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HANDEDNESS SUBTYPES, COGNITIVE, ACHIEVEMENT AND
PSYCHOPATHOLOGICAL MEASURES IN LEARNING DISABLED CHILDREN AND
ADOLESCENTS

City University of New York

PH.D.

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**HANDEDNESS SUBTYPES, COGNITIVE, ACHIEVEMENT
AND PSYCHOPATHOLOGICAL MEASURES
IN LEARNING DISABLED CHILDREN AND ADOLESCENTS**

by

BRENDA BEMPORAD

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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Abstract**HANDEDNESS SUBTYPES, COGNITIVE, ACHIEVEMENT
AND PSYCHOPATHOLOGICAL MEASURES
IN LEARNING DISABLED CHILDREN AND ADOLESCENTS**

by

BRENDA BEMPORAD**Advisor: Professor Louis J. Gerstman**

Achievement, cognitive and psychopathological measures were assessed in learning disabled children and adolescents with reference to age, sex, personal and familial handedness.

Age predicted the most variance and was negatively correlated with scale scored oral and silent reading, spelling, phonetic skills, math measures and Wechsler verbal factor scores. These findings suggest that learning disabilities have a cumulative negative effect. Younger students reported more symptomatology on self-rated measures of depression and self-esteem.

Females received higher scores than males on oral reading and spelling tests. Familial sinistrality (FS) did not differentiate performance on achievement measures.

Pure right or left handed were defined as those using their preferred hand to write, hammer, brush teeth and throw. Right or left mixed handed wrote with their right or left hand, but used their nonwriting hand for one or more of the other tasks. Collapsing the mixed handed into one group obscured differences on achievement, cognitive and psychopathological measures. The pure right handed and left mixed handed were the least impaired on achievement measures, and the right

over-representation of the right mixed (10.3%) and pure left handed (10.9%) in this sample, compared to the general population, in combination with their low performance within the sample, suggests that these groups may be at greater risk for academic failure and may be suspect of cerebral pathology.

There were few main effects for personal handedness on cognitive measures. Males were superior to females on most cognitive measures. FS+ received higher scores on some verbal measures than FS- subjects.

The left mixed handed subjects and females rated themselves higher on self-rated measures of dysphoria. FS+ subjects were rated as more hyperactive/attentionally disordered by their parents than FS- subjects across sex. Subjects whose verbal factor scores were lower than their spatial factor scores were more hyperactive/attentionally disordered across sex.

The least academically impaired were the FS+ left mixed handed males and FS-, the right handed, and females; the most impaired were the right mixed and FS+ left handed. The pattern of the cognitive scores suggested that the effect of FS+ is to enhance the cognitive skills of the right handed and the left mixed handed, but to depress the skills of the pure left handed. FS+ females reported more depressive symptomatology.

The results of achievement testing were discussed in terms of the influence of cognitive skills, psychopathology, and cerebral functional distance model. The influence of age, cognitive and achievement performance and functional cerebral distance model on measures of psychopathology were also discussed.

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Thank you very much.

INTRODUCTION AND LITERATURE REVIEW

This study examines relationships between subtypes of handedness, and some measures of academic achievement, cognitive abilities and psychopathology.

Although there has long been suspicion that left handed people are at risk for dyslexia, reviews have not found a consistent relationship (Beaumont, 1974; Hardyck and Petrinovich, 1977; Porac and Coren, 1981). However, in most of these studies dyslexia and left handedness are considered to be unitary traits. There may be at least two subtypes of dyslexia, and subgrouping subjects into categories based on strength of hand preference, sex, and the presence or absence of a family history of sinistrality may modify the effect of personal handedness on measures of cerebral laterality, cognitive skills and academic achievement. In the light of the present differentiation of both dyslexia and handedness into subtypes, the previously suspected relationship between them could profitably be reexamined. In addition, there are reports of an increased incidence of psychopathology in the learning disabled, and an over-representation of sinistrality in psychopathological groups. Perhaps similar subgrouping of the learning disabled would reveal differential risk patterns for psychopathology and/or cognitive ability patterns associated with psychopathology.

The incidence of sinistrality in the general population varies with the criteria used, but 10% is the most commonly used estimate (Hardyck and Petrinovich, 1977). The distribution of handedness, as assessed in college

students, conforms to a J-shaped curve, with the right and higher side of the curve representing the strongly right handed subjects and the smaller left side of the curve representing the strongly left handed. The slope, which is attenuated between the poles, represents the mixed handed population (Briggs and Nebes, 1975). Mixed handed in this study refers to the use of the right and left hand for different unimanual tasks, e.g., someone who writes with the left hand, but hammers with the right.

Theories of the origin of handedness

Both genetic and environmental theories of the origin of handedness have been extensively reviewed by Hardyck and Petrinovich (1977) and Hicks and Kinsbourne (1976, 1978) and will be discussed briefly here.

Environmental theories suggest that: 1. Children are taught, albeit unwittingly, by their parents and culture (Collins, 1975). 2. Left handedness is solely the result of negativism and implies psychopathology (Blau, 1946). 3. Soldiers who happened to hold their weapons in their right hands and thereby shielded their hearts with their left, had a better chance of survival; somehow this tendency became perpetuated (Woodruff, 1909). 4. Perinatal brain injury can produce manifest sinistrality or "pathological lefthandedness". This will be discussed in greater detail below.

The two major genetic theories are those of Annett (1972, 1978) and Levy-Nagylaki (1972). Annett proposed that the incidence of handedness is distributed binomially and handedness can be accounted for by a dominant "right shift" factor which is phenotypically expressed as right

handedness. If no right shift factor is inherited, environmental and/or random influences may predominate. Levy-Nagylaki (1972) suggested a two-gene, four allele genetic model. One gene would control in which hemisphere language was represented, the other, whether handedness is ipsi- or contralateral to the hemisphere dominant for speech.

There is considerable evidence for a genetic influence on the expression of handedness. Family studies show a positive correlation between the handedness of parent and children (Annett, 1973, 1974; Hicks and Kinsbourne, 1982); hand preferences of students correlate significantly with their biological parents but not with their step-parents (Hicks and Kinsbourne, 1974), nor with their adoptive parents (Carter-Saltzman, 1980); infants of right handed parentage show right sided asymmetries, i.e., hold a rattle longer in their right hand, (Caplan and Kinsbourne, 1976) and turn spontaneously more to their right than to their left while babies of mixed or left handed parents turn with equal frequencies in either direction (Liederman and Kinsbourne, 1980); family history of sinistrality predicts severity and recovery rates in aphasia in both left and right handed patients (Luria, 1970; Hecaen and Sauget, 1971).

Origins of left handedness

Bakan (1971, 1973) proposed that all left handedness is the result of cerebral anoxia or injury during pregnancy or delivery and that a family history of left handedness is mediated by a genetic predisposition to an abnormality, e.g., pelvic irregularities, that increase the possibility of birth trauma. Contradictory evidence has been reported (Bakan, Dibb

and Reed, 1973). Satz (1972, 1973) suggested that there are two types of left handedness: a natural left handedness which is assumed to be due to genetic or possible environmental influences, and pathological left handedness. The latter is thought to be due to early brain injury in genotypical dextrals severe enough to cause a shift in handedness and produce manifest, phenotypic left handedness. The total population of the pathological handed will be 90% left handed, as perinatal cerebral damage is presumed random in its effects and there is more possibility for the genetically right handed (being 90% of the total population) to have handedness shifted.

Literature Review

Few studies differentiate between people who use the left hand for all unimanual tasks and those who commonly use the right hand for some and the left for others. I shall refer to mixed handedness, ambidexterity or left handedness collectively as non-right handedness. I shall review first, non-right handedness in relationship to cognitive and subject variables, then dyslexia, in relationship to attempts to subtype. Psychopathology associated hemisphere asymmetries in emotional processing, and with sinistrality and learning disabilities will then be reviewed .

Sinistrality as a risk factor

Sinistrality has been considered a risk factor or marker for cognitive and emotional dysfunctions because:

1. There is considerable evidence that a large minority of the non-right

handed have unusual cerebral organization. Whereas almost all right and most non-right handers have language functions in the left hemisphere, many non-right handers have some language functions represented in both hemispheres and some have language functions primarily in the right hemisphere (Goodglass and Quadfasel, 1954); Hecaen and Piercy, 1956; Milner, Branch and Rasmussen, 1966; Luria, 1970; Hecaen and Sauget, 1971; Hecaen, de Agnostini, and Monzon-Montes, 1981). Left handed subjects in the general population show less hemispheric asymmetry when presented with competing visual or auditory stimuli than the right handed (Zurif and Bryden, 1969; Hardyck and Petrinovich, 1977). There is also some evidence that spatial functions are bilaterally organized in some non-right handed (Hecaen, de Agnostini and Monzon-Montes, 1981).

There is no obvious reason to assume that deviant cerebral organization should result in inferior intellectual performance, and certainly the vast majority of left handers function as well as do right handers (Hardyck, Petrinovich and Goldman, 1976). However, Orton (1937) suspected that aberrant cerebral organization and/or dominance is associated with reading disorders. He had observed that retarded readers often reversed letters or read the mirror image of words. He had also noted that many dyslexic children were left handed and/or had "mixed dominance", i.e., they preferred to use their right hand and eye, but their left foot, or they showed no consistent handedness. He assumed that these behavioral manifestations index a failure to establish fully lateralized cerebral organization, and proposed that when stimuli are perceived, they are represented in both hemispheres in mirror image relationship. Orton concluded that reading errors result if the dominant hemisphere

inadequately suppresses the nondominant image.

Other observers have speculated on the association of incomplete or abnormal cerebral relationships and reading dysfunctions (Zangwill, 1960; Critchley, 1970; Satz and Sparrow, 1973; Kinsbourne, 1975; Corballis and Beale, 1976). Bilateralization of verbal (Levy, 1969) and spatial (Witelson, 1976) functions has been hypothesized to compromise the effectiveness of one or both. These theorists use static models, viewing territories of brain as dedicated to specific functions. If a territory is committed to two functions, it allegedly subserves one or both inefficiently. However, even the more dynamic functional cerebral distance model (Kinsbourne and Hicks, 1980) suggests that some cerebral organizations may be more effective for some tasks than others, as interference between functions is a possibility. This theory predicts that the more bilaterally organized left handed may be less efficient than the right handed when performing a sequential and spatial task at the same time. It is hypothesized that these processes may compete for the same neural space when cerebral organization is not highly lateralized. The prediction has received some empirical support (Berry, Hughes and Jackson, 1980).

2. A family history of sinistrality in both the right and non-right handed may be a determinant of cerebral organization (Hardyck, 1976; Hecaen, et al., 1981) and the profile of cognitive skills. This evidence will be reviewed in detail below.

3. A cerebral insult sufficient to cause a shift in handedness may

also cause disturbed language functioning, i.e., the left handedness caused by pathology may be expected to be associated with language dysfunction.

It follows that family studies of the pathological left handed would reveal no higher incidence of familial sinistrality than is found in children of the right handed. In obviously brain damaged populations an excess of left handedness was found among those patients who gave evidence of left focal cerebral damage, but only when it was of early onset (Yanowitz, Willmore and Rice, 1982). In the absence of such specific evidence, but in a population in which left handedness is rife, indirect evidence would derive from the absence of significant correlation between the hand preference of the child and his parents. Bradshaw-McAnulty, Hicks and Kinsbourne (1984) found this to be the case in a sample of patients with major mental retardation (IQ less than 50). However, as a group, both the lower functioning patients and their parents exhibited relatively more non-right handedness. We can conclude that families with relatively high incidence of sinistrality are vulnerable to brain disorders, including pathological left handedness and language disorders.

A similar study with dyslexia is possible but has not been done. In the general population this methodology cannot be applied, and it is there that the lack of direct evidence for the pathological nature of left handedness in individuals is most handicapping. Satz's (1981) suggestion that a short right foot is a marker for left brain pathology may point to a solution to this problem. Efforts have been made to relate left handedness in the general population to perinatal stress. The

results have been negative (McManus, 1981; Spiegler and Yeni-Komshian, 1982). But contrary to assertions by these investigators, such findings do not disprove the presence of pathological left handedness in significant numbers of the populations. They merely fail to validate certain possible causes of this hypothesized situation. Brain maldevelopment often occurs in the absence of detectable pregnancy or birth stress; and pathological left handedness may be an instance. Left brain development may be compromised, some with delayed verbal/cognitive development as a serious consequence and failure to establish genetically preprogrammed right handedness as a trivial consequence, as suggested by Geschwind and Behan (1982). This "pathological left handedness" in the phenotype is thought by some to account for the following observation.

4. There are many reports of an increased incidence of sinistrality in a variety of pathological conditions: mental retardation (Hicks and Barton, 1975; Bradshaw-McAnulty et al., 1984), epilepsy (Bolin, 1953), stammering, cerebral palsy, developmental aphasia, dysarthria, reading delay and articulatory apraxia (Morley, 1965), reading disability (Vernon, 1957; Zangwill, 1962; Zurif and Carson, 1970; Geschwind and Behan, 1982), diseases of the immune system (Geschwind and Behan, 1982) (See Hicks and Kinsbourne, 1978, for a review).

5. However, relative cognitive deficits have been associated with non-right handedness even in populations in which little if any pathology would be expected, e.g., undergraduate and graduate college students and faculty (Levy, 1969, 1972; Miller, 1971; Nebes, 1971; Gibson, 1973; Briggs, Nebes and Kinsbourne, 1976; Kocel, 1977; Johnson and Harley,

1980). These and other studies reviewed below, suggest that some non-right handed may differ from the right handed on some cognitive and achievement measures.

In summary, sinistrality has been considered a risk factor for cognitive deficits because:

1. Many sinistrals may have aberrant cerebral organization which may be associated with relative cognitive deficits and/or reading disability.
2. There is evidence that a family history of sinistrality may be associated with both atypical cerebral organization and altered cognitive skills.
3. A subset of the non-right handed (pathological left handed) may result from brain damage which may also cause cognitive dysfunction.
4. An increased incidence of non-right handedness has been reported in a wide variety of neuropathological populations.
5. Relative weaknesses in specific cognitive areas have been associated with left handedness in apparently nonpathological populations.

Evidence of deficits in non-right handedness

Levy (1969, 1974) assessed male science graduate students at California Institute of Technology and found sinistrals to have a group mean WAIS Verbal IQ comparable to that of dextrals (mean of 142 for the left handers and 138 for right handers) but a significantly inferior mean WAIS Performance IQ (left handers mean 117 vs. right handers 130). There was a 25 point discrepancy between the mean Verbal IQ score and the mean

Performance IQ score for the sinistrals. Also significant was the difference between the 25 point sinistral discrepancy score and the 8 point dextral discrepancy score, although the right handers and left handers verbal IQ scores were not significantly different. Verbal and perceptual factor scores were significantly different; the sinistrals had a relatively elevated verbal factor and depressed perceptual factor (Levy, 1974). Miller (1971) reported that left handed university students have similar verbal but lower performance scores than the right handed on tests other than the WAIS. Bradshaw, Nettleton, and Taylor (1976) also reported sinistrals to have a significantly lowered WAIS performance IQ. Nebes (1971) found left handed university students to be inferior on a perceptual task compared to right handed students. Left handed college students performed less well than the right handed on the Rod and Frame Test and a line orientation task (Silverman, Adevai, and McGough, 1966). James, Mefferd, and Weiland (1967) found adult male sinistrals to score lower on tests of spatial perception than dextrals.

In contrast to these findings, and based on a larger sample, Briggs et al. (1976) found no selective differences on either WAIS Verbal IQ or Performance IQ but a slightly though significantly lowered Full Scale IQ for sinistrals. Healey (1980) found no main effect for personal handedness on either a verbal or spatial-orientation factor with university students. Newcombe and Ratcliffe (1973) found no differences in intellectual skills between right and left handed. Reviewing 34 studies of cognitive functions in the left handed, Hardyck et al. (1976) concluded that there were no significant differences in performance on cognitive tasks between right and left handed subjects despite the fact that the left handed were

found deficient on most of the studies of spatial skills.

Critique of methodology

Several methodological issues complicate the interpretation of the above mentioned studies of non-right handed for cognitive deficits. Obviously a negative study does not prove the null hypothesis. Negative data does need explanation, however. It is possible that there is an increased incidence of selective cognitive deficits in a subset of the non-right handed and that the proportion of this subset fluctuates from sample to sample, influencing the statistical outcomes in some studies and not in others.

