considered to be nested models of this composite model and it is possible to compare each of them with it to evaluate the relative goodness of fit. The fit indices for this model are available in Table 28.

Figure 11. Composite cognitive deficits model.



The composite model has a Chi-square which is 33.9681 points lower than that of the visuospatial model. At 9 degrees of freedom, this difference is significant beyond the .001 level. When model complexity is accounted for using the Steiger-Lind Adjusted RMS Index and the Adjusted Population Gamma Index the visuospatial model is a slightly better fit (.0903 for the visuospatial model compared to .0911 for the composite model and .8312 compared to .8277 for the respective indices).

When the attention model is compared to the composite model, it is found that the Chi-square of the attention model is 26.622 points higher, which is significant beyond the .001 level for 7 degrees of freedom. The Steiger-Lind Adjusted RMS Index (.0894 for the attention model and .0911 for the composite model) and the Adjusted Population Gamma Index (.8340 for the attention model and .8277 for the composite model) favor the less complex attention model.

The difference in Chi-squares of 15.6374 at 7 degrees of freedom indicates that the composite model is also an improvement over the verbal model (significant at the .05 level). When increased model complexity is taken into consideration, however, the composite model does not provide a better fit than the verbal model. The Steiger-Lind Adjusted RMS Index increased from .0874 for the verbal model to .0911 for the composite model and the Adjusted

Population Gamma Index decreased from .8401 for the verbal model to .8277 for the composite model.

Thus, the Chi-square values indicate that the composite model provides the best explanation of the relationships in the data, but the verbal model may be the most parsimonious theory.

Table 28. Indices of Fit for Composite Model.

Sample size	= 177
Degrees of Freedom	= 215
Chi-square	= 532.9912
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0911
S-L ARMSI Confidence Intervals	= .0812, .1008
Adjusted Population Gamma Index	= .8277
APGI Confidence Intervals	= .7951, .8591

The T-scores for the parameters within this composite model are seen in Table 29. The inclusion of many possible sources of variance within this model has modified the significance of many of the relationships in the model. With regard to relationships between cognitive and personality variables, the relationship between visuospatial skills and social confidence does not remain significant when considered in conjunction with the contributions of verbal and attentional skills. A significant relationship remains between verbal skills and both personality constructs, implying that verbal skills make an important contribution to the development of pro-

social values and social conformity and to social confidence. Attentional skills continue to make a significant contribution to the development of social values and conformity, but the relationship is now in a negative direction. The contribution of attentional skills to social confidence has been lowered to a level where it might be considered to be marginally significant. However, it does not reach the standard for significance adopted for this study and it must be concluded that this parameter is not significantly greater than zero.

None of the direct relationships of the cognitive variables with delinquency are statistically significant in this model, but the direction of the relationships are of interest. Although verbal skills have a negative relationship with seriousness of delinquency, the relationship of verbal skills with aggressiveness is in a positive direction. In the same vein, attentional skills have a negative relationship with aggressiveness, but a positive relationship with seriousness of delinquency. Visuospatial skills have a positive relationship with both aggressiveness and seriousness of delinquency.

The indirect paths to delinquency through personality variables are not statistically significant. The relationship between social confidence and seriousness of

delinquency, which was significant in other models, does not retain that distinction in this model.

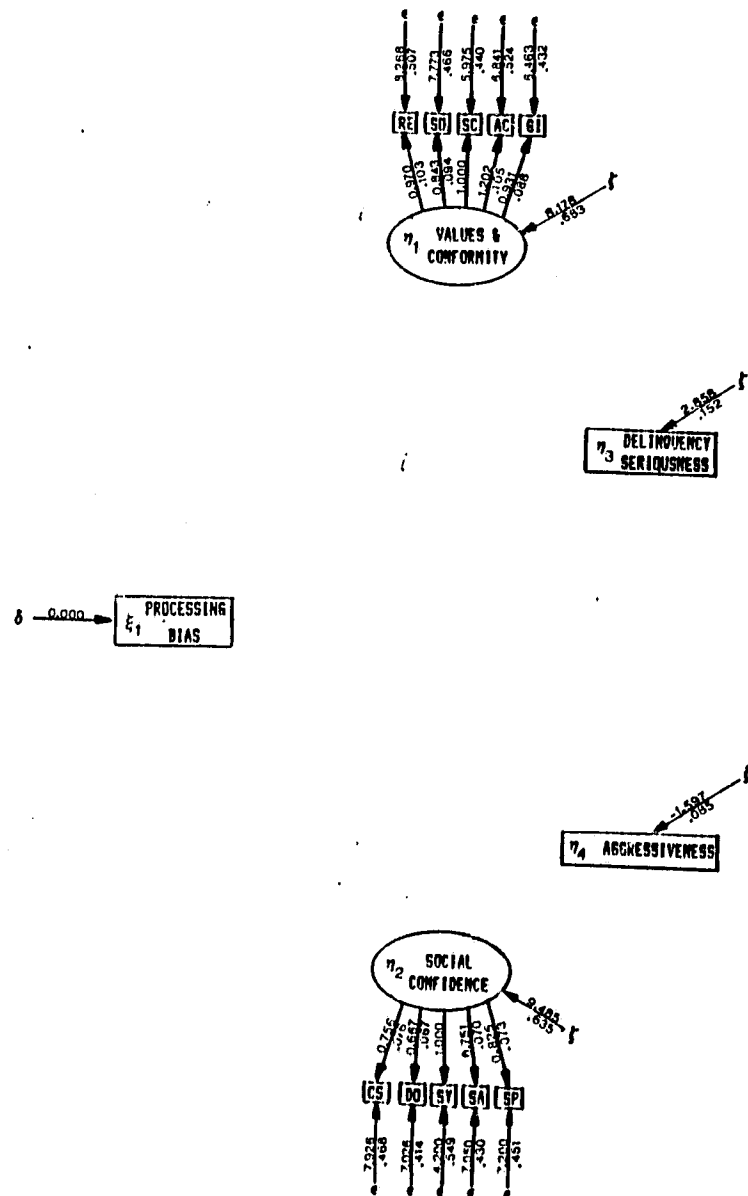
Table 29. T-scores for Composite Model.

<u>Parameter</u>	<u>T-score</u>
τ_{11}	2.74 *
τ_{21}	2.43 *
τ_{22}	-0.63
τ_{13}	-2.49 *
τ_{23}	-1.92
τ_{31}	-0.67
τ_{41}	0.71
τ_{32}	0.86
τ_{42}	1.28
τ_{33}	0.58
τ_{43}	-0.81
β_{31}	-0.01
β_{41}	-0.92
β_{32}	0.99
β_{42}	-0.62
β_{43}	1.59

Hypothesis 5

The measurement model for the processing bias model is presented in Figure 12. Linear redundancies made it impossible to evaluate this model in the context of the other cognitive skills. This model did not seem to be a very satisfactory test of this theory, and further evaluation of the theory will be possible in the models to follow which examine the role of learning problems in delinquency.

Figure 12. Measurement parameters for processing bias model.



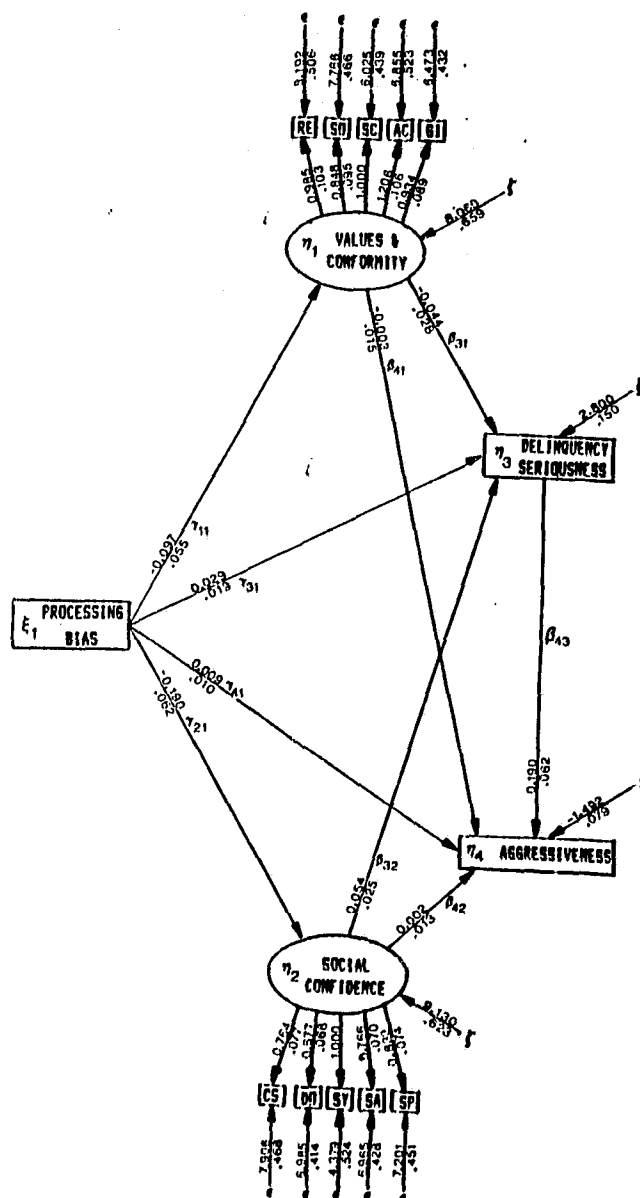
The processing bias variable in the current model is measured by the discrepancy between Performance IQ and Verbal IQ on the Wechsler scales. In order to process the measurement model in EzPath, it was necessary to have an error term indicated for the processing bias variable. In view of the fact that this variable will not have an error term specified in the model analysis, the error term was set at zero. The fit indices for this measurement model may be viewed in Table 30.

Table 30. Indices of Fit for Processing Bias Measurement Model.

Sample size	= 177
Degrees of Freedom	= 68
Chi-square	= 352.0685
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .1468
S-L ARMSI Confidence Intervals	= .1308, .1627
Adjusted Population Gamma Index	= .7538
APGI Confidence Intervals	= .7097, .7970

The processing bias model is outlined in Figure 13. It is presumed that this bias will make a direct contribution to the occurrence of delinquency and that it may also influence the personality dimensions in the model. The fit indices presented in Table 31 suggest that this model is not a very good fit to the data. The improvement in Chi-square over the measurement model of 42.4084 is

Figure 13. Processing bias model.



significant beyond the .001 level at 9 degrees of freedom. However, when increased model complexity is taken into consideration using the Steiger-Lind Adjusted RMS Index and the Adjusted Population Gamma Index, this model does little better than the measurement model.

Table 31. Indices of Fit for Processing Bias Model.

Sample size	= 177
Degrees of Freedom	= 59
Chi-square	= 309.6601
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .1451
S-L ARMSI Confidence Intervals	= .1279, .1622
Adjusted Population Gamma Index	= .7525
APGI Confidence Intervals	= .7026, .8007

The T-scores for the processing bias model can be seen in Table 32. The relationship of processing bias to social confidence may be considered as significant, while the relationship to values and conformity is not. In both cases the relationship is a negative one. A preference for visuospatial or right hemisphere processing is associated with reduced social confidence. Within this model the relationship of social confidence with seriousness of delinquency is positive and significant. This indirect route to delinquency implies that a verbal or left hemisphere processing bias is likely to lead to increased social confidence and that this, in turn, may contribute to more serious delinquency patterns. The direct contribution

of a right hemisphere processing bias to delinquency is substantial but does not reach the accepted alpha level. It will be observed in the models presented in evaluating hypothesis 6 that a right hemisphere processing bias makes a significant contribution to aggressiveness and a sizable, though non-significant, contribution to the seriousness of delinquency in a model where the role of verbal skills is also accounted for. This finding provides supportive evidence for the current hypothesis.

Table 32. T-scores for Processing Bias Model.

<u>Parameter</u>	<u>T-score</u>
τ_{11}	-1.76
τ_{21}	-3.06 *
τ_{31}	1.53
τ_{41}	0.90
β_{31}	-1.57
β_{41}	-0.20
β_{32}	2.16 *
β_{42}	0.15
β_{43}	3.06 *

Another difficulty in evaluating this model lies in the fact that the relationship of this processing bias with measures of delinquency may not be linear. According to the theory outlined, it is proposed that this bias is a learned one or may be associated with developmental changes that favor right hemisphere processing. One would expect this to contribute to modest biases in favor of Performance IQ on the Wechsler scales. More extreme biases are likely

to reflect neurological impairments of the left hemisphere. If this processing bias is a crucial factor in determining delinquent and anti-social behavior, one would expect that a modest bias in favor of non-verbal processing would be most likely to lead to delinquency. In other words, the relationship between delinquency and aggressiveness and processing bias would be expected to be non-linear.

In order to examine this possibility, the sample was divided into four groups. The first division was made at the average PIQ-VIQ value for the entire sample, which was 6.6. The second and third divisions were made at 15 point intervals on either side of 6.6, namely at PIQ-VIQ

Table 33. Delinquency seriousness and aggressiveness means for PIQ-VIQ groups.

Delinquency Seriousness

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	2.55	3.03
Verbal>Performance	68	1.97	1.95
Verbal<Performance	77	3.30	3.52
Verbal<<Performance	16	1.89	1.38
Entire Sample	177	2.60	2.86

Most Aggressive Offence

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	2.56	1.41
Verbal>Performance	68	2.87	1.45
Verbal<Performance	77	3.33	1.76
Verbal<<Performance	16	2.75	1.44
Entire Sample	177	3.03	1.60

differences of 21.6 and -8.4 points. The means and standard deviations for the delinquency seriousness and most aggressive variables are seen in Table 33. It is apparent that the group which, by theory, might be expected to display the most serious patterns of delinquency and the most aggressive behavior do have means for these variables which are higher than the other groups.

The linearity of the relationships of these variables to the PIQ-VIQ variable and the significance of the difference of the means of this group from the other groups were tested with an ANOVA design. Of primary concern in the analysis were the single degree of freedom tests that tested for a linear relationship across the groups, that tested a quadratic relationship across groups, and that tested the difference of the mean of the group with PIQ-VIQ values ranging from 6.6 to 21.6 with the means of all other groups. The outcome of this analysis is presented in Table 34. It may be seen that the relationship between the seriousness of delinquency and most aggressive offense variables and processing bias is not linear and is not quadratic. The ANOVA comparison is significant, however, for the analysis which assumes that the mean of the group with a PIQ-VIQ difference of 6.6 to 21.6 is greater than the means of the other groups for both of the variables tested. This finding both supports the processing bias

hypothesis and helps to explain why the relationship between processing bias and seriousness of delinquency does not reach significance in the models presented.

Table 34. ANOVA comparison of PIQ-VIQ groups on delinquency seriousness and most aggressive offense.

Delinquency Seriousness

<u>Source of Variation</u>	<u>SS</u>	<u>DF</u>	<u>MS</u>	<u>F</u>	<u>Sign. of F</u>
Within cells	1365.53	173	7.89		
Constant	1191.61	1	1191.61	151.08	.000
Group	73.33	3	24.44	3.10	.028
Linear	.00	1	.00	.00	.990
Quadratic	4.58	1	4.58	.58	.447
Group 3 greater	48.88	1	48.88	6.20	.014

Most Aggressive Offense

<u>Source of Variation</u>	<u>SS</u>	<u>DF</u>	<u>MS</u>	<u>F</u>	<u>Sign. of F</u>
Within cells	435.63	173	2.52		
Constant	1623.14	1	1623.14	644.59	.000
Group	13.23	3	4.41	1.75	.158
Linear	1.31	1	1.31	.52	.471
Quadratic	.28	1	.28	.11	.738
Group 3 greater	11.63	1	11.63	4.62	.033

Hypothesis 6

In order to test this hypothesis, a learning disability model will be outlined and compared with a cognitive deficit model. The components of the cognitive model were determined on an a priori basis without the benefit of the foregoing analyses. It was felt that the most important cognitive factors would be the verbal and attention concepts, with processing bias also being

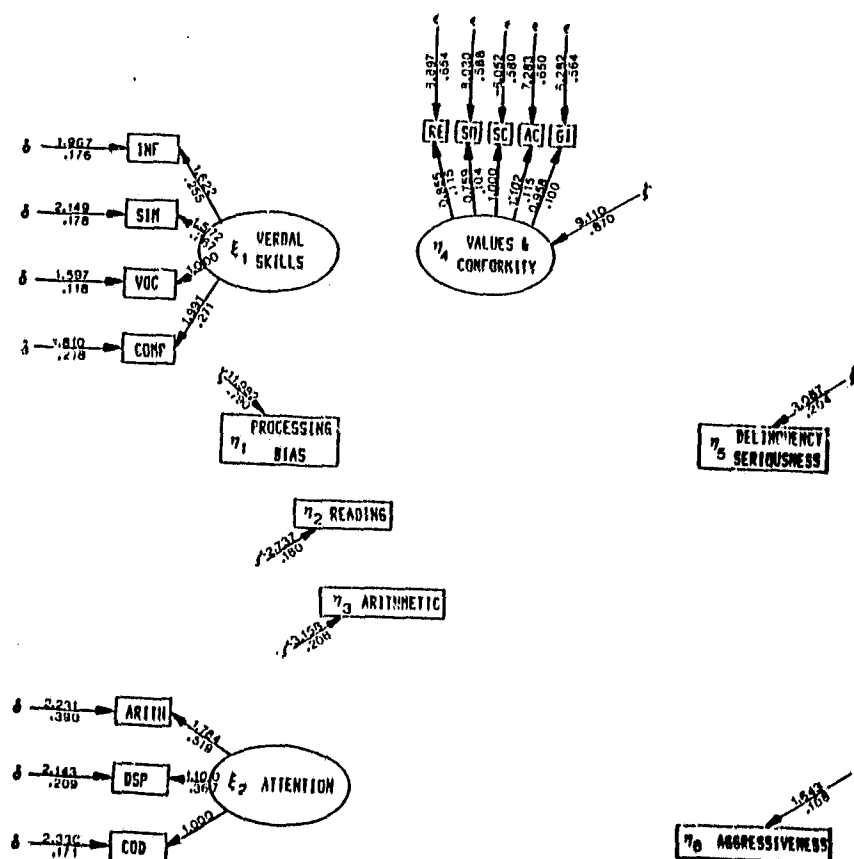
included. It was possible to include the Performance IQ minus Verbal IQ variable as an indicator of processing bias in this model because the elimination of the spatial concept removed the linear redundancy from the data matrix. The verbal and attention concepts continued to be measured as in the previous models, except that the Block Design subtest was left out of the estimation of the latent concept of attention. Reading and arithmetic were estimated through the use of scaled score conversions of the Reading and Arithmetic subtests of the Wide Range Achievement Test - Revised. The Social Confidence personality concept was excluded on an a priori basis, while the Values and Conformity concept are estimated by the same subtests of the California Psychological Inventory as in earlier models. The measurement model is presented in Figure 14 and its fit indices are given in Table 35.