Some studies defined left handedness in so restricted a fashion that one or more subtypes of non-right handers might have been excluded. To be identified as left handed by Newcombe and Ratcliffe (1973) one had to perform seven out of seven tasks routinely with the left hand. Only 26 of 823 people, about 3%, met this narrow definition. With such small sample size, statistical significance is relatively hard to achieve. Hardyck et al. (1976) found no significant differences in the scores of over 7600 right and left handed school children on intelligence and performance measures. They claimed that the children were so consistent on the three acts that they used to test handedness "as to eliminate the necessity for any mixed handedness group." (See also McManus, 1980.) However, most studies find that mixed handedness is quite common among the non-right handed, and it need not take more than three tasks to identify this group (Hicks and Kinsbourne, 1978; Swanson, Kinsbourne and

Horn, 1980).

Some studies may include samples of subjects that are attenuated by selection procedures, e.g., college students and academics who would be expected to be of above average intellectual abilities, so that subgroups of non-right handers with deficits may have been eliminated or greatly depleted (Gibson, 1973; Briggs et al., 1976).

In addition, the attribution "spatial" has been applied to a large number of tasks without evidence that they tap a unitary factor. Therefore, some of the non-right handed may be deficient on some tasks but not on others. Typically researchers pick a test which seems to them to require some spatial processing and assume that the performance on that task predicts to other "spatial" tasks. However, Johnson and Harley (1980) found that while a subgroup of left handers were significantly deficient on one spatial test, they performed comparably to right handers on two others.

Recent evidence, reviewed below, suggests that a variety of factors may influence the performance of both the left and right handed on some verbal and spatial tasks. The major factors that have been studied in connection with personal handedness and cognitive or laterality measures are strength of handedness, sex and family history of sinistrality (FS). None of the studies of cognitive deficits and sinistrality in the reviews cited above categorized left handers according to these variables to determine if a subtype or subtypes of the non-right handed account for the suspected deficits.

Handedness, sex, FS and cerebral organization

The study of the relationship of peripheral laterality and cerebral laterality to reading disorders was initiated by Orton's speculations. The relationship between handedness and cerebral organization is not uniform. As mentioned above, clinical evidence and experimental studies with normals suggest that speech and other language processes are left lateralized in the vast majority of the right handed, while the relationships among the non-right handed are far more complex and less predictable. Other subject variables, especially sex and family history of sinistrality, may modify outcomes on measures of cerebral organization. The influence of both these variables is controversial. When sex differences are found on laterality measures the usual conclusion has been that females are less asymmetrical or less lateralized. This may represent differences in cerebral organization, developmental and/or strategy differences between the sexes (Bryden, 1979; de Renzi, 1982; Sherman, 1978). Although, Kimura and Harshman (1984) presents evidence that females may be more focally organized for speech, but not other verbal functions.

The influence of a family history of sinistrality (FS) on measures of cerebral laterality is also contradictory (Orsini et al., 1984). Both a positive history of sinistrality, FS+, (Hecaen and Sauget, 1971; Hecaen et al., 1981) and a negative history of sinistrality, FS-, (Newcombe and Ratcliffe, 1973) have been associated with evidence of bilateral functions. Warrington and Pratt (1973) found no association between FS

and speech laterality. Hardyck (1976) and Hardyck and Petrinovich (1977) infer a continuum model of cerebral lateralization from the data that suggests FS+ predicts to the bilateral organization of language functions. Their formulation of the evidence is that the FS- right handed are more completely lateralized for language functions than any other group; and that the FS+ left handed are least lateralized and at the opposite end of the continuum. The FS+ right handed are intermediate to these groups. The little evidence available for the FS- left handed group suggests that they may be indistinguishable from the FS- right handed, and no firm predictions are made for this group. Although acknowledging that there are sex differences in laterality findings, Hardyck (1976) believe these influences are minimal.

Evidence of differential performance in subsets of non-right handedness

The above suggests that sex and handedness, both personal and familial, may influence measures of cerebral laterality. The data that FS, sex, strength of handedness and their interactions may modify performance on cognitive and achievement tasks will be reviewed below.

Family history of sinistrality

As already noted, Briggs et al. (1976), who studied university students, found that left and mixed handed subjects had a small but significantly lowered Full Scale WAIS, uniformly across the Verbal and Performance subscales. But across all handedness groups, FS+ subjects had lower Full Scale IQ scores. Also assessing university students, Bradshaw et

al. (1981) found a history of familial sinistrality was associated with lowered perceptual and verbal factors.

Handedness and family history of sinistrality

Carter-Saltzman (1979) reported that both right and left handed FS+ subjects with two or more left handed relatives had higher scores on the Perceptual Maze Task, Hidden Patterns, and reading tests. Subjects with only one left handed family member scored lower, and the lowest performances on all three tasks were by the left handed with no sinistral relatives. She speculated that this group may have included members with minimal cerebral pathology.

Studying only right handed subjects, Yeo and Cohen (1983) found that FS+ subjects, especially females, had lower scores than FS- subjects on the Hidden Figures Test; and FS+ subjects, especially males, had lower scores on tests on perceptual speed, scanning columns of words and numbers for a target. However, they found no differences between the FS+ and FS- right handed on a written verbal fluency test. Studying only the left handed, Gregory, Alley and Morris (1980) found no FS effect on the Spatial Reasoning Test from the Differential Aptitude Test.

Harshman, Hampson and Berenbaum (1983) added a disquieting note to the study of the influence of familial sinistrality. They pointed out that the criteria for determining FS has varied widely, and their unpublished findings suggest that lax versus strict criteria may actually reverse outcomes!

Strength of handedness

Swanson et al. (1980) investigated the patterns on Primary Mental Abilities (PMA) scores of children in the fourth and again in the seventh grade. Children were classified as "pure" left handers if they wrote and threw a ball with the left hand or "mixed" if they wrote or threw with the left. Both groups showed a significant fall in scores between the first and second testing. However, the pure left handers initially had significantly better PMA IQ scores than average for the school in the fourth grade (111 vs. 102) and fell to just slightly lower than the class average in the seventh grade. The scores of the mixed group were significantly lower than the average in the fourth grade (94.9 vs. 108) and by the seventh grade were almost 19 points below the average (88.1 vs. 107).

The numbers of subjects in this study is small and, as the investigators note, a large scale longitudinal study is necessary to establish definitely the relationship between handedness and cognitive abilities at different ages. Nonetheless, several possibilities are raised by this report: 1. Pure or firm left handers may have some superior abilities, although possibly only transiently. 2. Cognitive ability score elevations (and profiles) may change across the life span. It is possible that only some functions vary, or that some vary more than others, and that some decline (or improve) over time, only to change directions again. Left handers in general may suffer a decline in rate of development of cognitive abilities during their second decade. 3. Mixed left handedness may be a

marker of vulnerability. Their poor performance and inconsistency suggests that some members of this group may be pathological left handed.

The largest declines suffered by the left handers were on the Spatial and the Numerical subtests (-2.0 and -2.3) versus Verbal (-1.1) and Reasoning (which gained an insignificant 0.4). It is possible that the perceptual deficits that have been found in studies reviewed here are tapped by both the Spatial and Numerical Subtests of the PMA.

However, in a study of handedness, FS and sex, reported above, Carter-Saltzman (1979) found that the group who performed best on spatial and reading tasks, FS+ subjects with two or more left handed relatives, were "decidedly ambidextrous."

Sex

Gender differences in cognitive abilities are usually described in terms of a relative superiority of verbal fluency, spelling, finger dexterity, and perceptual speed for females and visual spatial, mechanical and mathematical abilities for males (Maccoby and Jacklin, 1974). However, there are tasks which are primarily visual-spatial at which females excel; such as the perception of fine visual detail when interpreting the meaning of facial expression (Bahrnick, Bahrnick, and Wittlinger, 1975) and visual memory (Harshman et al., 1983). Male superiority for some verbal functions is demonstrated by the following studies: verbal reasoning (Bennett, Seashore and Wesman, 1959); general information (Miele, 1958); mathematical reasoning (Hilton and Berglund, 1971; Svensson,

1971). Although estimates vary widely, combined studies suggest that the proportion of male to female dyslexics is four to one (Owen, 1978).

The literature on gender differences and their interactions with personal and familial handedness and strength of hand preference on cognitive measures will be reviewed in the next two sections.

Gender interactions with family history of sinistrality

The work of several investigators suggest that familial sinistrality interacts with sex to modify scores on spatial tests. Kocel (1977, 1980) and Healey (1981) found that among males, FS+ was associated with a decrement in spatial factor scores, but among females, FS+ was associated with an improvement in performance. The opposite findings were reported by McKeever and Hoff (1980), using the Stafford Identical Blocks, and Marino and McKeever (1982) using a clockface task. These investigators report that FS+ males perform better than FS- males and the FS- females perform better than the FS+ females.

A critical difference between the studies by Healey and Kocel and those by McKeever and colleagues may be that the former used primarily mental rotation tasks and the latter did not. Mental rotation has been related to left hemisphere activation as measured by electroencephalography (Ornstein et al., 1980). This may reflect the fact that some subjects, especially females, may rely more on verbal than spatial strategies to perform mental rotation tasks.

A positive history of sinistrality may be associated with enhanced verbal performance in females. In a study of 5 to 7 year olds, Pringle, Anderson and Jaffe (1985) used a color naming task, a subtest of the Rapid Automatic Naming (RAN) Test. Poor performance on the RAN has been correlated with reading failure. They found that girls with two or more sinistral relatives were fastest on the rapid color naming task. Girls with only one sinistral relative were slower and FS- girls were the slowest. There was no correlation between speed of reading and FS in boys.

Carter-Saltzman (1979) reported that there were no significant interactions between sex and FS on reading and spatial tests although males performed better on the spatial tests and females scored nonsignificantly higher on the reading tests. As noted above she found subjects with two or more left handed relatives to receive higher scores on reading and spatial tests than those with only one or no sinistral relatives.

Gender, FS and handedness

Healey (1981), who assessed verbal and spatial abilities tachistoscopically, noted that "Handedness modified these interactions such that male right handers without FS (FS-) had the most marked RVF (right visual field) asymmetry while the female left handers with FS+ had a reversed (LVF) asymmetry; these two subgroups also scored highest in spatial ability with respect to their sex groupings." These two subgroups represent the poles of the continuum suggested by combining the Hardyck model with the evidence of differential laterality effects

reported between males and females.

Kocel noted that among the strongly left handed, FS- was associated with enhanced scores on verbal tests for females but with decreased verbal scores for males. Healey found similar trends for the interaction of FS, gender, and the verbal factor she assessed, but they did not reach statistical significance.

Bradshaw et al. (1981) who found a "striking WAIS Performance deficit" among left handers especially those with a FS+, found no interaction with gender.

Gender interaction with handedness and strength of handedness

McGee (1978) found that sinistrality in males enhanced scores on a rotation task and depressed those in females. Two large sample studies, 1000 - 2500 subjects, yielded contradictory findings. Yen (1975) reported that sinistrality in males was associated with poor spatial performance and no relationship with handedness was found in females. Sanders, Wilson and Vandenberg (1982) found left handed females to be inferior and left handed males to be superior in spatial abilities. In a large review and re-analysis of three studies of sex and handedness effects, Harshman et al., (1983) concluded that in high reasoning groups, as determined by scores on the Raven's Progressive Matrices, right handed males were superior to left handed males and left handed females were superior to right handed females on a wide variety of spatial tasks, and the opposite pattern was true for the low reasoning group. The latter

pattern, left handed males and right handed females superior, also held for most verbal tasks in the high reasoning group. There was no discernable pattern for the low reasoning group on verbal tests. However, they reported that both male and female left handed scored higher than the right handed on the Christensen and Guilford Expressional Fluency test, especially in the high reasoning group. Perceptual speed tests produced the same results as the high spatial group, right males and left females superior; but in the low reasoning group both male and female left handed performed best.

Johnson and Harley (1980) gave 120 male and female right and left handed university students the Mill Hill vocabulary test (a verbal task), Flags (a spatial task) and two verbal and two performance subtests of the WAIS. Both male and female firmly left handed subjects had significantly elevated Mill Hill scores but lowered scores on the Flags test than dextrals or mixed left handed subjects. Mixed left handers and dextrals did not differ significantly on spatial or verbal tests although the mixed left females showed a trend toward depressed verbal scores. No other test differentiated handedness conditions. The authors concluded that handedness is a better predictor of cognitive abilities than gender. They also note that the spatial factor assessed by the Flags test differs from that assessed by the WAIS, and that the Mill Hill scores did not correlate well with the WAIS verbal subtests.

Summary of evidence of differential performance associated with non-right handedness

The evidence presented here suggests that groups based on subject variables (handedness, strength of hand preferences, sex and FS) may perform differentially on spatial and verbal tasks; and that the terms spatial and verbal are too global and need differentiation and refinement. With the exception of sex, the subject variables may be defined in a variety of ways and the Harshman et al. (1983) caveat with respect to FS may well apply to handedness and strength of handedness criteria. Recently Healey, Leiderman and Geschwind (in press) found four handedness factors, i.e., evidence that handedness is neither a unidimensional nor bipolar trait.

Harshman et al. (1983) also note that other variables such as reasoning ability may considerably alter outcomes on sex by handedness performance. This group is currently exploring the effect of other moderating variables.

As handedness, strength of handedness, sex and FS influence performance on cognitive skills, these variables may predict, in part, academic achievement. The following section will review the literature on the cognitive deficits, particularly spatial deficits, thought to underlie reading disability.

Dyslexia

Physicians and some psychologists often conceptualize dyslexia as a language disorder (McCready, 1910; Ewing, 1930; Rabinovitch, 1959; Vellutino, 1980) or a visual, spatial or perceptual dysfunction (Orton, 1937; Hermann and Norrie, 1958; Shankweiler, 1963). More recently dyslexia has been regarded as a group of disorders characterized by correlates of deficits associated with language (auditory or phonemic), visual spatial (or perceptual) functions, or both. These will be reviewed below.

Other investigators, often educators and psychologists, distinguish between reading problems based on difficulties with decoding individual syllables and words, i.e., appreciating the phonemic-grapheme relationships, and impairment of textual comprehension, or both (see Maria and MacGinitie, 1982, for a review). They describe models which describe a parallel and interactive process of reading, in which stress is placed on bottom up (decoding to comprehension) or simultaneous bottom up and top down strategies. These emphasize often excessive reliance of disabled readers on one or the other approach (Rumelhart, 1977; Kintsch, 1979). There has been little investigation of the relationships between these approaches, although most would agree on the importance of phonetic skills, for oral language and decoding, and memory functions for reading ability. I shall review the literature relevant to those who stress the distinctions between language or verbal and spatial functions.

Dyslexia subtypes

The first data based attempt to differentiate subtypes from a group of disabled readers was by Kinsbourne and Warrington (1963). They studied thirteen backward readers selected for having large (greater than twenty points) discrepancies between their Wechsler Verbal IQ and Performance IQ scores. Those with the lower Verbal score, mostly males, were characterized by impaired expressive and receptive language functions. The second group, mostly females, had no language difficulties but did have evidence of constructional ability and a Gerstmann syndrome with deficits on tests of finger order sense, right-left differentiation, spelling and arithmetic. (Non-right handedness and a history of perinatal brain damage were over-represented in the latter group.) The syndrome of the first type is similar to the picture seen in adult aphasia; the second syndrome suggests an impairment of the dominant parietal or biparietal cortex.

Denckla (1977, 1979); Mattis, French, and Rapin (1975); Mattis (1978); Petrauskas and Rourke (1979); Fisk and Rourke (1979); Pirozzolo (1979) and Morris (1981) have found similar distinctions among disabled readers in much larger scale studies of children and adults from different socioeconomic groups. Each of these groups of investigators find a group with dysfunctions in either the area of language or visual-perceptual processing or both. There are differences in the findings of these investigators which may be due to differences in selection procedures or to the tests used. Both the language and the perceptually disordered

subgroups are described differently by each investigator.