Table 35. Indices of Fit for Cognitive and Learning Disabilities Measurement Models.

Sample size	= 115
Degrees of Freedom	= 126
Chi-square	= 385.8349
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .1516
S-L ARMSI Confidence Intervals	= .1365, .1665
Adjusted Population Gamma Index	= .7459
APGI Confidence Intervals	= .6464, .7371

Within both the cognitive deficit and learning

Figure 14. Measurement parameters for cognitive deficits and learning disabilities models.

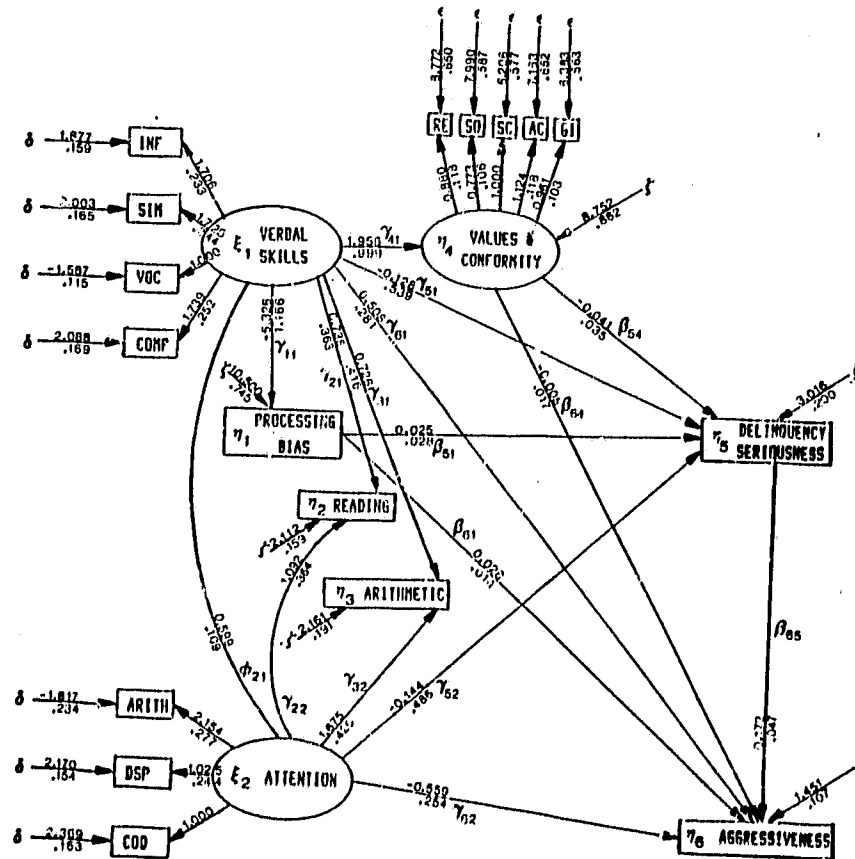


disabilities models it is expected that verbal skills will have significant relationships with the formation of values, with processing bias, and with reading and arithmetic performance. Thus, parameters τ_{41} , τ_{31} , τ_{21} , and τ_{11} will remain free. It is also expected that attentional skills will also contribute to performance in reading and arithmetic, so that parameters τ_{22} and τ_{32} will be free. The relationship between attentional and verbal skills will be represented by ϕ_{21} .

The delinquency seriousness variable is expected to contribute to aggressiveness and this is allowed for by leaving parameter β_{65} free.

The model presented in Figure 15 portrays a series of relationships that could be expected if both lowered academic performance and delinquency were concomitants of variations in verbal and attentional skills, coupled with a bias to process information nonverbally. Direct relationships would be allowed for between verbal skills and processing bias (parameters τ_{51} , τ_{61} , β_{51} , and β_{61} are free) and measures of delinquency. Attentional deficits would be expected to contribute to aggressiveness and seriousness of delinquency (parameters τ_{52} and τ_{62} are free). Values and social conformity would contribute to the presence of delinquency (parameters β_{54} and β_{64} are

Figure 15. Cognitive deficits with school achievement model.



free).

The fit indices for this cognitive deficits model are given in Table 36. The improvement of 192.3771 points in the Chi-square over the measurement model is highly significant ($p > .001$) at 16 degrees of freedom. The cognitive model appears to provide a good fit to the data when one examines the Steiger-Lind Adjusted RMS Index and the Adjusted Population Gamma Index.

Table 36. Indices of Fit for Cognitive Model.

Sample size	= 115
Degrees of Freedom	= 110
Chi-square	= 195.4578
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0820
S-L ARMSI Confidence Intervals	= .0624, .1004
Adjusted Population Gamma Index	= .8886
APGI Confidence Intervals	= .8394, .9332

The significance of individual parameters, as reflected in the T-scores, may be inspected in Table 37. Verbal skills make a significant contribution to the formation of values and social conformity. The influence of verbal skills on reading is significant, while the relationship with arithmetic performance approaches, but does not reach, significance. The contribution of verbal skills to pro-social values is very close to statistical significance. The relationship of verbal skills with aggressiveness, although not significantly different from

zero is, as in the earlier models, in a positive, rather than the expected negative, direction.

Attentional skills make a significant contribution to level of reading and, especially, to arithmetic proficiency. Attentional skills also have a significant negative relationship with aggressiveness, suggesting that attention deficit may play an important role in aggressive behavior. Right hemisphere processing bias makes a significant contribution to aggressiveness, while its role in the seriousness of delinquency is positive, but non-significant. The personality construct of pro-social values and conformity does not appear to have a relationship with delinquency measures which differs from zero.

Table 37. T-scores for Cognitive Deficits Model.

<u>Parameter</u>	<u>T-score</u>
τ_{11}	-4.57 *
τ_{21}	2.03 *
τ_{31}	1.75
τ_{41}	1.96
τ_{51}	-0.24
τ_{61}	1.81
τ_{22}	3.00 *
τ_{32}	3.99 *
τ_{52}	-0.30
τ_{62}	-2.20 *
β_{51}	0.89
β_{61}	2.00 *
β_{54}	-1.17
β_{64}	-0.29
β_{65}	3.66 *

Figure 16. Learning disabilities model.

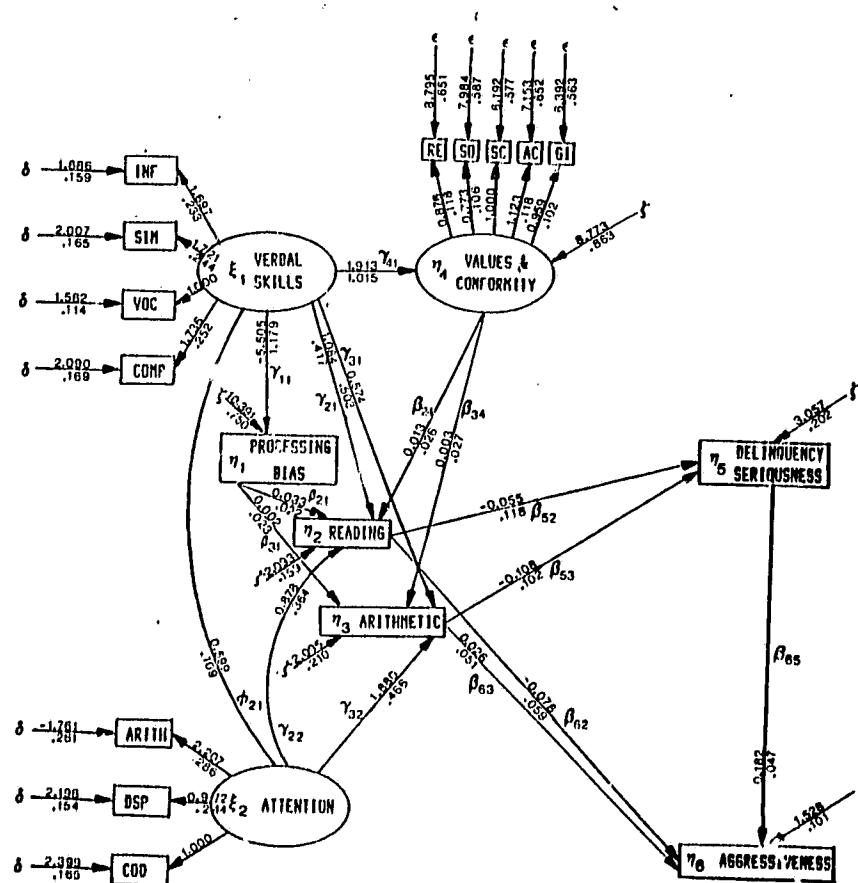


Figure 16 presents the model that would be expected if learning disabilities were the major determinant of delinquency. Within this theory, cognitive deficits are thought to contribute to learning problems and do not have any direct relationship to delinquency. The parameters β_{21} and β_{31} are free to allow for a contribution of processing bias to learning difficulties. Such a bias might be expected to play a role in learning difficulties by virtue of the fact that it might contribute to a reduced interest in verbal learning and limit the amount of cognitive rehearsal that might be used to enhance verbal learning. The role of values and conformity within this model is in supporting academic efforts. Thus, the parameters β_{24} and β_{34} are free, while the parameters β_{54} and β_{64} are fixed at zero. What is expected to cause delinquency is failure in basic academic subjects (reading and arithmetic). Consequently, parameters β_{52} , β_{62} , β_{53} , and β_{63} are free, while all other parameters directed at measures of delinquency are fixed at zero.

The fit indices for this model can be seen in Table 38. A reduction of 186.7275 in the Chi-square from the measurement model is an improvement which is significant beyond the .001 level at 16 degrees of freedom. Compared to the cognitive disabilities model, however, the Chi-square has increased by 5.6496 points with the same number

of degrees of freedom for each model. Since these are not nested models, a comparison by means of the Chi-square index is not possible. The Steiger-Lind Adjusted RMS Index is .0002 more than and the Adjusted Population Gamma Index is .0004 less than the same index for the cognitive disabilities model, indicating that it would be difficult to make any definitive statements about the relative merit of each of these models. The cognitive disabilities model may be slightly better than the learning disabilities model in accounting for delinquency, especially in view of the fact that there are some significant relationships with delinquency among the parameters of the cognitive disabilities model (Table 37) which are not accounted for in the learning disabilities model (Table 39).

Table 38. Indices of Fit for Learning Disabilities Model.

Sample size	= 115
Degrees of Freedom	= 110
Chi-square	= 199.1074
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0822
S-L ARMSI Confidence Intervals	= .0626, .1006
Adjusted Population Gamma Index	= .8882
APGI Confidence Intervals	= .8390, .9329

The significance of the parameters may be determined from the T-score values in Table 39. It may be stated with confidence that verbal skills are an important factor in determining performance in reading, but the relationship

between verbal skills and arithmetic does not reach significance. Verbal skills have a positive relationship with the values and conformity personality construct, but the T-score does not reach a value which would allow it to be considered significantly different from zero. Attentional skills have a significant causal relationship with both reading and arithmetic performance. The processing bias concept has a positive, but non-significant, relationship with reading performance, while its relationship with arithmetic performance is close to zero. The values and conformity construct does not appear to have much impact upon reading and arithmetic performance. The relationship of reading performance with

Table 39. T-scores for Learning Disabilities Model.

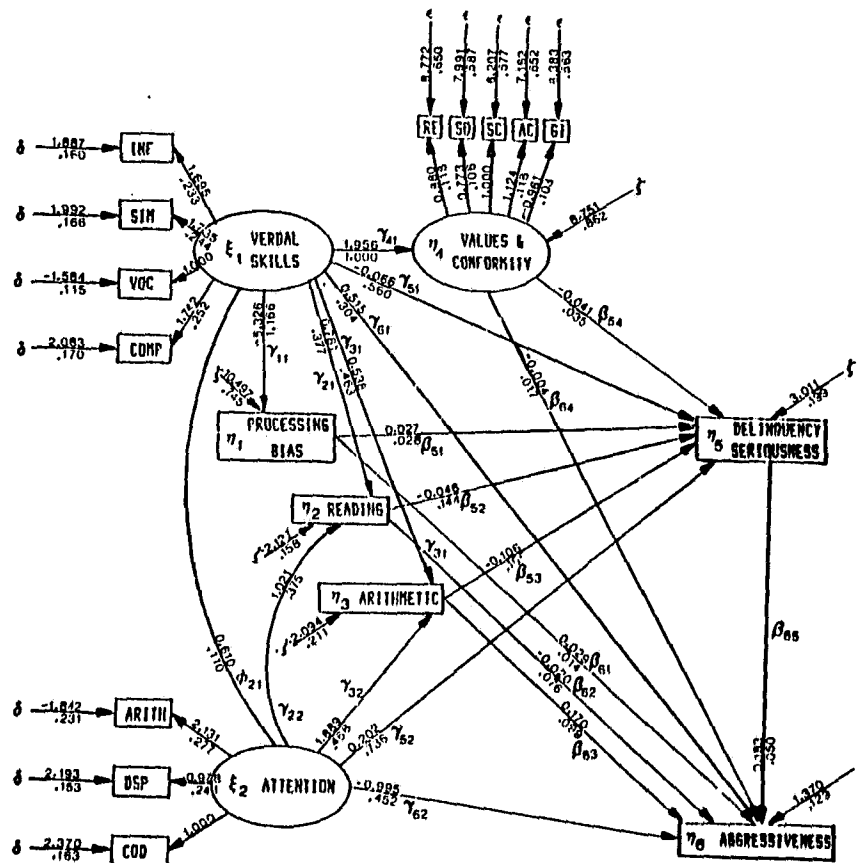
<u>Parameter</u>	<u>T-score</u>
τ_{11}	-4.67 *
τ_{21}	2.60 *
τ_{31}	1.14
τ_{41}	1.88
τ_{22}	2.41 *
τ_{32}	4.03 *
β_{21}	1.50
β_{31}	0.09
β_{24}	0.50
β_{34}	0.11
β_{52}	-0.47
β_{62}	-1.32
β_{53}	-1.06
β_{63}	0.51
β_{65}	3.87 *

measures of delinquency is strongest with the indicator of aggressiveness and lies in a negative direction. It is not, however, significantly different from zero. Reading performance appears to bear little relationship with the seriousness of delinquency. Arithmetic performance also does not have significant relationships with seriousness of delinquency or aggressiveness. What relationship does exist between arithmetic performance and aggressiveness appears to be in a positive direction.

Figure 17 presents an integration of the learning disability and cognitive deficits models. It is, essentially, the cognitive deficits model with the parameters β_{52} , β_{62} , β_{53} , and β_{63} free to allow for a contribution of school failure to delinquency. The values and conformity concept is directed only towards the measures of delinquency, not to reading and spelling, as it was in the learning disabilities model.

The fit indices for this model are available in Table 40. The cognitive deficits model is a nested model of this integrated model and it can be compared using the procedure recommended by Hayduk (1987). The difference between the Chi-square for the integrated model and the cognitive deficits model is 5.0523 which is non-significant at 4 degrees of freedom. Thus, the integrated model does not improve over the cognitive deficits model. This is further

Figure 17. Integrated cognitive deficits and learning disabilities model.



emphasized when the Steiger-Lind Adjusted RMS Index is considered. The value for the integrated model is .0827 while the value for the cognitive deficits model is .0820. The Adjusted Population Gamma Index is .8867 for the integrated model and .8886 for the cognitive deficits model. This comparison suggests that allowing for a contribution of school failure (i.e. reading and arithmetic performance) in the cognitive deficits model does not improve the fit of the model to the data. This supports the contention that the most persuasive model is that which views learning disabilities as another manifestation of the cognitive deficits that make a modest contribution to aggressiveness and the seriousness of delinquency.

Table 40. Indices of Fit for Integrated Learning Disabilities and Cognitive Deficits Model.

Sample size	= 115
Degrees of Freedom	= 106
Chi-square	= 188.4055
Probability Level	= .0000
Steiger-Lind Adjusted RMS Index	= .0827
S-L ARMS: Confidence Intervals	= .0628, .1014
Adjusted Population Gamma Index	= .8867
APGI Confidence Intervals	= .8361, .9324

The significance of the parameters in this integrated model are given in Table 41. The same parameters that have been observed to be significant in the cognitive deficits model are also seen to be significant in this model. Verbal skills make a significant contribution to reading

performance and attentional skills contribute to both reading and arithmetic achievement. The significant contributions to aggressiveness take place through a bias to process information through the right hemisphere and as a result of attention deficit. Reading and arithmetic achievement do not have a significant relationship with measures of delinquency.

Table 41. T-scores for Integrated Model.

<u>Parameter</u>	<u>T-score</u>
τ_{11}	-4.57 *
τ_{21}	2.07 *
τ_{31}	1.16
τ_{41}	1.96
τ_{51}	-0.12
τ_{61}	1.69
τ_{22}	2.72 *
τ_{32}	4.04 *
τ_{52}	0.27
τ_{62}	-2.20 *
β_{51}	0.96
β_{61}	2.07 *
β_{52}	-0.32
β_{62}	0.26
β_{53}	-0.64
β_{63}	1.72
β_{54}	-1.17
β_{64}	-0.24
β_{65}	3.66 *

Hypothesis 7

The Wechsler Variability Index was used as the dependent variable in a multiple regression equation with Total Aggressiveness, Most Aggressive Offense, and Offenses

per Year as the independent variables. This analysis was carried out first for the entire sample (n=177). The

Table 42. Correlations of Offense Variables and Wechsler Variability Index.

	Tot. Agg.	Most Agg.	WVI	Off./Yr.
Tot. Agg.	1.00			
Most Agg.	.45	1.00		
WVI	.05	.02	1.00	
Off./Yr.	.83	.13	.04	1.00

intercorrelations of the variables are presented in Table 42. The correlations of the Wechsler Variability Index with any of the measures of criminal offenses are poor, not

Table 43. Multiple Regression Analysis of Relationship of Criminal Offenses to Wechsler Variability Index.