Wepman (1962), Myklebust (1965) and Boder (1971, 1973) have claimed that disabled readers divide into those with auditory or dysphonetic deficits; those with visual or dyseidetic deficits; or those who have both types of difficulties. The extent to which the similarly named subtypes correspond or overlap has not been investigated except by Pirozzolo's confirmation (1979) of the subtypes identified by Kinsbourne and Warrington (1963). There has not been a study to determine if the auditory-language-dysphonemic or the visual-spatial-perceptual dysfunctional subtypes identified by different investigators are groups that make similar errors or have similar deficits. However, there is some evidence that the two major descriptions of visual spatial deficit dyslexia do not refer to the same entity, but to two different syndromes that imply impairment in different parts of the brain.

Mattis et al. (1975) and Mattis (1978) described a subgroup of disabled readers characterized by : 1. Wechsler Performance IQ of at least ten points less than the Verbal IQ, 2. Raven's Coloured Progressive Matrices percentile less than equivalent Performance IQ, and 3. borderline or lower score on the Benton Test of Visual Retention (ten second exposure, immediate reproduction). A similar subset was found by Denckla (1977). These findings suggest nondominant, usually right, posterior cerebral dysfunction. The Gerstmann syndrome dyslexia described by Hermann and Norrie (1958); Hermann (1959); Kinsbourne and Warrington (1963); Shankweiler (1963); Fisk and Rourke (1979) and Pirozzolo (1979) suggests dominant, usually left, parietal or biparietal dysfunction.

Hermann and Norrie (1958) and Hermann (1959) suggested that a directional or orientational deficit, right/left discrimination, impairment is the central disability in both Gerstmann syndrome and dyslexia. "This disturbance of lateral orientation relative to body schema was said to interfere with reading acquisition by producing errors such as reversals, rotation, and disfigurement of visual symbols" Doehring, 1968, p. 9). Kinsbourne and Warrington (1963) described this syndrome as a difficulty with sequential ordering (as evident in tests of finger agnosia, as well as arithmetic and spelling error patterns) and postulated this to be the common and limiting factor in both the Gerstmann syndrome and one type of dyslexia. The type of spelling and arithmetic errors commonly seen in this subgroup involve difficulties appreciate sequential order: letter order is mistaken and place value confusions decrease arithmetic performance.

Thus, these two groups of investigators have noticed that there are some reading retarded subjects who have a syndrome which when found in an adult would suggest dominant parietal or biparietal lobe damage, and hypothesized that the dyslexics who have similar symptoms have a spatial processing dysfunction, conceptualized as either a directional/orientational or sequencing disability.

Other large scale studies of disabled readers have also round evidence of right-left discrimination difficulties (Shankweiler, 1963; Belmont and Birch, 1965), finger agnosia (Reed, 1967; Doehring, 1968; Satz, Friel and Rudegeair, 1974; Petrauskas and Rourke, 1979; Fisk and Rourke,

1979) or both (Lefford, Birch and Green, 1974).

Deficits, dyslexia and sinistrality

Some have wondered if there is a relationship between evidence of directional or spatial processing dysfunction and left or mixed handedness. Both Orton (1937) and Zangwill (1960) noticed an increased incidence of sinistrality in the dyslexics they saw. Zangwill "suggested that ill-lateralised dyslexics show associated disabilities of a spatial and constructional nature, whilst the well-lateralised cases present dyslexia in a much purer form, as an isolated disability" (Shankweiler, 1963). In a study of twelve retarded readers, Shankweiler noted, in addition to difficulties on perceptual and constructional tests (e.g., copying a cube, tracing hidden figures in a complex design, human figure drawing, writing script legibly) and many reversed letters when reading and writing, there were right-left discrimination difficulties. "Reversals are of three types: 1) lateral inversions of individual letters (e.g. as reflected in confusions of "b" for "d"); 2) reversal of the position of letters within the word ("warp" for "wrap"); 3) reversal of whole words or syllables (e.g., "saw" for "was"). All three types of reversals often occurred in the same sample of reading or writing" (Shankweiler, 1963). These errors occurred in ten of the twelve subjects. Two of the subjects were left handed and six had family histories of sinistrality.

In a study of dyslexic children, Doehring (1968) found that when he removed the data of the left handed subjects, the previously significant factors of spatial orientation (right/left discrimination) and finger

agnosia for the left hand no longer distinguished between the normal and dyslexic groups. This suggested that the left handed children had the most difficulty with these tasks. This, however, was not tested directly.

Perhaps the most suggestive indication of an association between a directional disability and left handedness comes from Pirozzolo (1979). He studied two samples of dyslexics: a language dysfunctional group and one characterized by visual spatial deficits "such as directional and typographical disorientation, spatial dysgraphia and dyscalculia and finger agnosia" (Pirozzolo, 1979, p.86). He also noted these subjects usually have a Wechsler PIQ less than the VIQ and make letter and word reversal errors. He found that the visual-spatial deficit group showed shorter saccadic latencies toward verbal stimuli presented in the left visual field than normals or the language dysfunctional group. This suggested to him that the visual-spatial deficit group had inefficient left hemisphere processing, i.e., right hemisphere control of lateral gaze was overriding. In an earlier study, Pirozzolo and Rayner (1978) had found that normal left handers show no asymmetry for saccadic latencies whereas right handers make saccadic movement with shorter latencies to the right.

In summary, there are two major descriptions of visual-spatial deficits associated with dyslexia. One is characterized primarily by a coincident impairment of the Wechsler PIQ, Raven's Coloured Progressive Matrices and Benton Test of Visual Retention and implicates the right posterior cerebrum. The other includes symptoms associated with the Gerstmann syndrome which has been characterized as a directional, orientational or

sequencing deficit, and suggest dominant parietal or biparietal dysfunction. There is some evidence that left or mixed handedness may be associated with spatial, directional, or sequencing difficulties.

The most secure evidence for a relationship between sinistrality and dyslexia could be more direct: the identification of a dyslexic subtype characterized by a high incidence of left handedness and/or familial sinistrality. Some recent evidence from a totally different perspective suggests that such a sybtype exists.

Lefthandedness, dyslexia and vulnerability to immunological diseases

Geschwind and Behan (1982) reported an association between left handedness and certain diseases they refer to as derangement of the immune system: migraine, diabetes, asthma, myasthenia gravis and allergies. They also confirmed the previously reported association between left handedness and learning disability. They speculate that a common factor, testosterone, operating prenatally, delays immunological development and the maturation of the left hemisphere, generating vulnerability to dyslexia, as well as a tendency toward left hand preference. The hypothesis also accounts for the greater incidence of dyslexia in males. Just as sinistrality in a family is a marker for vulnerability to mental retardation (Bradshaw-McAnulty et al., 1984), it is a marker for vulnerability to diseases of the immune system. The dyslexia associated with this syndrome may be one subtype. It is not yet known whether the dextral and the sinistral related groups, differ in terms of the pattern of cognitive deficit and the locus of inadequate brain function. Therefore, there is cumulative evidence that left handedness, though not

a characteristic of all dyslexia, may characterize a subtype of this disorder.

Psychopathy: Evidence for emotional disturbance in sinistrals

Zangwill (1960) who studied mixed and left handed children and adults with reading and educational disabilities concluded that "indeterminate cerebral dominance may be associated with temperamental instability and undue sensitivity to stress." Orme (1970) found that left handed girls were more "unstable" than right handed girls in a detention home for juveniles. Hicks and Pellegrini (1978) reported that left and mixed handed students were more anxious than right handed ones. Lishman and McMeekan (1976) found an increased incidence of sinistrality among psychiatric patients. Left handedness was more common among the younger, male and psychotic, especially the manic and schizoaffective patients. While none of these studies offer any convincing explanation of these relationships, they raise questions about a possible brain basis for emotional problems in left handers.

Evidence for hemispheric asymmetry in emotional processing

There is increasing evidence from normals, and neurological and psychiatric patients that the two cerebral hemispheres may be differentially involved in the mediation of affect: the right more active during the processing of negative emotions and the left more involved in the processing of positive, pleasant or happy, feelings.

Studies with normal subjects

Haggard and Parkinson (1971) and Carmon and Nachson (1973) studied

normal subjects using the dichotic listening technique. They found the right hemisphere to be better able to assess emotion in speech or nonspeech (crying or laughing) sounds. Dimond, Farrington, and Johnson (1976) had normal subjects rate short films which were directed by means of a specially designed lens to either the left or right hemisphere. Those films which were directed to the right hemisphere were rated more unpleasant or horrific. In general, the ratings of the left hemisphere viewed films correspond closely to the ratings obtained under conditions of free vision. The authors suggest that the left hemisphere judgments may predominate over those of the right in everyday life.

Dimond and Farrington (1977) found that heart rate, an indicator of arousal, was increased during films of a surgical procedure when they were shown to students' right hemispheres and when a cartoon was shown to the left hemisphere. The authors concluded that the "left hemisphere is specialized for processing positive affective information, while the right is specialized for processing negative information."

Sackeim and Gur (1978) found that normal subjects rated as more emotionally intense photographs of faces that were composed of left side composites than right side composites of the original photographs. As the left side of the face is relatively more under the control of the right hemisphere, this finding argues for greater involvement of this hemisphere in the processing or expressing of emotion. However, these results were strongest for the negative emotions (anger, disgust, sadness, fear) and attenuated for the positive affects (happiness, surprise). The authors suggest that "as in the case of the processing of emotional

information, the direction of hemisphere control over emotional expression may be determined by the type of emotion being expressed."

Studies of neurological patients

Goldstein (1939) noted that patients with left hemisphere lesions were prone to "catastrophic reactions," which consists of anxiety, hostility, crying and compensatory boastfulness.

Right hemisphere lesions are more often associated with indifference reaction or unilateral neglect as described by Babinski (1914) and reviewed by Hecaen and Albert (1978). This syndrome is characterized by indifference or even denial of disability which usually includes a left hemiparesis. The patient is often jocular and may even ascribe the affected limb to another person. Gainotti (1972) studied 80 patients with left hemisphere lesions and an equal number with contralateral lesions and found the catastrophic reaction to be more common in the former group and the indifference reaction to be more common in the patients with right hemisphere lesions.

Similar observations have been made after unilateral intracarotid sodium amytal injections intended to determine which hemisphere is dominant for language processing prior to brain surgery. The effect on the dominant hemisphere is to produce a transient dysphasia. Perria, Rosadini and Rossi (1961) and Terzian (1964) have reported behavior similar to the catastrophic reaction during the recovery of the left hemisphere from inactivation and a euphoric response following right hemisphere inactivation.

Right hemisphere lesions impair memory for the emotional aspects of short stories more than left hemisphere damage (Wechsler, 1973). Heilman, Scholes and Watson (1975) noted that patients with right or left temporoparietal lesions were equally adept at comprehending the content of tape recorded sentences but those with the right hemisphere damage were less able to comprehend the affective significance of speech. For a recent review of this topic, see Sackeim, Greenberg, Weiman, Gur, Hungerbuhler, and Geschwind (1982).

Studies with psychiatric patients

Using a dichotic listening task, Moscovitch, Strauss and Olds (1981) assessed severely depressed women before and after unilateral ECT treatment. In this task, competing verbal stimuli are simultaneously presented to both ears; normal right handers report the information going into their right ear more accurately indicative of dominant (left hemisphere) activity. However, in this group five of the seven women had performance suggestive of "left hemisphere dysfunction or elevated right hemisphere activation." After treatment four of the five demonstrated clinical improvement and the usual right ear (left hemisphere) superiority; the one who did not relapsed within a few months despite initial clinical improvement. This study suggests that increased right hemisphere activity, or decreased left hemisphere activity, or both, may be associated with depression.

Warneke (1975) reported a fourteen year old boy diagnosed as manic depressive (bipolar disorder) in whom "the neuropsychological test battery

revealed right hemisphere dysfunction, most prominent in the fronto-temporal areas with some bilateral dysfunctions frontally." The reported test scores were consistent with this interpretation: the WIC verbal IQ was 92; performance IQ was 69. After the patient recovered (he was stabilized on lithium) his scores were: verbal IQ 94 and performance IQ 93, a gain of 25 points in the PIQ.

The above review suggests that there is a decrement in performance on tasks mediated primarily by the right, nondominant, hemisphere in subjects who are clinically depressed. For a recent review of the neurology of affect, see Kinsbourne and Bemporad (1984).

Evidence of Emotional Dysfunction in Learning Disabled Children

Learning disabled children may be more emotionally distressed than their peers as they are less able to be effective in one of the major areas of their lives. An extreme position is taken by Eisenberg, 1978: "The inevitability of psychiatric disturbance in poor readers stems from the pivotal role for success in schooling is, in the first instance, reading. Not only is this the major demand on the child in the early grades, but it is the fulcrum for the rest of his being." However, the following study does not support the suggestion that all dyslexic children are disturbed.

Rourke and his associates factor analyzed responses to a 600 question Personality Inventory for Children (PIC) by mothers of 100 learning disabled children. They found four subtypes; the largest group (N=37) of children were not distinguishable on this assessment from their

non-learning disabled peers. But 1. Twenty children appeared depressed. Their profiles suggested "poor interpersonal functioning, social isolation, and poor self-esteem." 2. Ten subjects had "somatic concerns" and "visual problems." They were further characterized as having less serious academic problems than the rest of the group. 3. Thirteen subjects were described as "hyperactive"...personally insensitive, disobedient, and disrespectful (Rourke and Fisk, 1981). Thus 43% of this sample had evidence of depression, somatization or hyperactivity.

Brumback and Staton (1983) have hypothesized a relationship between depression and poor right hemisphere mediated spatial skills in learning disabled children. In studies with Strang (1981) Rourke found that children with relatively poor verbal and language abilities but well developed visual spatial skills had PIC profiles similar to the non-learning disabled children with little evidence of psychopathology. However, the children with the opposite patterns, i.e., poor visual spatial skills were similar to the depressed learning disabled group (Rourke and Fisk, 1981).

Summary of the review of relevant aspects of psychopathology

There may be a relationship between sinistrality and psychopathology. These may represent the pathological left handed whose emotional as well as intellectual functions may be compromised by brain injury. Alternatively, some patterns of cerebral organization associated with a subtype of left handedness may be particularly vulnerable to psychiatric dysfunction.

There is evidence for the asymmetrical cerebral processing of emotions, and right hemisphere dysfunction has been associated with depression. Psychopathology has been associated with learning disabled children, and specifically with visual spatial deficits in learning disabled children.

Summary and Conclusions

The above review suggests that subject variables, handedness, sex and FS and their interactions, may influence outcomes on measures of cerebral organization, cognitive function and reading. Therefore, the relationships between the subject variables and measures of cognitive and achievement were explored.

One or more types of dyslexia may be associated with cognitive deficits conceptualized as spatial, directional, orientational and/or sequencing dysfunction. There is also evidence that personal sinistrality may be associated with some of these deficits in the learning disabled. Therefore, the relationships between the subject variables and measures of cognitive and academic achievement were explored.

An increased incidence in personal sinistrality has been associated with psychopathology, and the learning disabled, especially those with visual spatial deficits, are reported to have more psychopathology. As various subject variables may modify the effects of personal handedness on measures of cerebral organization and cognitive function, these variables were explored in relations to assessments of psychopathology.

HYPOTHESES

The hypotheses concern the three major independent variables and their interactions: handedness (or hand), sex and family history of sinistrality (FS). Contradictory hypotheses are generated when the evidence is contradictory. Verbal measures will refer to: The Wechsler Verbal Scale IQ (VIQ), the Wechsler Verbal Scale subtests, the Peabody Picture Vocabulary Test, and the Bannatyne Verbal Factor. Spatial measures refers to the Wechsler Performance Scale IQ (PIQ), the Wechsler Performance Scale subtests, the Raven's Coloured Progressive Matrices, the Berea Gestalt, measures of the Karnovsky Test of Mental Rotation, and the Bannatyne Spatial Factor. Achievement measures refers to the Gray Oral Reading Test, Slosson Oral Reading Test, Stanford Spelling Test, Stanford Work Skills Test, Stanford Reading Comprehension and the Stanford or Key Math Test. Psychopathology measures will refer to the Birleson Depression Inventory, Short Child Depression Inventory, Coopersmith Self-Esteem Inventory (Long and Short forms), Coopersmith Lie-Scale, Conners Hyperactivity Scale as reported by the child, classroom teachers, tutors, and parents, the SNAP, the All Psy and All ADD factors.