Multiple R	.05278
R Square	.00279
Adjusted R Square	-.01451
Standard Error	12.22902

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	72.26322	24.08774
Residual	173	25871.97864	149.54901

F = .16107

Significance of F = .9224

Variables in the Equation

Variable	B	SE B	Beta	T	Sign. T
Off./Yr.	-.10764	1.03724	-.01627	-.104	.9175
Most Agg.	-.06514	.75853	-8.568E-03	-.088	.9298
Tot. Agg.	.08657	.21663	.06946	.400	.6899
(Constant)	32.94189	2.10258		15.667	.0000

exceeding .05. Table 43 presents the outcome of the multiple regression analysis. The multivariate F test is non-significant.

The results of this analysis provide little support for the hypothesis that there is any relationship between neuropsychological dysfunction, as estimated by the Wechsler Variability Index, and criminal offense variables.

In order to evaluate whether this relationship is likely to be seen more prominently in the more chronic or serious juvenile offender, the analysis was carried out with those individuals who had been sentenced to periods of incarceration. Incarceration is generally used only in response to a serious criminal offense or as a escalating attempt to assert control on individuals who are chronically delinquent. Thus, selecting this sub-sample should restrict the analysis to the more aggressive or chronically delinquent youths. The means, standard deviations, and correlation matrix for this sub-sample is presented in Table 44.

The means of the incarcerated delinquents for the criminal offense categories, in comparison to the non-incarcerated means, suggest that the incarcerated group is, in fact, more seriously delinquent. A t-test comparing the

means on each of the three offense variables is significant beyond the .01 level. There is, however, no significant

Table 44. Means and Correlations for Criminal Offense Variables and Wechsler Variability Index for Incarcerated (n=79) and Non-Incarcerated (n=98) Delinquents.

Variable	Non-Inc.	Non-Inc.	Incar.	Incar.	t	2-tailed prob.
	Mean	St.Dev.	Mean	St. Dev.		
Total Agg.	5.05	4.26	16.75	10.72	9.88	.000
Most Agg.	2.71	1.55	3.42	1.57	2.98	.003
Off./Yr.	.62	.66	2.57	2.22	8.27	.000
WVI	33.31	12.36	33.68	11.95	.20	.838

Correlation Matrix

	Tot. Agg.	Most Agg.	WVI	Off./Yr.
Tot. Agg.	1.00			
Most Agg.	.35	1.00		
WVI	.09	.12	1.00	
Off./Yr.	.80	.03	.11	1.00

difference between the two groups in terms of the amount of variability seen on the Wechsler tests.

The correlations of the Wechsler Variability Index with the criminal offense variables are greater than in the full sample, but the highest correlation still is only 0.12. The outcome of the multiple regression analysis is presented in Table 45. The analysis fails to find any significant relationship between the Wechsler Variability Index and the multivariate constellation of criminal

offense variables. To the extent that this index is indicative of neuropsychological dysfunction, the

Table 45. Multiple Regression Analysis of Relationship of Criminal Offenses to Wechsler Variability Index for Incarcerated Delinquents (n=79).

Multiple R		.17217			
R Square		.02964			
Adjusted R Square		-.00917			
Standard Error		12.00032			
Analysis of Variance					
	DF	Sum of Squares		Mean Square	
Regression	3	329.94516		109.98172	
Residual	75	10800.58167		144.00776	
F = .76372 Significance of F = .5179					
Variables in the Equation					
Variable	B	SE B	Beta	T	Sign. T
Off./Yr.	1.15691	1.14623	.21476	1.009	.3161
Most Agg.	1.21537	1.02975	.16013	1.180	.2416
Tot. Agg.	-.15548	.25304	-.13946	-.614	.5408
(Constant)	29.15908	3.57327		8.160	.0000

hypothesis that there is a relationship between neuropsychological dysfunction and aggressiveness and frequency of delinquency is not supported.

Hypothesis 8

The results of the canonical correlation analysis testing the relationship between the Tolerance and Paranoia scales and the delinquency variables are presented in Table 46. The multivariate test of the canonical variates

linking the two sets of variables are non-significant, indicating that the experimental hypothesis should be rejected. The measures of paranoia or intolerance are unrelated to either aggressiveness, frequency of delinquency, or seriousness of delinquency. It noted, however, that the correlation of the estimated MMPI Paranoia scale with the actual score on this scale, as presented in Table 6 is only 0.47, below the level of

Table 46. Results of Canonical Correlational Analysis of Tolerance and Paranoia Scales with Delinquency.

Multivariate Test Statistics

Wilk's Lambda = 0.971
F-Statistic = 0.839 DF = 6, 342 p = 0.541

Tests of Residual Roots

Roots 1 Through 2
Chi-square = 5.024 DF = 6 p = 0.54
Roots 2 Through 2
Chi-square = 0.313 DF = 2 p = 0.85

Univariate F Tests

<u>Variable</u>	<u>SS</u>	<u>DF</u>	<u>MS</u>	<u>F</u>	<u>P</u>
Tolerance	284.93	3	94.98	0.786	0.503
Error	20773.96	172	120.78		
Paranoia	54.84	3	18.28	0.583	0.627
Error	5389.14	172	31.33		
Most Agg.	8.99	2	4.50	1.772	0.173
Error	438.92	173	2.54		
Total Agg.	48.99	2	24.49	0.255	0.776
Error	16648.81	173	96.24		
Off./Yr.	2.19	2	1.09	0.320	0.726
Error	590.70	173	3.41		

statistical significance for the sample used. The variability of the scale in the current research sample was also much less than the other estimated MMPI scales. The standard deviation was only 5.58 compared to standard deviations which ranged from 7.35 to 13.38 for the other clinical scales. This lack of variability may reflect the fact that there are only 17 items which overlap the MMPI and the CPI on this scale, while the other clinical scales are based upon between 21 and 30 overlapping items (with the exception of the Hypochondriasis scale which has only 10). Thus, the failure to support the experimental hypothesis may stem from an inadequacy of the measures used to evaluate the concept of paranoia.

Hypothesis 9

The means of the Depression scale of the projected MMPI and the Well Being scale of the CPI for the groups upon which the MANOVA analysis was carried out are displayed in Table 47.

It may be seen that the mean of the group with the greatest positive PIQ-VIQ discrepancy scores highest on depression, while the group with the greatest negative PIQ-VIQ discrepancy scores highest on the Well Being scale.

Tests for homogeneity of variance across the groups are available in Table 48. Based upon these results, there

Table 47. Means of Depression and Well Being Scales for Performance IQ minus Verbal IQ Groups.

Depression

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	62.06	13.19
Verbal>Performance	68	62.85	10.99
Verbal<Performance	77	62.29	11.14
Verbal<<Performance	16	65.56	12.32
Entire Sample	177	62.78	11.32

Well Being

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	25.81	17.33
Verbal>Performance	68	22.68	14.92
Verbal<Performance	77	23.33	16.62
Verbal<<Performance	16	22.56	16.49
Entire Sample	177	23.23	15.93

is little reason to believe that variances are not homogeneous across the cells.

Table 48. Tests for Homogeneity of Variance for Depression and Well Being Scales Across MANOVA Groups.

<u>Variable</u>	<u>Bartlett-Box F(1,25491)</u>	<u>Probability</u>
Depression	.37854	.768
Well Being	.35414	.786

Box's M = 2.77706

F with (9, 16870) df = .29684 p = .976

Three single degree-of-freedom tests were carried out. The results are presented in Table 49. The first of these tested for the linear effect across the groups, the second

tested the quadratic effect, and the third contrasted the two extreme groups with each other.

None of the multivariate tests for the single degree-of-freedom tests were significant confirming the null hypothesis that there is no difference in measures of depression and generalized emotional distress between

Table 49. MANOVA Comparison of Depression and Well Being Scales (Single DF tests).

1. Linear Contrast Matrix

Multivariate Test of Significance (S=1, M=0, N=85)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.99615	.33244	2.00	172.00	.718

2. Quadratic Contrast Matrix

Multivariate Test of Significance (S=1, M=0, N=85)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.99608	.33809	2.00	172.00	.714

3. Extreme Group Comparison Contrast Matrix

Multivariate Test of Significance (S=1, M=0, N=85)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.99515	.41900	2.00	172.00	.658

groups with evidence of varying degrees of lateral asymmetry of cognitive function, as measured by the Wechsler scales.

The correlation coefficients of the Wechsler subtests with the Depression and Well Being scales are presented in Table 50.

A multiple regression analysis of the relationship between the Well Being scale and the Wechsler subtests produced a non-significant multivariate F suggesting that univariate relationships between the scale and subtests of the Wechsler scales should not be interpreted. The outcome of this multivariate test is presented in Table 51.

The multiple regression analysis of the Wechsler subtests on the Depression scale is presented in Table 52. The multivariate F is significant allowing for an analysis of the individual relationships of Wechsler subtests with the Depression scale. This is presented in Table 53.

Table 50. Correlations of Depression and Well Being Scales with Wechsler Subtests (n=177).

<u>Variable</u>	<u>Well Being</u>	<u>Depression</u>
Information	.19	-.01
Similarities	.20	.00
Arithmetic	.19	.09
Vocabulary	.20	.04
Comprehension	.15	.04
Digit Span	.07	.26
Pict. Comp.	-.01	.10
Pict. Arr.	.10	-.05
Block Design	.17	.09
Object Assembly	.11	.05
Coding	.07	.14
Well Being	1.00	-.34
Depression	-.34	1.00

Table 51. Multivariate Tests for Multiple Regression of Wechsler Subtests on Well Being (n=177).

Multiple R	.29184		
R Square	.08517		
Adj. R Square	.02418		
St. Error	15.73146		
Analysis of Variance			
	<u>DF</u>	<u>Sum of Squares</u>	<u>Mean Square</u>
Regression	11	3801.51002	345.59182
Residual	165	40833.99280	247.47874
F = 1.39645		Sign. of F = .179	

Table 52. Multivariate Tests for Multiple Regression of Wechsler Subtests on Depression (n=177).

Multiple R	.34526		
R Square	.11921		
Adj. R Square	.06049		
St. Error	10.97361		
Analysis of Variance			
	<u>DF</u>	<u>Sum of Squares</u>	<u>Mean Square</u>
Regression	11	2689.08890	244.46263
Residual	165	19869.31788	120.42011
F = 2.03008		Sign. of F = .029	

The relationships of the subtests to the Depression scale suggest that the primary relationship is that of Digit Span to Depression. That the correlation between these two variables is positive is somewhat surprising. Digit Span is often considered a measure of attention

(Bannatyne, 1974) or of working memory (Lezak, 1983). It might reasonably be expected that memory and attention

Table 53. Multiple Regression of Wechsler Subtests on Depression (n=177).

<u>Variable</u>	<u>B</u>	<u>SE B</u>	<u>Beta</u>	<u>T</u>	<u>Sign. T</u>
Coding	.41196	.33928	.09594	1.214	.2264
Pict. Compl.	.61628	.37607	.14108	1.639	.1032
Vocabulary	.21223	.49720	.04442	.427	.6700
Obj. Assembly	.05784	.31808	.01609	.182	.8559
Digit Span	1.28154	.36051	.29668	3.555	.0005
Pict. Arrang.	-.53519	.35028	-.12935	-1.528	.1285
Arithmetic	.10128	.34900	.02672	.290	.7720
Comprehension	.06372	.37719	.01696	.169	.8661
Block Design	.05572	.38722	.01400	.144	.8858
Information	-.54342	.42575	-.12691	-1.276	.2036
Similarities	-.44856	.37444	-.11968	-1.198	.2326
(Constant)	50.95758	5.46535		9.324	.0000

would be impaired by increasing levels of depression, whereas these results suggest that they are enhanced.

Hypothesis 10

The means of the Anxiety, F, and Psychasthenia scales for the respective lateral asymmetry groups are presented in Table 54. Contrary to expectations, the mean of the group with the greatest bias to Performance IQ has the highest mean score on each of the variables measured.

Estimates of homogeneity of variance indicate that it may be accepted that this assumption has not been violated by the data. The results of homogeneity of variance tests are presented in Table 55.

Table 54. Means of Anxiety, F, and Psychasthenia Scales for Performance IQ minus Verbal IQ Groups.

Anxiety

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	8.50	4.69
Verbal>Performance	68	8.93	3.20
Verbal<Performance	77	8.53	3.71
Verbal<<Performance	16	9.69	3.09
Entire Sample	177	8.79	3.56

F Scale

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	55.69	10.20
Verbal>Performance	68	56.72	8.72
Verbal<Performance	77	54.90	9.86
Verbal<<Performance	16	60.63	8.02
Entire Sample	177	56.19	9.37

Psychasthenia

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	59.25	14.32
Verbal>Performance	68	60.78	9.24
Verbal<Performance	77	59.88	11.91
Verbal<<Performance	16	63.25	11.28
Entire Sample	177	60.48	11.10

Table 55. Tests for Homogeneity of Variance for Anxiety, F, and Psychasthenia Scales Across MANOVA Groups.

<u>Variable</u>	<u>Bartlett-Box F(3,25491)</u>	<u>Probability</u>
Anxiety	1.64329	.177
F	.63630	.592
Psychasthenia	2.32675	.073

Box's M = 21.54052

F with (18,10095) df = 1.2731 p = .317

Single degree-of-freedom tests were carried out for a linear relationship across the groups, for a contrast of the groups with relatively higher Verbal IQ's with the groups with relatively higher Performance IQ's, for a

Table 56. MANOVA Comparison of Anxiety, F, and Psychasthenia Scales (Single DF tests).

1. Linear Contrast Matrix

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.99153	.48719	3.00	171.00	.692

2. P>>V and P>V Groups Compared to P<V and P<<V Groups

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.99534	.26684	3.00	171.00	.849

3. V>>P Group Compared to Remaining Groups Contrast Matrix

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.99657	.19590	3.00	171.00	.899

4. V<<P Group Compared to Remaining Groups Contrast Matrix

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.97845	1.25524	3.00	171.00	.291

contrast comparing the group with the most extreme bias to Verbal IQ with the means of the other three groups, and comparing the group with the most extreme bias to

Performance IQ with the means of the other three groups. The results of the multivariate tests of these hypotheses are presented in Table 56. None of the multivariate tests was significant, indicating acceptance of the Null hypothesis that there is no difference between groups which vary in their degree of lateral asymmetry of cognitive functioning, as measured by the Wechsler scales.

An analysis of the relationships of the Wechsler subtests to these measures of anxiety was carried out by means of a multiple regression analysis. The correlations of the Anxiety, F, and Psychasthenia scales with the Wechsler subtests is presented in Table 57.

Table 57. Correlations of Anxiety, F, and Psychasthenia Scales with Wechsler Subtests (n=177).

<u>Variable</u>	Anxiety	F	Pt
Information	-.11	-.17	-.19
Similarities	-.15	-.10	-.14
Arithmetic	-.11	-.11	-.16
Vocabulary	-.16	-.15	-.11
Comprehension	-.15	-.14	-.10
Digit Span	.01	.04	-.05
Pict. Comp.	-.02	.02	.02
Pict. Arr.	-.08	-.06	-.04
Block Design	-.10	-.10	-.08
Object Assembly	-.09	-.05	-.07
Coding	.02	-.02	-.05
Anxiety	1.00	.65	.64
F	.65	1.00	.59
Pt	.64	.59	1.00

The multivariate tests of the multiple regression of the Wechsler subtests on each of the scales were non-significant, indicating that it should be concluded that no significant relationships between the three measures of anxiety and the various measures of cognitive skills can be found in the data. The multivariate test results are presented in Tables 58 to 60.

Table 58. Multivariate Tests for Multiple Regression of Wechsler Subtests on Anxiety (n=177).

Multiple R	.23729		
R Square	.05630		
Adj. R Square	-.00661		
St. Error	3.56637		
Analysis of Variance			
	<u>DF</u>	<u>Sum of Squares</u>	<u>Mean Square</u>
Regression	11	125.21279	11.38298
Residual	165	2098.62901	12.71896
F = .89496		Sign. of F = .547	

Table 59. Multivariate Tests for Multiple Regression of Wechsler Subtests on F (n=177).

Multiple R	.25771		
R Square	.06641		
Adj. R Square	.00417		
St. Error	9.35423		
Analysis of Variance			
	<u>DF</u>	<u>Sum of Squares</u>	<u>Mean Square</u>
Regression	11	1027.07146	93.37013
Residual	165	14437.77599	87.50167
F = 1.06707		Sign. of F = .391	

Table 60. Multivariate Tests for Multiple Regression of Wechsler Subtests on Psychasthenia (n=177).

Multiple R	.24585		
R Square	.06044		
Adj. R Square	-.00220		
St. Error	11.10787		
Analysis of Variance			
	<u>DF</u>	<u>Sum of Squares</u>	<u>Mean Square</u>
Regression	11	1309.63244	119.05749
Residual	165	20358.50315	123.38487
F = .96493		Sign. of F = .481	

Hypothesis 11

The means of the groups are presented in Table 61. The means of the groups appear to conform to a quadratic pattern for the Hysteria and K scales of the projected MMPI, but a linear relationship is suggested for the Self Acceptance scale.

Estimates of homogeneity of variance are presented in Table 62. The results indicate that this assumption may be violated by the data. The results of the MANOVA analysis must be interpreted with caution.

The multivariate comparisons which were carried out were single degree-of-freedom tests of the linear and quadratic effects and a comparison of the extreme groups with each other. Each of these multivariate tests were

Table 61. Means of Hysteria, K, and Self Acceptance Scales for Performance IQ minus Verbal IQ Groups.

Hysteria

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	69.38	15.91
Verbal>Performance	68	67.77	12.45
Verbal<Performance	77	65.08	10.52
Verbal<<Performance	16	70.75	13.66
Entire Sample	177	67.01	12.16

K Scale

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	52.50	8.17
Verbal>Performance	68	49.07	6.40
Verbal<Performance	77	48.77	6.99
Verbal<<Performance	16	53.69	10.78
Entire Sample	177	49.67	7.41

Self Acceptance

<u>Group</u>	<u>N</u>	<u>Mean</u>	<u>St. Dev.</u>
Verbal>>Performance	16	53.19	12.23
Verbal>Performance	68	51.97	8.05
Verbal<Performance	77	48.94	10.67
Verbal<<Performance	16	43.63	9.22
Entire Sample	177	50.01	10.02

Table 62. Tests for Homogeneity of Variance for Hysteria, K, and Self Acceptance Scales Across MANOVA Groups.