MAIN EFFECTS

I. Handedness

- A. Because mixed and/or left handed have atypical cerebral organization that could underlie cognitive deficits and reading, because they perform less well on some cognitive tasks than the right handed, because they are over-represented in pathological conditions, and because a subset, the pathological left handed, may result from early brain damage:

Hypothesis I.A:

It is predicted that subjects who are mixed or left handed will perform less well on measures of cognitive function and school achievement than subjects who are right handed.

- B. Because of the increased incidence of sinistrality in psychopathological groups and the evidence that the non-right handed may have specific cognitive deficits; and impaired cognitive functioning has been implicated in the etiology of the learning disabled:

Hypothesis I.B:

Subjects who are mixed or left handed will receive higher scores on measures of psychopathology than right handed subjects.

- C. As some (Doehring, 1968; Shankweiler, 1963; Zangwill, 1960) have noted a relationship between left handedness, reading disorders and spatial deficits:

Hypothesis I.C:

Subjects who are mixed or left handed will have more evidence of spatial deficits than right handed.

- D. As the left handed have been found superior to the right handed on a test of verbal fluency (Harshman et al., 1983):

Hypothesis I.D:

The left handed will receive higher scores than the right handed on oral reading tests.

- E. Mixed handedness

1. As mixed handedness implies a measure of sinistrality between right and left handedness:

Hypothesis I.E.1:

The mixed handed subjects will receive scores on measures of cognitive function, achievement and psychopathology that fall between those of the right and left handed.

2. As mixed handedness may imply mixed laterality and/or brain damage and has been noted in association with cognitive deficits (Swanson et al., 1980):

Hypothesis I.E.2:

The mixed handed will score lower on measures of cognitive function, achievement and psychopathology than the right and left handed.

3. As mixed handedness has been found in association with superior performance on reading and spatial tests (Carter-Saltzman, 1979):

Hypothesis I.E.3:

The mixed handed will perform better than the right handed on reading and achievement tests.

II. Family History of Sinistrality

A. As family history of sinistrality has been associated with atypical cerebral organization suspected to underlie cognitive deficits, and subjects with FS+ perform less well than FS- subjects on some cognitive measures (Bradshaw et al., 1981; Briggs et al., 1975; Yeo and Cohen, 1983):

Hypothesis II.A:

FS+ subjects will perform less well on measures of cognitive functions and achievement than FS- subjects.

- B. As a family history of sinistrality has been associated with enhanced performance on spatial and reading tasks (Carter-Saltzman, 1979; Pringle et al., 1985):

Hypothesis II,B:

FS+ subjects will perform better on measures of cognitive functions and achievement than FS- subjects.

- C. As a personal history of sinistrality has been associated with psychopathology and FS+ has been associated with poorer performance on some measures of cognitive function relative to FS-, and impaired cognitive function has been implicated in the etiology of psychopathology in the learning disabled:

Hypothesis II,C:

FS+ subjects will receive higher scores on measures of spy than FS- subjects.

III. Sex

- A. As females have been found to be superior on verbal, reading and spelling skills and males have been found to be superior on spatial and math skills (e.g. Maccoby and Jacklin, 1974):

Hypothesis III,A:

Females will receive superior scores on verbal, reading and spelling measures and males will receive superior scores on spatial and math measures.

INTERACTIONS

The range of individual differences associated with both cerebral organization and cognitive skills related to personal handedness, sex, FS and their interactions suggests that subtypes of dyslexics, who are suspected to have different cognitive profiles underlying their disabilities, may be differentiated by examining the performance of the groups formed by the interactions among these subject variables. The hypotheses are suggested by the literature reviewed above. Contradictory hypotheses are generated when there are contradictory findings.

IV. Hand and Sex

Hypothesis IV,A:

- A. Left handed males will receive lower scores on the spatial cognitive tests than right handed males (Levy, 1969; Miller, 1971; Silverman et al., 1966).

- B. As left handed males and right handed females have been found superior on mental rotation tasks (McGee, 1970):

Hypothesis IV,B:

The left handed males will perform better than right handed males and right handed females will perform better than left handed females on Karnovsky Mental Rotation Test measures.

The following contradictory hypotheses are suggested by Harshman et al. (1983), who reported opposite findings for high and low "reasoning ability" groups. As their definition of

reasoning ability is questionable, and high and low reasoning ability in a learning disabled group may be different than in other populations, both hypotheses are generated.

- C. As left handed males and right handed females have been found superior on spatial tests:

Hypothesis IV,C:

The left handed males will receive higher scores than right handed males, and right handed females will receive higher scores than left handed females on spatial tests.

- D. As right handed males and left handed females have been found superior on spatial tests:

Hypothesis IV,D:

The right handed males will receive higher scores than left handed males; and left handed females will receive higher scores than right handed females on spatial tests.

- E. As left handed males and right handed females have been found superior on verbal tests:

Hypothesis IV,E:

The left handed males will receive higher scores than right handed males, and right handed females will receive higher scores than left handed females on verbal and achievement tests.

V. Hand and FS

- A. The effects of personal and familial sinistrality will be additive:

Hypothesis V.A:

The scores of cognitive and achievement tests of the FS+ right handed subjects will be intermediate to those of the FS- right and left handed FS+ left handed (Hardyck, 1976).

VI. Sex and FS

Hypothesis VI.A:

- A. FS+ males will receive lower scores on the visual-spatial perceptual cognitive tests than FS- males. FS+ females will receive higher scores on the visual-spatial cognitive tests than FS- females (Healey, 1981; Kocel, 1977, 1980)

Hypothesis VI.B:

- B. FS+ males will receive higher scores on the visual-spatial perceptual cognitive tests than FS- males. FS+ females will receive lower scores on the visual-spatial cognitive tests than FS- females (McKeever and Hoff, 1980; Marino and McKeever, 1982).

VII. Psychopathology and Cognitive Skills

Hypothesis VII.A:

- A. As there is evidence for an association between poor spatial skills and depression in learning disabled children (Rourke and Fisk, 1981; Strang, 1981), those subjects with lower spatial skills will have more evidence of psychopathology.

METHODS

Subjects

The subjects are 494 students, mostly adolescents, who are students at the Landmark School in Beverly, MA. Children at this school are diagnosed as learning disabled and have generally had several years of what was considered insufficient progress in key subjects, usually reading, writing and sometimes mathematics.

Procedures

Personal handedness was assessed by a questionnaire which required the subject to report whether he/she uses the right or left hand for writing, throwing a ball, hammering and brushing teeth. For most analyses the subjects were classified as right handed if they reported using their right hand for all four activities, or mixed handed, if they used their left hand for one to three of the four tasks or left handed if they used their left hand for all four tasks.

Information on the family history of sinistrality was obtained from a questionnaire given or sent to parents. Data on the handedness of parents, siblings and grandparents was received for 234 subjects. A positive history of sinistrality was assigned if any relative performed any of the four tasks listed above with his/her left hand or any two tasks with either hand.

Birth and medical histories were derived from questionnaires obtained from parents or guardians of 234 children. Based on this information,

these subjects were classified as apparently normal, possibly abnormal, abnormal. In some cases medical information sufficient to classify subjects in category 2 or 3 was obtained from the school records. The 14 children classified as abnormal were not included. (Children for whom no medical history could be obtained from parents or school records were assumed to be normal.) One child was classified as a pathological left hander, and presumptively neurologically abnormal, as his right foot was shorter than his left by more than 0.5 cm. His data were not included in the analyses.

Parents or guardians were requested to fill out the revised short form of the Conners Parent-Teacher Questionnaire, the Conners Hyperactivity Index, a ten question hyperactive scale, and the SNAP, 23 question scale which assesses Attention Deficit Disorder (ADD) according to the criteria set forth in the Diagnostic and Statistical Manual III of the American Psychiatric Association.

Subsets of the children were given paper and pencil questionnaires to assess depression (Birlson Depression Inventory and the Short Childrens' Depression Inventory or SCDI) and self-esteem (Coopersmith Self-Esteem Inventory or the Coopersmith Self-Esteem Inventory - Short Form). (The SCDI was dropped from the study when several children objected to its obvious depressive content. The short form of the Coopersmith was introduced as a replacement for the long form to reduce the demand on the students' time.) They were also asked to fill out the ten question Conners Hyperactivity Index on themselves. None of the measures of psychopathology were identified by name, nor did the words depression,

self-esteem or hyperactivity appear on any form. A subset of subjects were also given the Raven's Coloured Progressive Matrices and the Karnovsky Test of Mental Rotation.

Tutors and classroom teachers were asked to assess the children with the revised short form of the Conners Hyperactivity Index. When available scores on the WAIS or WISC or WISC-R, Gray Oral Reading, Slosson Oral Reading, Stanford Spelling, Stanford Word Skills, Stanford Reading Comprehension, Stanford or Key Math, the Peabody Picture Vocabulary Test and the Brea Gestalt were obtained from the school records. Table 1 in Appendix I presents the sample sizes for the variables.

DATA ANALYSIS

The major independent variables of interest in this study are personal handedness, family history of sinistrality (FS), sex and age. The dependent variables are considered in three broad categories, achievement, cognitive and psychopathology.

1. Achievement Tests

All achievement tests are scored in grade equivalents.

Gray Oral Reading: The requirements for this test are to read aloud a series of paragraphs of increasing difficulty and to answer specific questions designed to assess comprehension. Although both decoding and comprehension skills are required, decoding is not specifically assessed and comprehension skills are limited, i.e., often

only retrieval of factual information is tested.

Slosson Oral Reading: A series of words of increasing difficulty are to be read aloud. This test requires only the ability to decode.

Stanford Spelling: The correct spelling of a series of increasingly difficult words is to be recognized from distractors.

Stanford Reading Comprehension: A series of paragraphs of increasing difficulty are read silently. Comprehension is tested. Decoding skills are not assessed.

Stanford Word Skills: This is a written assessment of phonetic skills.

Stanford or Key Math: These are written assessments of arithmetical skills.

2. Cognitive

Wechsler (WISC-R or WAIS)

Full Scale IQ (FSIQ)

Verbal IQ (VIQ), Information, Similarities, Arithmetic,
Comprehension, Vocabulary, Digit Span

Performance IQ (PIQ), Picture Completion, Picture Arrangement,
Object Assembly, Block Design, Coding

Bannatyne Factors were constructed from the Wechsler Tests. They

are:

Verbal (Similarities, Comprehension and Vocabulary)

Spatial (Picture Completion, Object Assembly, Block Design)

Sequencing (Arithmetic, Digit Span, Coding)

Acquired Knowledge (Information, Arithmetic, Vocabulary)

Peabody Picture Vocabulary Test percentile

Raven's Coloured Progressive Matrices error score

Berea Gestalt, scored as a deviation score from performance expected for age. This is a memory for form test developed by the present director of the Landmark School. It is similar to the Bender Gestalt Test. The subject is requested to copy 12 designs after having seen them for 5 seconds. After all forms are copied, the subject is requested to reproduce as many as he can from memory. Memory for correct form is assessed.

Karnovsky Test of Mental Rotation. This test, developed for children and adolescents, has two forms, both with 14 test forms. One form has pictures of common objects; the other, abstract shapes. Each item consists of a target and four choices. The task is to choose the rotated form of the target among four choices. The distractors include one mirror image of the target and two choices that are similar in configuration, but have minor details changed. For each form scores for mirror errors and total errors were computed. A total error score for both forms combined was also generated.

3. Psychopathology

The identifying information on all questionnaires were removed. The wording and order of some questions on the Birleson were altered slightly to improve readability. The questions on the original SNAP were organized under the headings "hyperactivity, inattention, impulsivity, and peer interactions." The headings were removed to reduce biased answers and the questions were randomly ordered. Forms used in this study are in Appendix VII.

Birleson Depression Inventory: This is an 18 question inventory assessing affect, appetite, sleep, attitudes toward self and others that has been demonstrated to correlate well with clinical status for children and young adolescents.

Short Children's Depression Inventory (SCDI): This is a 19 question inventory adapted from the short Beck Depression Inventory for children.

Coopersmith Self-Esteem Inventory - Long Form: This is a 58 question inventory assessing self-esteem in children and adolescents. Attitudes toward self, peers, parents and schoolwork are measured.

Coopersmith Self-Esteem Inventory Lie-Scale: A scale to assess tendency to give socially approved answers, for the long form only.

Coopersmith Self-Esteem Inventory - Short Form: A 29 question version of the long form. The correlation of the two tests is reported to be .86.

Conners Hyperactivity Index - Revised: A 10 question inventory assessing impulsive, inattentive, distractible, irritable and restless behavior in children.

Scored by the subject (HI-Self)

Scored by the parent (HI-Parent)

Scored by a classroom teacher (HI-Classroom Teacher)

Scored by a tutor (HI-Tutor)

SNAP: A 23 question scale which assesses Attention Deficit Disorder (ADD) according to the criteria set forth in the Diagnostic and Statistical Manual III of the American Psychiatric Association.

Although data were obtained on almost five hundred subjects, there were very few on whom all measures could be obtained. Data was derived from 1. questionnaires filled out by the subjects on handedness, Raven's and Karnovsky tests, and some measures of psychopathology; 2. questionnaires filled out by the parents or guardians on the handedness of family members, medical history of the subjects, and some measures of psychopathology; 3. a questionnaire filled out by a classroom teacher; 4. a questionnaire filled out by a tutor; 5. school records for Wechsler, Peabody, and Berea Gestalt data; and 6. separate school records for achievement testing. Not all information was available from sources 2 through 6.

In each section the analysis of the reading, spelling and math achievement measures will be presented first, followed by the results of the cognitive measures. The analyses of the indices of psychopathology

will be presented last. The data for the measures of achievement, psychopathology, the Karnovsky Mental Rotation Tests, and Raven's Coloured Progressive Matrices were first regressed for age. These age residuals and the scaled scores for the IQ subtests and the Brea Gestalt and the Peabody Picture Vocabulary Percentile were subjected to specific contrasts to examine the main effects of handedness, sex and FS. Then the groups formed by interactions between handedness and sex, handedness and FS and sex and FS, were contrasted for all the dependent variables.

Bannatyne factors (verbal, spatial, sequencing and acquired knowledge) were constructed from the Wechsler subtests and the contrasts were rerun.

As all of the dependent variables are expected to be affected by the age of the subjects, and age regression may have still left some of the groups formed by the interactions differing in age, regression analyses, using stepwise procedure (SPSSX) were also performed to determine the effects of the subject variables, age and all the interactions with age. Additionally, the dependent variables were factor analyzed (Verimax Rotation, SPSSX) and stepwise regressions with listwise mean deletion were done to address specific a priori hypotheses and to explore the relationships among the dependent variables.

Groups that differed by approximately one standard deviation or more on the Bannatyne verbal and spatial factors were constructed and contrasted with and each other and with the residual "equal" group on psychopathology factors. the following factors were constructed: All

Self was equal to the mean of the Z-score for each measure the subjects rated on themselves. A minimum of three variables was required for the factor to be constructed. (Factor analyses of the psychopathological variables showed this to be a clearly interpretable factor.) All Psy was equal to the mean of the Z-score for each measure of all the psychopathological measures for each subject. A minimum of 6 was required for this factor to be constructed. All ADD was constructed from all measures purporting to assess hyperactivity or attention deficit disorder. A minimum of three were required. The groups were also contrasted on the Short Child Depression Inventory, as this was judged, post hoc, to be an easier and therefore, possibly more accurate inventory for the learning disabled.

Higher scores on the achievement and cognitive scores reflect better performance, with the exceptions of the Karnovsky Test of Mental Rotation, the Raven's Coloured Progressive Matrices and the Berea Gestalt measures which were recorded as error scores. Higher scores on the measures of psychopathology represent more evidence of disturbed behavior. Psychopathological measures were reported in two groups, those generated by self-report and report by others.

Contrasts for main effects of handedness, FS and sex are presented in the first three chapters. The data for the interactions hand and sex, hand and FS, and sex and FS are in chapters four, five and six. Within each chapter the data and contrasts for measures of achievement, cognition and psychopathology are presented respectively. In the chapter on handedness, the mixed handed category was divided into right mixed and

left mixed handed. The data on the collapsed category, mixed handed, is reported only in the appendix, as these findings were less informative, and in the interest of concise presentation. The mixed handed category was collapsed for the two interaction chapters to maintain adequate cell sizes. However, the independent effects of the right and left mixed handed groups were assessed in the regression analyses reported in chapter seven. Contrasts of psychopathological factors on groups which differed on Bannatyne verbal and spatial factor scores are reported in chapter eight.