<u>Variable</u>	<u>Bartlett-Box F(3,16720)</u>	<u>Probability</u>
Hysteria	1.97505	.116
K	2.90137	.034
Psychasthenia	2.48513	.059

Box's M = 31.11270

F with (18,10095) df = 1.62826 p = .045

significant. Table 63 provides the outcome of the test of the linear contrast matrix; Table 64 displays the results of the quadratic contrast matrix; and Table 65 presents the extreme group comparisons.

Table 63. MANOVA Comparison of Groups on the Hysteria, K, and Self Acceptance Scales (Linear Contrast).

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.93182	4.17071	3.00	171.00	.007

Univariate F-Tests with (1,174) DF

<u>Var.</u>	<u>Hypo. SS</u>	<u>Error SS</u>	<u>Hypo. MS</u>	<u>Error MS</u>	<u>F</u>	<u>Sig.</u>
Hy	.00757	25386.5178	.00757	146.74288	.00005	.994
K	8.10206	9197.86206	8.10206	53.16683	.15239	.697
SA	930.63370	16510.8040	930.63370	95.43817	9.75117	.002

Table 64. MANOVA Comparison of Groups on the Hysteria, K, and Self Acceptance Scales (Quadratic Contrast).

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.92612	4.54715	3.00	171.00	.004

Univariate F-Tests with (1,174) DF

<u>Var.</u>	<u>Hypo. SS</u>	<u>Error SS</u>	<u>Hypo. MS</u>	<u>Error MS</u>	<u>F</u>	<u>Sig.</u>
Hy	347.31768	25386.5178	347.31768	146.74288	2.36685	.126
K	456.37166	9197.86206	456.37166	53.16683	8.58377	.004
SA	109.72287	16510.8040	109.72287	95.43817	1.14967	.285

Table 65. MANOVA Comparison of Groups on the Hysteria, K, and Self Acceptance Scales (Extreme Group Contrast).

Multivariate Test of Significance (S=1, M=1/2, N=84 1/2)

<u>Test Name</u>	<u>Value</u>	<u>Approx. F</u>	<u>Hypoth. DF</u>	<u>Error DF</u>	<u>Sign.</u>
Wilks Lam.	.94471	3.33606	3.00	171.00	.021

Univariate F-Tests with (1,174) DF

<u>Var.</u>	<u>Hypo. SS</u>	<u>Error SS</u>	<u>Hypo. MS</u>	<u>Error MS</u>	<u>F</u>	<u>Sig.</u>
Hy	15.12500	25386.5178	15.12500	146.74288	.10307	.749
K	11.28125	9197.86206	11.28125	53.16683	.21219	.646
SA	731.53125	16510.8040	731.53125	95.43817	7.66498	.006

It can be seen that the significance of the linear effect and the extreme group comparison arises from the distribution of means for the Self Acceptance scale. The greater the bias in favor of verbal skills, the higher individuals tend to score on this scale. The group with the greatest achievement on tests of visuospatial skills scoring significantly lower than the group which does relatively better on verbal skills.

The quadratic effect is seen most significantly in the group means for the K scale. The Hysteria scale means conform to a quadratic pattern, but it does not reach statistical significance. The results of the K scale

suggest that the experimental hypothesis that those who have large discrepancy in favor of either verbal or visuospatial functioning will be more defensive and rely more heavily on denial and repression as a means of managing uncomfortable emotional states should be accepted. This might be more appropriately stated as suggesting that individuals who rely more heavily upon one mode of information processing, either verbal or visuospatial, to the exclusion of the other, may have more trouble integrating strong emotional states. Those with a visuospatial bias may not have the verbal skills at hand to process their emotional states and integrate them into their self concept and social relationships. The linear effect on the Self Acceptance scale could be interpreted to support the notion that the reduced efficiency of verbal processes in these subjects may leave them feeling more vulnerable and ill-at-ease in their social environment. Those who rely more heavily on verbal processes, on the other hand, may exercise excessive cognitive control over their emotional states, not allowing them to be integrated as a normal part of their experience. Their positive image of themselves may represent an unrealistically positive self-appraisal, just as conditions such as anosognosia and anosodiaphoria, which sometimes accompany right-hemisphere organic impairments, are associated with a general

indifference to impairments or the consequences of impairments (Heilman et al, 1985).

DISCUSSION

In summary, this study has used structured equation modelling to test models which related general intelligence; verbal, visuospatial, and attentional skills; and a bias for processing information using right hemisphere, rather than verbal, mechanisms to measures of delinquency. Personality variables of social conformity and social confidence served as mediating variables.

The verbal model was most parsimonious. Verbal skills were significantly associated with greater social conformity and social confidence. Social confidence was associated with more serious patterns of delinquency. Direct relationships between general intelligence, verbal, visuospatial, and attentional skills and measures of delinquency were all non-significant. A hypothesized right-hemisphere processing bias was shown to have a non-linear relationship with seriousness of delinquency and aggressiveness, with the group with a modest bias in favor of Performance IQ showing the most serious patterns of delinquency and greatest aggressiveness.

A model which attributed both delinquency and academic performance to cognitive deficits was slightly better than

one which attributed delinquency to academic performance. Performance in reading and arithmetic was not significantly associated with measures of delinquency. Within these models, a right-hemisphere processing bias and reduced attentional skills were associated with greater aggressiveness.

No relationship between neuropsychological dysfunction, as measured by an index of variability on the Wechsler scales, and a multivariate constellation of criminal offense variables was found. A hypothesized relationship between paranoia and aggressiveness was not supported. No difference in measures of depression, generalized emotional distress, or anxiety was found between groups with varying degrees of lateral asymmetry of performance on the Wechsler scales. A linear relationship was found between lateral asymmetry groups and a measure of self-acceptance, with individuals with a strong verbal bias having the highest scores and those with a strong non-verbal bias having the lowest scores. This corresponds with what might be expected from indifference and catastrophic (Hecaen, 1962), respectively. Groups with extreme verbal or performance biases scored highest on a measure of defensiveness, suggesting that they rely more on denial as a defense.

In spite of the many reports in the literature of cognitive deficits among delinquents, the results of this study do not support the argument that such deficits are important factors contributing directly to the seriousness of delinquency or the level of aggressiveness, as measured by actual criminal offense records within a delinquent population. Although some interesting relationships emerge, the cognitive and personality variables under study accounted for only a small part of the variance in criminal offenses. Unfortunately, EzPath (Steiger, 1989) does not allow for an estimation of the actual proportion of variance of the final endogenous concepts that is accounted for by other concepts in the models. It is apparent from the size of the structural disturbance coefficients relative to the size of the modelled causal paths, however, that a very large amount of the variance is not accounted for by the cognitive and personality variables.

Studies which have proposed that cognitive deficits are an important determinant of delinquency have usually compared delinquents to non-delinquent control groups. To show that these groups differ on cognitive variables is not the same as to establish that the cognitive deficits play a role in causing delinquency. The comparison of groups chosen for some particular feature is likely to find

differences that may have no direct relationship to the characteristic under study (Spreen, 1981).

This study has attempted to examine the contribution of various aspects of cognitive functioning to the seriousness of delinquency and the level of aggressiveness as this is reflected in official records of criminal behavior. The use of structured equation modelling in the data analysis allows for multiple indicators to be employed in defining the underlying constructs being studied and for models to be constructed and tested which imply causative relationships among the variables. The models were designed according to existing neuropsychological theories and concepts about delinquency.

In spite of the abundance of reports in the literature that delinquents tend to have lower intelligence, little evidence is found to support the argument that level of intelligence has any direct bearing on the seriousness of delinquency or level of aggressiveness. The mean IQ of the sample was the same as the published norms for the tests (Wechsler, 1974, 1981) and the first principal component of the subtests of the Wechsler scales showed no significant direct causal relationship with measures of delinquency and aggressiveness.

Two indirect routes were available by which general intelligence might contribute to delinquency. The first of these proposed that level of intelligence is important in determining the degree to which youngsters learn appropriate social values and conform to expectations of them. This positive value orientation and tendency to social conformity would be expected to play an important part in determining the occurrence of delinquency, as Luria (1961) has suggested. The second indirect route is by way of the latent personality construct called Social Confidence. The role of social confidence in relation to delinquency could be thought of as a protective factor against delinquency by assuring that social needs are met, but it could also be argued that this construct is an extraversion factor. Eysenck (1964) has suggested that extraversion is an important determinant of criminal behavior.

The first of these indirect routes approached significance in the models. General intelligence contributed to the adoption of pro-social values and social conformity to a significant manner, but it could not be demonstrated that social conformity was significantly related to seriousness of delinquency or aggressiveness. In the former case, the relationship approached, but did not reach, significance.

The second indirect route was significant, but not in a direction which could be considered to support the view that higher intelligence acts as a protective factor in preventing criminal activity, as is suggested by Kandel et al. (1988) and White et al. (1989). Level of intelligence was found to contribute to social confidence, but social confidence was positively associated with the seriousness of delinquency, as was suggested by Eysenck (1964). The relationship between social confidence and aggressiveness was not significant.