As not all achievement scores for these subjects could be considered reflective of learning disability, the contrasts were also run on a sample of subjects who met a strict criterion for dyslexia, i.e., three grade deviations below grade expected for age. These findings, for the most part, are not greatly different from those of the total sample and are, therefore, reported in full only in the appendices, but are referred to in the results and discussion.

If the contrasts reached the .05 level for the post hoc comparisons Newman-Keuls and/or Scheffe, the abbreviations N-K and/or S were added in the probability column. Only significant and marginal contrasts are presented in the chapters. Complete tables are in the appendices.

DESCRIPTION OF SAMPLE

There were 93 females and 401 males. their ages ranged from 7.6 to 21.6 years. Mean age was 15.11 years; the standard deviation was 2.56. Right handed were 71.1% of the sample, 10.3% were right mixed, 7.7% were

left mixed (total of 18.0% mixed), and 10.9% were left handed. The total non-right handed was 28.9%. In the Chi Square test there were no significant differences in the groups formed by hand, sex and FS, although not all measures were given to all subjects and the groups formed for each measure may not be representative of the entire sample (Appendix I, Table 2).

The mean Wechsler Full Scale IQ was 100.67 (S.D. 12.46, range 73-139, N=260). The mean Wechsler Verbal Scale IQ was 99.63 (S.D. 12.33, range 73-142, N=266). The mean Wechsler Performance Scale IQ was 101.38 (range 64-149, N=265). The achievement measures, in grade deviations, are reported in the following table.

Scores of Achievement Measures

<u>Achievement Tests</u>	<u>Mean</u>	<u>S.D.</u>	<u>Range</u>	
			<u>Max</u>	<u>Min</u>
Gray Oral Reading	-4.30	2.44	2.39	-11.09
Slosson Oral Reading	-2.94	2.46	3.92	-10.29
Stanford Spelling	-4.05	2.54	1.83	-11.49
Stanford Word Skills	-3.99	2.82	4.40	-11.22
St. Reading Comp.	-3.84	2.84	5.42	-10.66
Stanford or Key Math	-2.32	2.78	4.92	- 9.72

Complete descriptive statistics are in Appendix I, Table 1.

I. HANDEDNESS

Contrasts of the achievement, cognitive and psychopathological measures are presented for the total sample. Only those contrasts which were significant or approached significance are reported below. A complete table of the contrasts for the total sample and the dyslexic sample is in Appendix II. (Based on the figures obtained from the Gray Oral Reading Test, the dyslexic group was composed of: 69.6% of the right handed, 84.2% of the right mixed handed, 82.6% of left mixed handed and 83.3% of the left handed from the total sample.)

For both the total sample and the dyslexic subgroup, the data was first analyzed by comparing the scores of the right, mixed and left handed. A second analysis was done contrasting the right, right mixed, left mixed, and left handed. No analyses are included contrasting right and non-right handed subjects as the above analyses suggested that the non-right handed were a diverse group.

ACHIEVEMENT MEASURES

The right handed received the highest scores on five of six achievement tests and performed significantly better than the left handed on the Gray Oral Reading Test and the Stanford Spelling Test. Although the specific contrasts do not confirm that mixed handers are intermediate to right and left, this is suggested by the linear trends for the Gray Oral, Slosson Oral and Stanford Spelling (See Appendix II).

The mixed handed group was subdivided into two groups: those subjects who wrote with their right hand (RM) and those that wrote with their left hand (LM). All handedness groups were contrasted.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	RH	204	-.0421	.969			
	RM	38	-.2598	.290	LM>LH		
	LM	23	.0538	1.179			
	LH	36	-.4713	1.080	LM>RH>RM>LH		
Slosson Oral	RH	207	-.0445	.977	RH>RM	2.12	.035
	RM	38	-.4094	.912	RH>LH	1.87	.062
	LM	23	.0193	.905	LM>RM	1.67	.097
	LH	36	-.3741	1.062	LM>RH>LH>RM		
Stanford Spelling	RH	190	-.0656	.973	RH>LH	2.06	.041
	RM	34	-.2915	.982	LM>LH		
	LM	22	.1379	1.097			
	LH	35	-.4424	1.066	LM>RH>RM>LH		
Stanford Word Skills	RH	149	-.1236	.976	RH>RM	2.21	.028
	RM	31	-.5575	.796	LM>RM		
	LM	18	.1952	1.176	LM>LH	1.68	.094
	LH	27	-.3134	1.165	LM>RH>LH>RM		
Stanford Reading Comprehension				ns.			
				LM>RM>RH>LH			
Math	RH	178	.0210	1.022	(RH>RM)	1.61	.109)
	RM	36	-.2726	.908	(RH>LH)	1.62	.107)
	LM	22	.1204	.776			
	LH	31	-.2930	.969	LM>RH>RM>LH		

The left mixed group received significantly higher scores than the left handed on the Gray Oral and Stanford Spelling and than the right mixed on the Stanford Word Skills. The right handed had significantly higher scores than the right mixed on the Slosson Oral and the Stanford Word Skills and than the left handed on the Stanford Spelling. The left mixed group received the highest scores on all measures; the left handed and right mixed handed were the lowest performing groups.

COGNITIVE MEASURES

The following analyses contrasted RH, MH and LH groups.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	Total	251	100.46	12.53			ns.
					MH>RH>LH		

VERBAL MEASURES

Similarities	RH	143	11.01	3.04	RH>LH	1.70	.091
	MH	48	10.85	2.77			
	LH	26	9.96	2.37	RH>MH>LH		

There were no significant contrasts. The left handed were the lowest performing group on five of the six verbal subtests and on the VIQ. They received the highest scores on the Peabody Picture Vocabulary Test Percentile.

SPATIAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
PIQ	Total	254	101.19	15.19			ns.
					MH>LH>RH		
Berea	RH	133	-6.27	2.98	MH>LH	1.68	.094
Gestalt	MH	35	-6.00	2.62			
Deviation	LH	24	-7.29	2.81	MH>RH>LH		

There were no significant contrasts between the handedness group on any spatial measure. There was no obvious pattern of performance on spatial tests.

The following contrasts were on the handedness variables divided into RH, RM, LM, LH groups.

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ					LM>RH>RM>LH		

VERBAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
VIQ					LM>RH>RM>LH		ns.
Similarities	Total	217	10.85	2.91	RH>LH RH>LM>RM>LH	1.69	.092
Arithmetic	RH	143	8.46	2.65	RH>RM	1.68	.095
	RM	25	7.52	2.93	LM>RM	2.14	.034
	LM	22	9.14	2.26	LM>LH	1.87	.062
	LH	25	7.72	2.05	LM>RH>LH>RM		

There was only one significant contrast. The left mixed received significantly higher scores than the right mixed handed on Arithmetic. The left mixed received the highest scores on five of the six verbal subtests and the VIQ. As above, the left handed received the lowest scores on five of the six verbal subtests and the VIQ.

SPATIAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
PIQ					LM>LH>RM>RH		ns.
Block Design					LM>RH LM>LH>RM>RH	1.83	.069
Berea Gestalt Deviation	RH	133	-6.27	2.98	RM>LH	2.05	.042
	RM	18	-5.44	2.23			
	LM	17	-6.59	2.94			
	LH	24	-7.29	2.81	RM>RH>LM>LH		

There was only one significant contrast; the right mixed received higher scores than the left handed on the Berea Gestalt.

BANNATYNE FACTORS:

Verbal (Sim. + Vocab. + Compreh.)	RH>LM>RM>LH
Spatial (P.C.+ B.D. + O.A.)	LM>RM>LH>RH
Sequencing (Arith. + D.S. + Cod.)	RH>LM>LH>RM
Acquired Knowledge (Info. + Vocab. + Arith.)	LM>LH 1.72 .088 LM>RH>RM>LH

In, summary, there were very few differences that were significant or approached significance between the handedness groups on cognitive tests.

PSYCHOPATHOLOGY

The following analyses contrasted right, mixed and left handed groups.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Report by Self</u>							
Conners	RH	239	-.0434	.978	LH>RH	1.70	.098 N-K
Hyperactivity	MH	66	-.0473	.852			
Index by Self	LH	34	.3149	1.176	LH>RH>MH (separate variance)		

On the self-esteem measures, the left handed rated themselves highest, i.e., most symptomatic, most often, but no contrast was significant. The left handed rated themselves significantly higher than the right handed on the Conners Hyperactivity Index. The mixed handed were rated highest on three of the four indices of hyperactivity/ADD by teachers and parents, but no contrasts were significant.

The handedness groups were subdivided into the right mixed and left mixed groups and all handedness groups were contrasted.

PSYCHOPATHOLOGY

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Report by Self</u>							
Short Child Depression Inventory	RH	172	-.0077	1.026	LM>RH	1.79	.075
	RM	30	-.1497	.647	LM>RM	1.97	.050
	LM	18	.4304	.943			
	LH	23	-.0554	1.084	LM>RH>LH>RM		
Coopersmith Self-Esteem Long Form	RH	184	-.0422	.999	LM>RH	1.92	.056
	RM	30	-.0141	.920			
	LM	18	.4278	.875			
	LH	24	.1967	1.078	LM>LH>RM>RH		
Coopersmith Self-Esteem Short Form	RH	60	-.0063	.943	LH>LM	2.34	.017
	RM	6	.4298	.605	RM>LM	2.11	.038
	LM	9	-.6654	1.089	RH>LM	1.87	.065
	LH	9	.4652	1.326	LH>RM>RH>LM		
Conners Hyperactivity Index by Self	RH	239	-.0434	.978	LH>LM	1.84	.070
	RM	37	.0491	.801	LH>RH	1.70	.098
	LM	29	-.1703	.912			
	LH	34	.3149	1.176	LH>RM>RH>LM		
<u>Report by Others</u>							
Conners by Tutor	HI				RM>RH	1.68	.094
					RM>LH>RH>LM		

When the mixed group is subdivided and all handedness groups are contrasted, the left mixed received significantly higher scores than the right mixed handed on the Short Child Depression Inventory. The left handed and right mixed handed received the highest score on the Coopersmith Self-Esteem, short form. The left mixed received the highest scores on the both measures of depression, the long form of the Coopersmith Self-Esteem Inventory and three of the measures of hyperactivity and attention disorder rated by others, although none of these reached significance.

SUMMARY

Achievement

In the total sample and the dyslexic subgroup, when the division of the handedness category is right, left and mixed, the performance of the mixed handedness group is misleading. When the mixed group is divided into left and right mixed, it is apparent that the left mixed receive the highest achievement scores and are nonsignificantly better than the right handed. The right mixed handed and the left handed receive the lowest scores. One or both of these groups are often significantly inferior to one or both of the highest groups.

Cognitive

Verbal: In the total sample the left mixed often were ranked highest, but only one contrast was significant. The left mixed received higher scores on Arithmetic than the right mixed. The left mixed received marginally higher scores than the left handed on the Bannatyne acquired knowledge factor. In the dyslexic group, the right handed and the left mixed handed were superior to the right mixed handed on Arithmetic. The right handed obtained higher scores on the sequencing factor than the right mixed handed.

Spatial: In the total sample the left mixed were often the nonsignificantly highest scoring group, although the one significant contrast found the right mixed handed superior to the left handed on the Barea Gestalt. In the dyslexic subset, the left handed received higher scores than the right handed and the left mixed handed on Object Assembly. The right mixed received higher scores than the left handed on the Barea Gestalt.

Psychopathology

In the total sample, the left handed rated themselves higher on the Conners Hyperactivity Index than the right handed and were higher than the left mixed on the Coopersmith, short form. The right mixed were higher than the left mixed on the short form. In the dyslexic group, the left mixed handed rated themselves higher than all groups on the Short Child Depression Inventory; the only significant contrast was with the right mixed handed. The left mixed ranked highest on the Birleson Depression Inventory and the Coopersmith Self-Esteem Inventory-long form. The right mixed, however, was significantly higher than the left mixed on the short form of the Coopersmith. There were no significant contrasts on the measures of hyperactivity/ADD rated by teachers or parents.

In the dyslexic group the mixed handed rated themselves highest on the Birleson; although the left handed ranked lowest, the contrast was only significant for the right handed, a larger group. When the mixed handed group was broken down, the left mixed had rated themselves significantly higher all three other groups. Again the left handed ranked the lowest. The left mixed were significantly higher than the right handed on the Coopersmith Self-Esteem Inventory, long form.

There were no significant differences between the groups on the hyperactivity/ADD indices rated by parents or teachers although the left handed ranked lowest on all.

II. FAMILY HISTORY OF SINISTRALITY

Subjects with FS+ or FS- were contrasted. There was no significant difference in age between the two groups. Only those contrasts which reached or approached significance are reported here. Results for the total group are presented in section A; those for the dyslexic group are presented in section B.

A. ALL SUBJECTS

ACHIEVEMENT MEASURES

There were no main effects for any achievement measure for FS.

COGNITIVE MEASURES

Variable	FS-			FS+			t value	df	Probab
	N	Means	Std.Dev.	N	Means	Std.Dev.			
<u>VERBAL MEASURES</u>									
VIQ	56	97.86	11.01	70	102.84	14.37	2.14	124.8	.029
Arithmetic	47	7.77	2.18	61	9.13	3.14	2.66	104.9	.009
Vocabulary	47	9.53	2.20	62	10.40	3.24	1.67	105.8	.097

FS+ subjects received higher scores on all verbal measures and performed significantly better on VIQ, and Arithmetic than FS- subjects.

SPATIAL MEASURES

Variable	FS-			FS+			t value	df	Probab
	N	Means	Std.Dev.	N	Means	Std.Dev.			
Karnovsky TMR-Picture Mirror Errors	40	0.17	1.16	40	-0.31	0.94	2.05	78	.043

FS+ subjects received higher scores on 14 of 15 verbal measures and were significantly better than FS- subjects on Mirror Errors on the Picture form of the Karnovsky Test of Mental Rotation.

PSYCHOPATHOLOGY

Variable	FS-			FS+			t value	df	Probab
	N	Means	Std.Dev.	N	Means	Std.Dev.			
<u>Report by Others</u>									
Conners Hyperactivity Index by Parents									
	108	-0.25	0.85	124	0.14	1.07	3.10	228.1	.002
SNAP	112	-0.24	0.78	124	0.12	1.07	2.98	224.6	.003

The FS+ subjects received higher scores, evidence of more psychopathology, than the FS- subjects, on six of ten measures of psychopathology. The differences were significant on the two forms assessing hyperactivity/attentional deficit disorder rated by parents.

BANNATYNE FACTORS

Factor	FS-			FS+			t value	df	Probab
	N	Means	Std.Dev.	N	Means	Std.Dev.			
Acq.	41	26.59	5.04	60	29.30	7.37	2.25	102.8	.027

FS+ subjects received higher scores on the Bannatyne Factor acquired knowledge than the FS- subjects.

B. DYSLEXIC SUBJECTS

ACHIEVEMENT MEASURES

There were no main effects for FS on any achievement measure.

COGNITIVE MEASURES

Variable	FS-			FS+			t value	df	Probab
	N	Means	Std.Dev.	N	Means	Std.Dev.			
FSIQ	36	97.64	13.13	40	102.90	13.40	1.73	74	.089

SPATIAL MEASURES

Picture Arrangement	32	10.69	2.88	35	12.14	2.81	2.09	65	.040
Object Assembly	30	9.87	3.99	33	11.61	3.58	1.82	61	.073
Coding	31	7.06	3.52	37	8.49	3.18	1.75	66	.085

In summary, on the verbal measures, there were no significant differences between the dyslexic FS+ and FS- groups, although the FS+ received higher scores on all verbal measures. Dyslexic FS+ received higher scores on the majority of spatial measures, and performed significantly higher on Picture Arrangement than FS- subjects.

PSYCHOPATHOLOGY MEASURES

Variable	FS-			FS+			t value	df	Probab
	N	Means	Std.Dev.	N	Means	Std.Dev.			
<u>Report by Self</u>									
Coopersmith Self-Esteem									
Long Form	25	-0.38	0.62	39	0.12	0.94	2.54	61.9	.014
<u>Report by Others</u>									
Conners' Hyperactivity Index									
by Parents									
	45	-0.25	0.87	66	0.13	0.13	1.89	109	.062
SNAP	46	-0.22	0.75	67	0.11	1.10	1.90	111	.060

Dyslexic FS+ received higher scores on five of ten measures than FS-. FS+ subjects rated themselves as having less self-esteem, as rated by the the long form of the Coopersmith. The FS+ subjects received marginally higher scores on the forms assessing hyperactivity/ attentional deficit disorder rated by their parents.

Summary

Achievement

There were no differences between FS+ and FS- subjects in the total sample or in the dyslexic subgroup on achievement testing.

Cognitive

Verbal: FS+ received higher scores on all verbal measures in both groups, although only in the total sample did three contrasts reach significance. Although the FS+ received higher scores on all of the Bannatyne factors, the only significant contrasts was on acquired knowledge (Information, Arithmetic, Vocabulary), all verbal measures.

Spatial: FS+ received higher spatial scores than the FS- in both groups which reached or approached significance for one contrast in the total sample and three contrasts in the dyslexic sample.

Psychopathology

In both samples FS+ subjects were rated as having less self-esteem than FS- subjects and they were rated as more hyperactive/ attentional disordered by their parents on two measures.

III. SEX

The sexes were contrasted for achievement, cognitive and psychopathology measures. Those contrasts which reached or approached significance are reported here. The contrasts for the total groups are presented in section A. The contrasts for the dyslexic group are presented in section B.

A. ALL SUBJECTS

ACHIEVEMENT MEASURES

Variable	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
Gray Oral	255	.0210	.981	60	.4354	1.013	2.93	313	.004
Slosson Oral	258	.0540	.996	60	.3059	.886	1.80	316	.073
St. Spelling	235	-.0345	.957	57	.5053	1.042	3.75	290	.000

Females received higher scores on all achievement tests than males. The differences were significant on the Gray Oral and the Stanford Spelling Test.

COGNITIVE MEASURES

Variable	N	Mean	Std.Dev.	N	Mean	Std.Dev.	t	df	Prob.
FSIQ	209	101.40	12.47	51	97.67	12.09	1.93	258	.055

VERBAL MEASURES

Variable	N	Mean	Std.Dev.	N	Mean	Std.Dev.	t	df	Prob.
VIQ	210	100.58	12.00	53	95.79	13.00	2.56	264	.011
Info	178	9.60	2.51	48	8.31	2.38	3.20	224	.002
Vocabulary	175	9.79	2.57	48	8.98	2.63	1.92	221	.056
PPVT Perc.	177	61.62	27.62	46	46.93	27.05	3.22	221	.001

Males received higher scores on all of the verbal measures. The differences reached significance on VIQ, Information, and the Peabody Picture Vocabulary Test Percentile.

SPATIAL MEASURES

Variable	Male			Female			t	df	Probab.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
Block Dsgn.	175	10.67	3.44	47	9.00	2.81	3.07	220	.002
Coding	177	7.70	3.37	44	9.59	2.94	3.41	219	.001

In the total sample males received higher scores on the majority of spatial measures. They were significantly higher on Block Design. Females received significantly higher scores on Coding.

BANNATYNE FACTORS

Factor	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
Spatial	170	32.53	8.68	45	29.31	7.50	2.27	213	.024
Acquired Knowledge	171	27.87	5.96	48	25.33	6.20	2.58	217	.010

Males received higher scores on all Bannatyne factors; the differences on the spatial and acquired knowledge reached significance.

PSYCHOPATHOLOGY

Variable	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
Coopersmith Self-Esteem Short Form	62	-0.15	1.02	22	0.43	0.89	-2.33	82	.022

In the total sample females received significantly higher scores, indicative of more symptoms, on the short form of the Coopersmith Self-Esteem Inventory, and scored higher than the males on eight of the ten measures.

B. DYSLEXIC SUBJECTS

Based on their performance on the Gray Oral, the dyslexic group represents 75% of the males and 65% of the females of the total sample. A dyslexic performance was defined as three or more grade deviations below expectation for age.

ACHIEVEMENT MEASURES

Variable	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
St.Spelling	176	-0.26	0.89	37	0.11	0.94	2.21	211	.028

Dyslexic females received higher scores on four of the six achievement measures and scored significantly higher on the Stanford Spelling test than dyslexic males.

COGNITIVE MEASURES

Variable	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
FSIQ	125	100.45	12.23	24	94.38	6.95	3.39	54.9	.001

VERBAL MEASURES

VIQ	127	99.17	11.53	25	92.08	7.08	4.06	52.9	.000
Information	117	9.43	2.50	25	7.36	2.10	3.85	140	.000
Vocabulary	114	9.69	2.53	25	8.24	1.62	3.00	52.8	.004
Digit Span	107	8.09	3.11	21	6.52	2.86	2.14	126	.034

Dyslexic males received higher scores on all verbal measures and were significantly higher than the dyslexic females on VIQ, Information, Vocabulary and Digit Span.

SPATIAL MEASURES

Variable	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
PIQ	127	101.85	16.13	24	96.63	10.64	2.01	45.7	.050
Picture Completion									
Picture Completion	114	11.25	3.31	24	10.04	2.33	2.14	45	.038
Block Design									
Block Design	115	10.68	3.59	24	8.21	2.75	3.18	137	.002
Coding									
Coding	115	7.27	3.00	22	9.59	3.17	3.38	127	.001
Karnovsky Test of Mental Rotation: Pictures Form									
Mirror Error	80	-0.08	0.98	18	0.50	1.01	2.30	96	.024
Total Err.	79	-0.05	0.97	18	0.72	0.77	3.16	95	.002
Shapes Form									
Mirror Err.	80	-0.12	0.90	18	0.51	0.98	2.67	96	.009
Total Err.	79	-0.13	0.85	18	0.75	0.96	3.88	95	.000
Both Forms									
Total Err.	76	-0.10	0.91	18	0.82	0.84	3.91	92	.000

Dyslexic males received higher scores on the majority of the spatial measures, and were significantly higher on all of the above, except for Coding on which the females excelled.

PSYCHOPATHOLOGY

Variable	Male			Female			t	df	Prob.
	N	Mean	Std.Dev.	N	Mean	Std.Dev.			
<u>Report by Self</u>									
Birleson Depression Inventory									
	147	-0.08	0.96	29	0.49	1.17	2.78	174	.006
Short Child Depression Inventory									
	112	-0.60	0.96	18	0.46	1.03	2.11	128	.037
Coopersmith Self-Esteem Inventory-Long Form									
	118	-0.15	0.92	21	0.58	1.08	3.27	137	.001
Coopersmith Self-Esteem Inventory-Short Form									
	27	0.03	1.09	8	0.88	0.91	2.01	33	.053

Dyslexic females received higher scores, indicative of more pathology, on seven of the ten measures of psychopathology than the dyslexic males. The differences reached significance on the Birleson and the Short Child Depression Inventories and both the long and the short form of the Coopersmith Self-Esteem Inventory.

Summary

Achievement

Females, in both groups, received higher scores on 11 of the 12 measures. This difference achieved significance for Gray Oral and Stanford Spelling in the total sample and on the Stanford Spelling for the dyslexic group.

Cognitive

Verbal: Males in the total sample received significantly higher scores on VIQ, Information and the Peabody Picture Vocabulary Test Percentile and on VIQ, Information, Vocabulary and Digit Span in the dyslexic subgroup than females. Males received nonsignificantly higher scores on the Bannatyne verbal factor and significantly higher scores on the acquired knowledge factor.

Spatial: In the total group, males received significantly higher scores on Block Design. In the dyslexic group, males performed better on PIQ, Picture Completion and Block Design. Males received significantly higher scores on Mirror Errors and Total Errors on the Picture and the Shape forms and the combined Total Errors of the Karnovsky Mental Rotation Test. Males received significantly higher scores on the Bannatyne spatial factor. Females in both groups were superior on Coding.

Psychopathology

Females in the total sample received higher scores, indicative of more psychopathology, on the short form of the Coopersmith Self-Esteem Inventory. The dyslexic females received higher scores on the two measures of depression and the two measures of self-esteem. No measure of hyperactivity/attention disorder by the student, teachers nor parents differentiated the sexes.

IV. HAND AND SEX INTERACTIONS

The interactions were assessed with the handedness variable in divided into right, mixed and left groups. Male right, mixed and left handed are abbreviated: MR, MM, ML; females are FR, FM, FL. Only variables with contrasts that were significant or approached significant are reported here. Complete tables are in Appendix III.

ACHIEVEMENT MEASURES

Variables	Group	N	Means	Std.Dev.	Contrasts	T-Value	Probability
Gray Oral	MR	163	.0644	.936	FR>MR	3.05	.003 N-K
	MM	51	.0366	1.059	FR>MM	2.68	.008 N-K
	ML	29	-.2885	1.059	FR>ML	3.05	.002 N-K S
	FR	41	.5868	.995	MR>ML	1.79	.075
	FM	10	.2248	.882			
	FL	7	-.1909	1.278	Rank Order: FR>FM>MR>MM>FL>ML		
Slosson Oral	MR	166	.1255	.982	FR>ML	2.40	.017
	MM	51	-.0609	.960	FR>MM	2.16	.031
	ML	29	-.1886	1.131			
	FR	41	.3877	.945			
	FM	10	.1332	.738			
	FL	7	-.0512	.800	Rank Order: FR>FM>MR>MM>FL>ML		
Stanford Spelling	MR	150	.0039	.923	FR>MR	3.51	.001 N-K S
	MM	46	-.0192	1.031	FR>MM	3.00	.003 N-K S
	ML	29	-.3093	1.048	FR>ML	3.88	.000 N-K
	FR	40	.6094	1.016	FM>ML	2.16	.032
	FM	10	.4650	1.040			
	FL	6	-.0773	1.286	Rank Order: FR>FM>MR>MM>FL>ML		
Stanford Reading Comprehension	MR	106	.0116	.896	FM>ML	2.37	.034
	MM	36	.0745	1.098			
	ML	13	-.4118	1.100			
	FR	18	.1464	1.019			
	FM	6	.6972	.872			
	FL	5	.1133	1.415	Rank Order: FM>FR>FL>MM>MR>ML		

Math	MR	.1428	FR>ML	1.99	.048
	MM	.0292	FR>MM	1.84	.067
	ML	-.0907			
	FR	.4338			
	FM	.1861			
	FL	-.2191			
			Rank Order: FR>FM>MR>MM>ML>FL		

Right handed females were the highest performing group; followed by the mixed handed females. Right handed females performed significantly better on the Gray Oral and Stanford Spelling than the right handed males and significantly better than the mixed and left handed males on the Gray Oral, the Slosson Oral, and the Stanford Spelling. Right handed females were superior to left handed males on Math. Mixed handed females received significantly better scores than left handed males on the Stanford Spelling and the Stanford Reading Test. Left handed males were the lowest performing group on four of six measures. The mixed handed females were the highest performing group on the Stanford Reading Comprehension Test.

COGNITIVE MEASURES

Variables	Group	N	Means	Std.Dev.	Contrasts	T-Value	Probability
FSIQ	MR	139	101.06	12.80	MR>FL	2.41	.036
	MM	41	101.29	12.34	MM>FL	2.16	.045
	ML	22	101.18	11.55	ML>FL	1.91	.070
	FR	34	97.41	13.92	FM>FL	2.45	.029
	FM	7	103.00	6.40			
	FL	8	95.50	7.05			
Rank Order: FM>MM>ML>MR>FR>FL							

VERBAL MEASURES

VIQ	MR	141	100.45	12.52	MR>FL	4.07	.001
	MM	42	100.86	11.73	MM>FL	3.26	.002
	ML	22	98.45	9.28	ML>FL	2.06	.049
	FR	34	97.09	15.49			
	FM	7	96.14	7.86			
	FL	9	93.56	3.97			
Rank Order: MM>MR>ML>FR>FM>FL							
Information	MR	113	9.53	2.59	ML>FR	1.79	.075
	MM	42	9.69	2.46	MM>FR	2.54	.012
	ML	17	9.53	2.27	MR>FR	2.65	.009 N-K
	FR	30	8.17	2.38	MR>FL	1.66	.099
	FM	7	10.00	2.24	MM>FL	1.74	.084
	FL	9	8.11	1.69	FM>FR	1.76	.079
Rank Order: FM>MM>ML=MR>FR>FL							
Arithmetic	MR	113	8.45	2.73	MR>FL	3.56	.004
	MM	40	8.25	2.61	MM>FL	2.88	.010 N-K
	ML	16	8.56	1.75	ML>FL	3.25	.005
	FR	30	8.50	2.36	FR>FL	3.18	.005
	FM	7	8.42	3.60			
	FL	9	6.22	1.72			
Rank Order: ML>FR>MR>FM>MM>FL							
Peabody	MR	117	60.09	28.17	ML>FR	2.84	.005 N-K
Picture	MM	37	60.76	29.26	MM>MR	1.73	.085
Vocabulary	ML	16	72.88	20.21	MM>FR	1.80	.074
Percentile	FR	31	48.61	27.42	MR>FR	2.05	.042
	FM	6	54.83	29.98	MR>FL	2.46	.015
	FL	7	33.57	26.28	MM>FL	2.38	.018
Rank Order: ML>MM>MR>FM>FR>FL							

All three male groups performed significantly better than the left handed females on VIQ, Arithmetic and Peabody Picture Vocabulary Percentile. Right and mixed handed males were superior to right handed females on Information and right and left handed males were superior to right handed females on the Peabody. Right handed females were superior to left handed females on Arithmetic.

SPATIAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
PIQ	Total	253	101.19	15.19	Rank Order: FM>ML>MM>MR>FR>FL		
Block Design	MR	111	10.39	3.68	ML>FR	2.54	.012
	MM	41	11.07	3.04	MM>FR	2.87	.005 N-K
	ML	17	11.35	2.91	MR>FR	2.37	.019 N-K
	FR	27	8.73	2.98	MM>FL	1.89	.060
	FM	7	9.86	2.79	ML>FL	1.90	.059
	FL	8	8.63	2.20	Rank Order: ML>MM>MR>FM>FR>FL		
Object Assembly	MR	109	10.83	3.72	ML>FR	1.71	.090
	MM	40	10.83	3.64	MR>FR	1.88	.061
	ML	17	11.29	3.58			
	FR	29	9.38	3.57			
	FM	6	11.83	3.82			
	FL	8	11.00	2.88	Rank Order: FM>ML>FL>MR=MM>FR		
Coding	MR	113	7.67	2.81	FR>ML	2.12	.035 N-K
	MM	41	7.26	3.53	FR>MM	3.60	.001 N-K S
	ML	17	7.88	4.73	FR>MR	4.03	.000 N-K S
	FR	27	9.93	2.61	FM>MR	2.23	.061
	FM	7	10.71	3.55	FM>MM	2.38	.042
	FL	8	7.38	2.92	FR>FL	2.23	.048
				FM>FL	1.97	.072	
				Rank Order: FM>FR>ML>MR>FL>MM			
Berea Gestalt	MR	102	-6.41	2.98	MR>FL	1.71	.088
	MM	30	-6.00	2.75	MM>FL	1.93	.055
	ML	18	-6.89	2.81	FR>FL	2.08	.039
	FR	31	-5.81	2.98			
	FM	5	-6.00	1.87			
	FL	6	-8.50	2.66	Rank Order FR>MM=FM>MR>ML>FL		
Karnovsky Test of Mental Rotations					(Rank Order by Performance)		
Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Picture: Mirror Errors	MR	92	-.0194	.973	ML>FR	2.030	.045
	MM	30	-.0229	1.085	ML>MR	1.72	.079
	ML	16	-.4943	.729			
	FR	20	.1791	1.102			
	FM	8	.0678	.682			
	FL	9	.1435	1.044	Rank Order: ML>MM>MR>FM>FL>FR		

Picture:	MR	92	-.1066	.981	ML>FR	2.07	.040
Total Errors	MM	30	.0427	.989	MR>FR	1.68	.095
	ML	15	-.3928	1.015			
	FR	20	.3007	1.018			
	FM	8	.0541	.962			
	FL	9	.2221	.984	Rank Order:	ML>MR>MM>FM>FL>FR	

Shape: Mirror Errors					ML>FL	1.93	.055
Total	176		-.0167	1.010	Rank Order:	ML>MR>FR>MM>FM>FL	

Shape:	MR	92	-.1212	1.013	MR>FL	2.07	.040
Total Errors	MM	31	.0007	.851	ML>FL	2.16	.032
	ML	14	-.3171	.937			
	FR	21	.0667	1.100			
	FM	8	.1336	.963			
	FL	9	.5961	1.048	Rank Order:	ML>MR>MM>FR>FM>FL	

Both Forms	MR	90	-.1353	.986	MR>FL	1.70	.092
Total Errors	MM	29	-.0092	.939	ML>FL	1.89	.061
	ML	13	-.3597	1.038	ML>FR	1.66	.098
	FR	20	.2258	1.029			
	FM	8	.0969	1.075			
	FL	9	.4523	.975	Rank Order:	ML>MR>MM>FM>FR>FL	

Left handed males received the highest scores on Block Design and all Karnovsky measures. Left handed females received the lowest ranking on Block design, Berea Gestalt deviation score and all measures of the Karnovsky measures on the Shape form. Female right handed received the highest scores on the Berea Gestalt and were significantly higher than all male groups and the female left handed on Coding. However, the female right handed were the lowest or one of the two lowest ranking on Block Design, Object Assembly and the Karnovsky measures on the Picture form. In summary, on most spatial measures the scores of all male groups were higher than those of the females and within the male group, the left handed were the highest ranking (except on the Berea Gestalt). On those measures for which fine motor control or reproduction of detail is required, the right and mixed handed females received relatively higher rankings than the males.