In examining the components of intelligence, it was apparent that attributing the important effects to verbal skills alone provided the most parsimonious model. Verbal skills appear not to have a direct effect upon the seriousness of delinquency or the level of aggressiveness, but the indirect routes noted for the general intelligence model were supported. T-score values for the parameters linking verbal skills to the values and conformity and social confidence personality constructs exceeded those linking general intelligence with the same constructs. The implication is that the verbal skills are the primary cognitive component determining personality constructs which play a role in delinquency. As with the general intelligence model, verbal skills appear to pose both a protective and risk factor. Where they contribute to the

adoption of pro-social values and social conformity, they may mitigate against serious delinquency. This has not been established since this parameter approaches, but does not reach, significance.

The risk factor associated with verbal skills lies in their contribution to social confidence. The more verbally adept individual is likely to have enhanced social confidence and this is likely to contribute to more serious delinquency.

The apparent contradiction whereby verbal skills can both place an individual at risk and protect him from involvement in delinquency requires further information to be able to resolve. It may be that some other personality variable, such as anger and rebelliousness, or a sociological variable, such as peer group influence, may be critical in determining which path is most important for any individual.

The part that attentional skills play in delinquency also has some importance. In the learning disability model, attention deficit is significantly linked with level of aggressiveness. This supports previous research findings that link aggressiveness and neurological dysfunction (Pincus et al., 1979; Elliott, 1982; Bach-y-Rita et al., 1971; Lewis et al., 1979, 1987, 1989;

Spellacy, 1977, 1978; Krynicki, 1978; Brickman et al., 1984), although attempts to evaluate this relationship using an index of variability on the Wechsler scales as an estimate of neuropsychological dysfunction failed to confirm such a relationship. There is little evidence, however, for a direct link between attention deficit and seriousness of delinquency. The indirect paths from attention deficit to seriousness of delinquency and aggressiveness through personality variables are not supported in the same manner as they are for the verbal model. Although significant parameter values linking attention and the two personality constructs are observed in the attention model, the parameters linking the personality constructs and seriousness of delinquency approach, but do not reach, significance. Furthermore, when both verbal and attentional skills are included in the same model, the relationship of attentional skills to personality constructs becomes negative. The parameter linking attention and social confidence was non-significant, while the parameter linking attention and values and conformity was significant.

Visuospatial skills do not appear to play a noteworthy role in delinquency. They do not bear any substantial effect on seriousness of delinquency or aggressiveness, and what effect they have appears to be in the direction of

enhancing delinquency and aggressiveness. The hypothesized association of visuospatial skills with social confidence holds up only if one does not take into account the role of verbal or attentional skills.

The data analysis supports the contention that academic achievement has little to do with the seriousness of delinquency or aggressiveness. No direct measure of frustration about school failure was included in the analysis, but it might be presumed that greater impairment of academic performance is likely to lead to greater frustration. A model which attributes delinquency to cognitive deficits and processing bias and views academic performance as another manifestation of cognitive impairment more adequately accounts for the relationships in the data than one which attributes delinquency to school failure.

Of primary interest are the results that relate to the proposed theory of a right hemisphere processing bias. It was difficult to adequately evaluate this theory, but the results obtained tend to support it. The expected non-linearity of the relationship confounds the analysis, but it was shown that the group which is expected to display this bias does engage in the most serious patterns of delinquency and the most aggressive behavior. Furthermore, a significant direct link between processing bias and

aggressiveness is demonstrated in the learning disability models. These models are especially important in evaluating this hypothesis because they also include the verbal skills concept. The inclusion of this concept removes the likelihood that the proposed processing bias variable is merely a aberration of verbal skill deficits. The link between the processing bias variable and delinquency is positive and substantial, even though it does not reach significant levels. In view of the non-linearity of the relationship, it merits further investigation.

A right hemisphere processing bias may be an important cognitive feature in determining delinquency. It has been hypothesized that this bias is the result of learning, although a pattern of neuronal organization which favors right hemisphere processes (Geschwind and Galaburda, 1985) might be an important pre-condition for it to occur. This would suggest that it would be more likely to occur in males than females. The descriptive data for the sample indicates that delinquent males differ more dramatically from the normative samples for the tests used than do delinquent females.

The evaluation of the relationship between lateral asymmetry, as reflected in relative values of Wechsler Verbal and Performance IQ, and features of emotional

functioning failed to confirm any significant relationship between lateral asymmetry of cognitive performance and measures of either anxiety or depression. The significant relationship of the Digit Span subtest with the Depression scale of the projected MMPI hints that a pattern of left hemisphere arousal might accompany depressive states, but the evidence is too weak to make any definitive statements. The fact that this is not a sample where clinical patterns of depression and anxiety would be expected to commonly occur may account for the failure to confirm these relationships.

The outcome of lateral asymmetry groups on tests measuring self acceptance and defensiveness provides support for the proposal of Galin (1974) that repression and denial might be associated with patterns of lateral asymmetry and for research on alexithymia (Buchanan et al., 1980; Hoppe, 1977; Hoppe and Bogen, 1977; TenHouten et al., 1986; Zeitlin et al., 1989) which suggests that a strong laterality bias in favor of either verbal or nonverbal cognitive processes might be associated with poor awareness of feelings due to interhemispheric transfer deficits.

The experimental hypothesis that those who have large discrepancy in favor of either verbal or visuospatial functioning will be more defensive and rely more heavily on denial and repression as a means of managing uncomfortable

emotional states is supported. Individuals who rely more heavily upon one mode of information processing, either verbal or visuospatial, to the exclusion of the other, may have more trouble integrating strong emotional states. Those with a visuospatial bias may not have the verbal skills at hand to process their emotional states and integrate them into their self concept and social relationships, while those with a verbal bias may have trouble identifying emotional states or allowing their expression when they may conflict with an overly rigid self concept. A pronounced bias in favor of visuospatial skills may be accompanied by an inability to use verbal skills to mediate interpersonal relationships, which contributes to reduced self-acceptance. Those who rely more heavily on verbal processes, on the other hand, may exercise excessive cognitive control over their emotional states, not allowing them to be integrated as a normal part of their experience. Their positive image of themselves may represent an unrealistically positive self-appraisal, just as conditions such as anosognosia and anosodiaphoria, which sometimes accompany right-hemisphere organic impairments, are associated with a general indifference to impairments or the consequences of impairments (Heilman et al, 1985).

The conclusions of this research must be viewed in the context of several methodological problems. The first of

these is the question of whether this is truly a representative sample of delinquents. The sample was drawn from youths referred to the clinic for assessment and/or treatment. It is conceivable that there may be a bias in the types of individuals referred. For example, probation officers or court officials may not refer the most incorrigible offenders because of a perception that the correctional system is better suited to their needs. One reassurance against such a sampling bias is that some of the subjects were evaluated in conjunction with consultation services to a closed custody correctional unit which housed some of the most difficult offenders. It is also possible that the sample may have been biased by the fact that subjects were, to some degree, selected on the basis of the psychological tests that had been administered to them. This is not the case for all subjects since this particular collection of tests was used as a routine battery by some of the psychologists involved in assessing the delinquents.

A second methodological consideration is the extent to which criminal records are an accurate indication of antisocial behavior. Little can be done to prevent biases from affecting this information. For example, intelligence may play a role in determining the likelihood that a youth may be apprehended for criminal activity. Furthermore, for

crimes such as sexual assault, only one charge is usually laid even though there may be multiple offenses against a victim. One of the goals of this research was to examine behavioral controls from the perspective of neuropsychological systems. Using criminal records for this purpose is a crude instrument. In this light any significant results should be viewed with some confidence.

A third methodological problem lies in the measures used to evaluate various aspects of emotional adjustment, particularly the projected MMPI scores. As Cripe (1990) pointed out, even the full MMPI is a questionable instrument by which to evaluate features of emotional adjustment. When it is applied to the task of investigating neuropsychological relationships confounding factors may influence the results. It has already been established that groups with extreme lateral asymmetry biases tend to rely upon denial and repression more extensively than groups with less extreme lateral asymmetry biases. It could be expected, therefore, that they will under-report symptomatology. The negative findings with respect to anxiety and depression with respect to lateral asymmetry groups should not be regarded as a very rigorous test of the theories involved.

A fourth methodological problem has been separating and measuring the hypothesized processing bias from the

verbal and visuospatial skills which form the parameters from which it is created. The measure of laterality used in this study is limited. A thorough neuropsychological battery would be desirable in evaluating the relative efficiency of performance in each of these skills. To effectively measure this bias and to establish its validity as a clinical entity some other measure or measures should be used in conjunction with tests of verbal and visuospatial skills. For example, it has been observed clinically that the amount and nature of verbal and non-verbal communication on a task like the Picture Completion subtest of the Wechsler scales may provide clues about the presence of this bias. Any task which gives the subject the option of responding verbally or engaging in non-verbal problem-solving behavior may reveal left- or right-hemisphere biases.

A final methodological problem relates to the assumption of causality in structured equation modelling. In the models examined it has been assumed that cognitive variables contribute to personality characteristics, academic performance, seriousness of delinquency, and aggressiveness. These models are useful only insofar as they have not been mis-specified. The most likely way in which that might occur would be in the assumption that

cognitive variables lead to certain features of personality.

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