BANNATYNE FACTORS

Bannatyne factors were run with the mixed group separated into right and left mixed handed.

ALL SUBJECTS-HAND AND SEX

Group	Verbal			Spatial			Sequencing			Acquired		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
MR	110	31.7	7.2	108	32.3	8.9	100	24.5	6.3	109	27.8	6.2
FR	30	31.5	7.7	29	28.3	7.7	23	25.7	5.5	30	25.9	6.6
MRM	21	31.5	6.6	19	32.3	9.2	19	22.3	8.3	21	27.1	5.6
FRM	4	28.0	3.6	4	30.5	9.0	4	21.3	7.4	4	23.8	4.0
MLM	20	32.0	7.6	20	33.6	8.3	17	23.5	5.1	19	28.5	
FLM	3	29.3	3.1	2	36.5	3.5	2	35.0	2.8	3	32.7	2.3
ML	17	30.1	5.7	17	32.6	7.9	16	23.6	5.5	16	27.8	4.6
FL	9	28.3	3.5	8	29.6	7.0	7	20.7	5.2	9	22.8	4.3

Verbal Factor Contrasts: MLM> MR> FR> MRM> ML> FLM> FRM> FL
No significant differences

Spatial Factor Contrasts: FLM> MLM> ML> MRM> MR> FRM> FL> FR
MR>FR 2.22 .028 MLM>FR 2.12 .035 ML>FR 1.66 .100

Sequencing Factor Contrasts: FLM> FR> MR> ML> MLM> MRM> FRM> FL

Contrast	t	p	Contrast	t	p	Contrast	t	p
FLM>MR	5.00	.051	FLM>MRM	2.27	.010	FLM>MLM	3.98	
.028								
FLM>FR	4.02	.046	FLM>FRM	4.23	.027	FLM>ML	2.44	
.024								
FLM>FL	2.80	.008	FR>FL	4.02	.049			

Acquired Knowledge Factor Contrasts:			FLM>	MLM>	MR>	ML>	MRM>	FR>	FRM>	FL	
Contrast	t	p	Contrast	t	p	Contrast	t	p	Contrast	t	p
MR>FL	2.34	.021	FLM>FRM	1.94	.053	FLM>FL	2.44				
.015											
FLM>FR	1.86	.064	MLM>FL	2.30	.023	ML>FL	1.94				
.053											
MRM>FL	1.78	.077									

On the Bannatyne factors there were no significant contrasts on the verbal factor; the right handed females were significantly lower than the right and mixed left handed males. The mixed left handed of both sexes ranked higher than the left handed males. (There were very few

female mixed left handed and the mixed left handed males, N=20, received only one point more than the left handed males.)

There were more significant contrasts on the sequencing and acquired knowledge factors. Most of these involved the mixed left handed females, of whom there were very few, but whose scores were much higher than all of the other subgroups. Right handed females were significantly higher than left handed females on both factors. Left handed females rank lowest on the verbal, sequencing and acquired knowledge factor.

PSYCHOPATHOLOGICAL MEASURES

Variables	Group	N	Means	Std.Dev.	Contrasts	T-Value	Probability
<u>Self Report Measures</u>							
Coopersmith	MR	158	-.1163	.933	FR>MR	2.03	.051
Self-Esteem	MM	40	.0626	.912	FM>MR	2.23	.055
Inventory	ML	16	-.0041	1.106	FL>MR	2.06	.073
Long Form	FR	26	.4082	1.262			
	FM	8	.5966	.878			
	FL	8	.5983	.961	Rank Order: FL>FM>FR>MM>ML>MR		
Coopersmith	MR	43	-.1466	.959	FR>MM	2.57	.018
Self-Esteem	MM	11	-.5070	.879	FR>MR	2.00	.054
Inventory	ML	8	.3648	1.380	FM>MM	1.83	.071
Short Form	FR	17	.3483	.825	FL>MM	1.73	.088
	FM	4	.5418	1.249			
	FL	1	1.2682	-	Rank Order: FL>FM>ML>FR>MR>MM		
<u>Report by Others</u>							
Conners HI by Classroom Teacher							
	Total	169	-.0301	.973	MM>ML	1.77	.077
						Rank Order: FL>MM>MR>FR>FM>ML	
Conners HI by Parent							
					FR>ML	1.66	.098
					FL>ML	1.78	.076
	Total	279	-.0101	1.013	Rank Order: FL>FM>FR>MR>MM>ML		

Summary

Achievement

In the total sample, right handed females in the total sample received higher scores than all male groups on the Gray Oral Reading and the Stanford Spelling Tests, than two male groups on the Slosson Oral Reading and one male group on Math. Mixed hand females were superior to left handed males on the Stanford Reading Comprehension Test. In the dyslexic group, for which only about one third of the right handed females from the complete sample met the criteria, female mixed handed receive higher scores than all of the male groups, usually than the female right handed and always than the female left handed. Right and mixed handed males received nonsignificantly higher scores than left handed males. measures. (The results of the regression analyses in Chapter VII clarify the relative performance of the left and right mixed handed groups.) The female left handed perform the poorest on all achievement measures.

Cognitive

In general females perform less well than the males. Among the females, the mixed handed perform the best. Note: there are no female mixed handed with FS-. Right handed females received low spatial scores, except on Coding and the Berea Gestalt. Left handed males often received the highest spatial scores, left handed females the lowest.

There were no significant contrasts on the Bannatyne verbal factor in either the the total or dyslexic groups. The few reportable contrasts on the spatial factor underscored the some of the poor spatial skills of the right handed females in this sample. Bannatyne sequencing

and acquired knowledge factors revealed that the left mixed handed females, although very few in number, recieved often significantly higher scores than most other hand and sex subsets. In the dyslexic subgroup, mixed right handed males and females and left handed females were the lowest the lowest ranking groups on the sequencing factor. These three groups and the female right handed were the lowest ranking on acquired knowledge factor.

Psychopathology

In the total sample, females received higher scores, indicative of more symptomatology, than males. The left handed and mixed handed females were often the highest ranking.

In the dyslexic sample, the female mixed handed group rated themselves as more depressed on the Birleson Depression Inventory than two male groups. Left handed females were the highest scoring on two of the self report measures. Right handed females rated themselves high on the Birleson and the short form of the Coopersmith; they were also rated highest by parents. Left handed males were often the lowest rated group.

V. HAND AND FAMILY HISTORY OF SINISTRALITY

Six hand by FS groups were contrasted. Subject groups with a positive family history of sinistrality (FS+) and who were right, mixed and left handed were abbreviated R+, M+ and L+ respectively. Similarly those with FS- were abbreviated R-, M- and L-. Significant and marginal contrasts are reported in this chapter. Complete tables are in Appendix IV.

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	R-	50	.0250	.894	R->L+	2.63	.009
	M-	11	-.4484	.859	R+>L+	2.04	.043
	L-	10	-.3634	1.088	M+>L+	2.74	.007
	R+	55	-.1445	.920	M->L+	1.79	.075
	M+	18	.1972	.930			
	L+	15	-.7048	1.136	Rank Order: M+>R->R+>L->M->L+		
Slosson Oral	R-	51	.0965	.944	R->L+	2.55	.012
	M-	11	-.2117	.752	M+>L+	2.42	.017
	L-	10	-.2793	1.111	R+>L+	1.75	.083
	R+	55	-.1399	1.041			
	M+	18	.1908	.713			
	L+	15	-.6382	1.168	Rank Order: M+>R->R+>M->L->L+		
Stanford Spelling	R-	49	-.0218	.888	M+>L+	3.23	.002 N-K
	M-	10	-.2174	.988	R->L+	2.64	.009
	L-	9	-.2160	1.334	M+>R+	2.02	.045
	R+	50	-.2118	.873	R+>L+	1.96	.052
	M+	17	.3194	.892			
	L+	15	-.7521	1.044	Rank Order: M+>R->R+>L->M->L+		
Stanford Word Skills	R-	33	-.1594	1.118	M+>L+	3.06	.003 N-K
	M-	8	.0296	1.118	L->L+	2.34	.021 N-K
	L-	9	.1138	1.432	R+>L+	2.15	.034 N-K
	R+	44	-.2096	.738	R->L+	2.22	.028
	M+	15	.2848	1.171	M->L+	2.09	.038
	L+	10	-.9559	.728	M+>R+	1.67	.098
					Rank Order: M+>L->M->R->R+>L+		

Stanford	R-	22	-.1088	.846	M+>L+	3.02	.003	N-K
Reading	M-	6	-.1804	.978	R+>L+	1.97	.052	
Comprehension	L-	7	.0117	1.341	M+>R+	1.96	.053	
	R+	33	-.0783	.915	M+>R-	1.93	.057	
	M+	13	.5265	.896	R->L+	1.85	.069	
	L+	5	-.9696	.993	L->L+	1.78	.079	
Rank Order: M+>L->R+>R->M->L+								
Math	R-	43	-.1661	1.032	R+>L+	2.34	.021	
	M-	11	-.1933	.915	R->L+	1.68	.096	
	L-	9	-.0782	.746				
	R+	49	.0444	1.044				
	M+	17	-.1252	.996				
	L+	13	-.6931	1.065				
Rank Order: R+>L->M+>R->M->L+								

Overall the M+ received the highest scores and the L+ received the lowest on the reading and spelling measures. The M+, R-, and R+ significantly higher scores than the L+ the Gray Oral and Stanford Spelling. M+ were superior to R+ on the spelling test. R- and M+ were superior to L+ on the Slosson Oral and all groups performed significantly better than L+ on the Stanford Word Skills. M+ and R+ received higher scores than L+ and M+ were superior to R+ on Reading Comprehension. R+ received significantly higher scores than R- on Math. The pattern R->R+>L+ was found in the Gray, Slosson, Spelling, and Word Skills, although the differences between each group was not always significant.

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	R-	36	97.58	11.81	M+>R-	2.01	.047
	M-	10	98.80	11.20			
	L-	9	100.44	13.69			
	R+	46	104.49	15.81			
	M+	16	105.69	10.68			
	L+	7	95.71	12.09			
Total		123	101.37	13.62	Rank Order: M+>R+>L->M->R->L+		

VERBAL MEASURES

VIQ	R-	36	97.33	11.20	R+>R-	2.23	.029
	M-	10	99.90	10.02	M+>R-	1.92	.066
	L-	9	98.78	12.30	R+>L+	3.81	.000
	R+	46	104.02	15.92	M+>L+	3.18	.005
	M+	16	103.94	11.60			
	L+	8	93.88	3.56			
Total		125	100.73	13.18	Rank Order: R+>M+>M->L->R->L+		

Information	R-	30	8.87	2.54	M+>R-	2.12	.036
	M-	10	10.10	2.72	M->L+	2.10	.038
	L-	8	9.38	2.00	R+>L+	2.16	.033
	R+	39	9.72	2.97	M+>L+	2.68	.009
	M+	16	10.56	2.03			
	L+	7	7.43	1.51	Rank Order: M+>M->R+>L->R->L+		

Arithmetic	R-	29	7.38	2.09	R+>R-	3.41	.001 N-K
	M-	10	8.40	2.45	R+>L+	2.32	.022
	L-	8	8.38	2.06			
	R+	40	9.60	3.31			
	M+	15	8.80	2.54			
	L+	6	6.83	2.56	Rank Order: R+>M+>M->L->R->L+		

Vocabulary	R-	29	9.41	2.19	M+>R-	1.86	.074
	M-	10	8.80	1.87	R+>L+	1.83	.081
	L-	8	9.63	2.77	M+>L+	2.18	.041
	R+	39	10.44	3.58			
	M+	16	10.94	2.84			
	L+	7	9.00	1.41	Rank Order: M+>R+>M->L->R->L+		

Peabody Picture Vocabulary Test							
Percentile Total		84	59.59	29.48	R+>R-	1.71	.091
					Rank Order: M->R+>L->M+>R->L+		

R+ and M+ most often received the highest scores on verbal tests.

L+ and R- were the lowest performing groups. R+ and M+ were superior on VIQ and Information to L+. M+ received significantly higher scores than

R- on Information. R+ performed significantly better than R- on VIQ and Arithmetic and than L+ on Arithmetic. M- were superior to L+ on Information.

SPATIAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
PIQ	Total	123	101.42	16.00	ns.		
					Rank Order: M+>R+>L->L+>R->M-		
Picture Arrangement	Total	107	11.16	2.85	R+>R-	1.81	.075
					Rank Order: L->R+>M+>L+>R->M-		
Raven's Coloured Progressive Matrices							
Error Score	Total	75	-.1738	.8846	M+>M-	1.79	.078
					Rank Order: M+>R+>L->R->L+>M-		
Karnovsky Test of Mental Rotation:Pict. Form					Rank Order by Performance		
Mirror Errors	R-	23	.3204	1.071	M+>R-	2.08	.042
	M-	7	.1844	1.215	L->R-	2.62	.027
	L-	9	-.5546	.625	R+>R-	2.34	.022
	R+	23	-.3569	.840			
	M+	9	-.4820	.894			
	L+	8	.0154	1.280	Rank Order: L->M+>R+>L+>M->R-		
Total Errors	Total	80	-.1007	1.026	R+>L-	1.75	.085
					Rank Order: R+>M->R->L+>M+>L-		

There were no significant findings on the any subtest of the Wechsler Performance Scale, Berea Gestalt or Raven's Coloured Progressive Matrices, although M+ were the highest performing group on the majority these measures. L-, M+ and R+ performed significantly better than R- on the Mirror Errors of the picture form of the Karnovsky Test of Mental Rotation.

BANNATYNE FACTORS

Group	Verbal			Spatial			Sequencing			Acquired		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
R-	29	31.2	6.4	28	30.5	9.8	25	23.7	6.1	28	25.8	4.8
R+	39	33.3	9.6	36	32.9	9.7	36	25.7	5.9	39	29.8	8.0
RM-	5	30.2	1.6	4	32.3	14.3	4	24.0	6.4	5	28.6	5.4
RM+	5	33.6	11.6	4	33.5	8.7	4	20.5	9.0	5	27.4	5.6
LM-	5	30.8	7.0	5	29.4	6.6	4	24.0	7.5	5	28.0	6.4
LM+	11	34.6	6.4	10	34.7	8.4	10	26.8	6.4	10	31.8	4.3
L-	8	31.1	7.3	8	32.4	8.1	8	21.5	7.2	8	27.4	5.1
L+	7	29.1	2.5	6	30.0	11.0	5	21.8	3.3	6	23.2	5.3

Verbal Factor Contrasts: Rank Order: LM+>RM+>RH+>RH-=LH->LM->RM->LH+>R+>RM-												
		1.82	.076									
R+>L+	2.30	.027		LM+>RM-	2.14	.052		LM+>L+	2.54	.023		

Spatial Factor Contrasts: No significant differences												
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Sequencing Factor Contrasts: Rank Order: LM+>RH+>LM-=RM->RH->LH+>LH->RM+												
R+>L-	1.75	.084		LM+>RM+	1.71	.090		LM+>L-	1.80	.075		

Acquired Knowledge Factor Contrasts: LM+>RH+>RM->LM->RM+=L->R->L+												
R+>R-	2.60	.011		LM+>R-	2.58	.011		R+>L+	2.39	.019		
LM+>L+	2.62	.010										

With the exception of the FS+ left handed, the FS+ groups were higher ranking on the verbal measures than the FS- groups. FS+ right and left mixed handed were significantly or marginally higher than the FS+ left handed and the FS- right mixed handed.

There were no reportable contrasts on the spatial factor in this sample. On the sequencing factor the FS+ right and left mixed handed were the superior groups; no contrast was significant.

FS+ right and left mixed handed received significantly higher scores than the FS- right handed and the FS+ left handed.

PSYCHOPATHOLOGY MEASURES

Variable	Hand/FS	N	Means	Std Dev.	Contrasts	T-value	Probabil.
<u>Self-Report Measures</u>							
Short Child	R-	31	-.0659	.707	M+>L-	1.95	.068
Depresssion	M-	8	.2910	.798			
Inventory	L-	8	-.4121	.841			
	R+	39	-.0305	.767			
	M+	10	.3926	.903			
	L+	5	.3884	1.290	Rank Order: M+>L+>M->R+>R->L-		
Coopersmith	R-	34	-.1301	.854	M+>R-	2.06	.042
Self Esteem	M-	7	.0354	.936	M+>R+	1.72	.088
Inventory	L-	8	-.1228	.977			
Long Form	R+	42	-.0122	.872			
	M+	11	.5188	1.093			
	L+	5	.5421	1.055	Rank Order: L+>M+>M->R+>L->R-		
Conners	R-	44	.0288	.913	M+>R+	1.94	.076
Hyperactivity	M-	11	-.0848	.811	L+>R+	1.66	.100
Index	L-	10	-.1033	1.448			
	R+	55	-.2266	.879			
	M+	18	.2031	.964			
	L+	9	.3316	.786	Rank Order: L+>M+>R->M->L->R+		
<u>Report by Others</u>							
Conners	R-	23	-.0146	1.038	R->L+	2.63	.014
Hyperactivity	M-	4	-.1356	1.682	R+>L+	2.48	.020
Index	L-	5	-.2136	.755	M+>L+	2.12	.058
by Classroom	R+	30	-.1445	.945			
Teacher	M+	9	-.0131	.844			
	L+	5	-.6572	.255	Rank Order: M+>R->M->R+>L->L+		
Conners	R-	79	-.3353	.803	R+>M+	1.77	.078
Hyperactivity	M-	14	-.1045	.897	R+>L+	3.03	.003 N-K
Index	L-	13	.1417	1.052	R->L-	1.66	.099
by Parents	R+	79	.3445	1.093	R+>R-	4.45	.000 N-K S
	M+	22	-.0659	.903			
	L+	21	-.3692	1.013	Rank Order: R+>L->M+>M->R->L+		
SNAP	R-	83	-.3320	.762	M+>R-	1.77	.077
	M-	14	.0258	.634	R+>L+	2.39	.018
	L-	13	.0540	.924	R+>R-	4.02	.000 N-K S
	R+	79	.2507	1.099			
	M+	22	.0656	1.038			
	L+	21	-.2966	.938	Rank Order: R+>M+>L->M->L+>R-		

Most of the differences between groups on the self-report measures were marginal. M+ rated themselves significantly higher, indicating

more pathology, than the R- on the long form of the Coopersmith. L+ were the highest scoring on four of the six self-report measures.

However, the classroom teachers rated both right handed groups significantly higher than the L+, and on both measures of hyperactivity rated by parents, the R+ received significantly higher scores than the L+ and the R-.

SUMMARY

Achievement

In both the total sample and the dyslexic subgroup the mixed handed with a positive family history of sinistrality (M+) received the highest scores and the left handed with a positive history of sinistrality (L+) received the lowest scores on reading and spelling measures. On math achievement both right handed groups in the total group and R+ in the dyslexic subgroup were superior to the L+. The pattern R->R+>L+ was found on seven of the ten reading or spelling measures in both groups.

Cognitive

Verbal: In the total sample M+ and R+ were the highest performing groups; L+ and R- were the lowest scoring groups. In the dyslexic group L+ were low.

Spatial: In the total sample M+ were high scoring and R- and M- were low. In the dyslexic subgroup R- and M- were low, although R- received the highest score on the Raven's.

Psychopathology

The M+ and L+ rated themselves as most symptomatic in both groups. Teachers and parents rated the R+ as most symptomatic. (There was a strong main effect finding for FS+ on psychopathology.)

VI. SEX AND FAMILY HISTORY OF SINISTRALITY

Four groups of subjects from the total sample categorized by sex and family history of sinistrality were contrasted. Males and female FS+ groups were abbreviated M+ and F+ respectively. Similarly the FS- groups were M- and F-. Significant and marginal contrasts are reported in this chapter. Complete tables are in Appendix V.

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T-Value	Probability
Gray Oral	M-	56	-.0485	.899	F->M+	2.22	.028
	M+	70	.0506	1.041	F->F+	1.96	.051
	F-	17	.6199	.810	F->M-	2.55	.012 N-K
	F+	18	-.0085	.805	Rank Order: F->M+>F+>M-		
Slosson Oral	M-	57	.1341	.990	F->M+	2.40	.021
	M+	70	.0792	1.087	F->F+	2.35	.025
	F-	17	.5726	.657	F->M-	2.12	.040
	F+	18	-.0062	.798	Rank Order: F->M->M+>F+		
Stanford Spelling	M-	54	-.0024	.905	F->M+	2.30	.023
	M+	64	-.0745	1.010	F->M-	1.99	.048
	F-	16	.5341	1.007			
	F+	18	.2136	.758	Rank Order: F->F+>M->M+		

F- perform best on five of the six achievement. Their performance was significantly better than all other groups on the Gray Oral and the Slosson Oral and than both male groups on the Stanford Spelling Test.

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T-Value	Probability
FSIQ	M-	45	98.87	12.26	M+>M-	2.01	.047
	M+	55	104.29	14.85	M+>F-	1.88	.063
	F-	10	95.60	9.82			
	F+	13	102.08	13.42	Rank Order: M+>F+>M->F-		

VERBAL MEASURES

VIQ	M-	45	98.36	11.52	M+>M-	2.05	.042
	M+	56	103.70	14.13	M+>F-	1.84	.069
	F-	11	95.82	8.74			
	F+	14	99.43	15.34	Rank Order: M+>F+>M->F-		
Information	M-	38	9.47	2.52	M+>F-	2.11	.038
	M+	49	10.08	2.72	M+>F+	2.40	.018
	F-	10	8.20	2.25			
	F+	13	8.15	2.34	Rank Order: M+>M->F->F+		
Arithmetic	M-	37	7.70	2.38	M+>M-	2.64	.010
	M+	48	9.25	3.03	M+>F-	2.12	.041
	F-	10	8.00	1.25			
	F+	13	8.69	3.64	Rank Order: M+>F+>F->M-		
Vocabulary	M-	37	9.54	2.12	M+>M-	1.98	.050
	M+	49	10.76	3.19	M+>F+	1.91	.059
	F-	10	9.50	2.59			
	F+	13	9.08	3.20	Rank Order: M+>M->F->F+		
Digit Span	M-	35	8.54	2.77	M->F-	1.79	.077
	M+	47	8.34	3.18			
	F-	8	6.50	2.51			
	F+	13	8.54	2.40	Rank Order: M-=F+>M->M+		
Peabody Picture Vocabulary Percentile	M-	40	59.00	28.86	M+>F-	1.92	.058
	M+	45	65.09	28.92	M+>F+	1.95	.055
	F-	9	44.67	30.58			
	F+	11	46.00	30.38	Rank Order: M+>M->F+>F-		

M+ received the highest scores on all verbal measures except Digit Span. They were significantly higher than M- on VIQ, Arithmetic and Vocabulary, than F- on VIQ, Information, and Arithmetic and than F+ on Information, Vocabulary and Peabody Picture Vocabulary Test Percentile.

SPATIAL MEASURES

PIQ	M-	45	99.93	15.30	M+>F-	1.71	.100
	M+	55	103.11	18.07	F+>F-	1.79	.087
	F-	11	96.09	10.92			
	F+	13	104.15	11.06	Rank Order: F+>M+>M->F-		
Picture Arrangement					M+>F-	1.69	.094
					Rank Order: M+>F+>M->F-		
Block Design	M-	37	10.57	3.83	M+>F-	1.97	.052
	M+	47	11.09	3.57			
	F-	10	8.70	2.31			
	F+	13	9.58	2.57	Rank Order: M+>M->F+>F-		
Object Assembly					M+>M-	1.67	.099
					Rank Order: M+>F+>F->M-		
Coding	M-	38	7.32	3.10	F+>M+	2.25	.026
	M+	49	7.86	2.98	F+>M-	2.71	.008 N-K
	F-	9	7.89	3.38			
	F+	11	10.18	3.34	Rank Order: F+>F->M+>M-		

 Karnovsky Test Of Mental Rotation: Picture form:

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Mirror Errors	M-	31	.3104	1.197	F->F+	1.72	.090
	M+	29	-.6065	.824	M+>M-	3.58	.001 N-K S
	F-	9	-.2966	.908	M+>F+	3.06	.003 N-K S
	F+	11	.4696	.795	Rank Order: M+>F->M->F+		
Total Errors	M-	31	.1010	1.037	M+>M-	2.57	.012 N-K
	M+	29	-.5615	1.041	M+>F+	3.17	.002 N-K S
	F-	9	-.0442	1.081	Rank Order: M+>F->M->F+		
	F+	11	.5596	.635			

 Shapes:

Mirror Errors	M-	32	-.0262	1.009	M+>F+	2.24	.028
	M+	29	-.3206	1.095	Rank Order: M+>M->F->F+		
	F-	9	.1941	1.153			
	F+	11	.5240	1.085			
Total Errors	M-	32	-.1473	.916	M+>F+	2.44	.025
	M+	29	-.3644	.953	M->F+	1.83	.085
	F-	9	.3411	1.434	Rank Order: M+>M->F+>F-		
	F+	11	.4490	.940			

 Both Forms:

Total Errors	M-	30	.0269	.985	M+>M-	2.10	.039 N-K S
	M+	29	-.5265	1.034	M+>F+	3.01	.004 N-K S
	F-	9	.1630	1.171	M+>F-	1.79	.078
	F+	11	.5518	.867	Rank Order: M+>M->F->F+		

Although M+ received the highest score on the majority of the spatial measures. M+ received significantly scores than F- on Block Design and on the Karnovsky Test of Mental Rotations M+ were superior to M- and F+ on Mirror Errors and Total Errors on the Picture form. On the Shapes form, M+ were superior to F+ on Mirror Errors and Total Errors. On Total Errors for both forms, M+ were superior to M- and F+.

F+ received significantly higher scores on Coding than the both male groups.

BANNATYNE FACTORS

The mixed handed group is divided into right and left mixed handed for further analysis.

Group	Verbal			Spatial			Sequencing			Acquired		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
M-	31	31.1	6.0	35	31.3	10.0	34	23.6	6.4	36	26.8	5.4
M+	49	33.7	9.0	45	33.4	10.0	44	24.8	5.8	47	30.2	7.0
F-	10	30.7	6.8	10	29.4	7.3	7	22.0	6.1	10	25.7	3.7
F+	13	30.7	7.2	11	31.2	6.5	11	27.0	7.5	13	25.9	8.1

There were no significant differences between any Verbal and Spatial Factor Contrasts.

Sequencing Factor Contrasts: F+>F- 1.67 .099

Acquired Knowledge Contrasts:

M+>M- 2.51 .014 NK M+>F- 2.91 .008 M+>F+ 1.75 .098

There were no reportable differences in the verbal and spatial factors. FS+ females received marginally higher scores than the FS- females on the sequencing factor. FS+ males were superior to FS- males and females and marginally better than the FS+ females on the acquired knowledge factor.

PSYCHOPATHOLOGICAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T-Value	Probabil.
<u>Self-Report Measures</u>							
Short Child Depression Inventory	M-	37	-.0463	.778	F+>F-	2.78	.006 N-K
	M+	44	-.0824	.737	F+>M-	3.19	.002 N-K S
	F-	13	-.1300	.713	F+>M+	3.38	.001 N-K S
	F+	10	.8304	.945	Rank Order: F+>M->M+>F-		
Coopersmith Self-Esteem Inventory Long Form	M-	39	-.1381	.907	F+>F-	1.71	.091
	M+	46	-.0046	.847	F+>M+	2.35	.021
	F-	10	.0229	.724	F+>M-	2.76	.007
	F+	12	.6765	1.137	Rank Order: F+>F->M+>M-		
Coopersmith Self-Esteem Inventory Short Form	M-	17	-.4009	1.099	F+>F-	1.95	.059
	M+	15	-.1094	.923			
	F-	3	.0567	.784			
	F+	8	.4506	1.078	Rank Order: F+>F->M+>M-		
Conners Hyperactivity Index by Self	M-	53	-.0183	.900	F+>M+	2.20	.037
	M+	63	-.1988	.848			
	F-	12	.0224	1.328			
	F+	19	.3525	.990	Rank Order: F+>F->M->M+		
<u>Report by Others</u>							
Conners Hyperactivity Index by Classroom Teacher	M-	23	-.0793	1.134	F->F+	1.83	.094
	M+	35	-.0688	.950	M->F+	2.02	.053
	F-	10	-.0680	.858	M+>F+	2.82	.007
	F+	9	-.5924	.281	Rank Order: F->M+>M->F+		
Conners HI by Tutor	Total	102	-.0884	.981	F+>M+	1.69	.094
					Rank Order: F+>F->M->M+		
Conners HI by Parents	M-	85	-.2707	.854	F+>F-	2.15	.033
	M+	98	.0732	1.084	F+>M-	3.13	.002 N-K S
	F-	23	-.1860	.850	M+>M-	2.39	.018 N-K
	F+	26	.4118	.987	Rank Order: F+>M+>F->M-		
SNAP	M-	89	-.2294	.775	F+>F-	1.85	.071
	M+	99	.0883	1.049	F+>M-	1.99	.055
	F-	23	-.2723	.811	M+>M-	2.38	.019 N-K
	F+	25	.2530	1.139	Rank Order: F+>M+>M->F-		

F+ report themselves more depressed on the Short Child Depression Inventory than all other groups. F+ rated themselves significantly higher, indicative of more pathology, on the long form of the

Coopersmith than both male groups. They report more hyperactivity than the M+ on the Conners Hyperactivity Index.

Parents of F+ rated their daughters higher than the parents F- and M- on the Conners Hyperactivity Index and on the SNAP the F+ were higher than M-. M+ also received higher scores on the parents' ratings than M-. (There was a significant main effect for FS+ on the two parental measures.) Classroom teachers, however, scored the two male groups significantly higher than the F+

SUMMARY

Achievement

In the total sample the FS- females performed significantly better than all groups on the two measures of oral reading and than both male groups on the spelling measure. Only 35.3% of the FS-females met the criteria for dyslexia, in contrast to approximately 70-90% of the other groups. In the subgroup the FS- females rank nonsignificantly highest on only one measure, oral reading of words. F+ were the highest ranking on all other measures although only one contrast reached significance.

Cognitive

Verbal: In the total sample FS+ males received higher scores than all groups on all but Digit Span. FS+ males performed significantly better than all three groups on at least three verbal measures. While there were no reportable contrasts on the Bannatyne verbal factor for the total sample, FS+ males were superior to the FS- male and female subjects and marginally higher than the FS+ females on the acquired knowledge factor. FS+ females were marginally higher than FS- females

on the sequencing factor.

In the dyslexic subgroup FS+ males received the highest scores on all verbal measures and the FS- females were the lowest rank group on seven of eight measures. Both FS+ and FS- males were superior to the FS- females on the Bannatyne verbal factor. FS+ males received higher scores than FS- females and marginally higher scores than the FS+ females on the acquired knowledge factor.

Spatial: In the total sample FS+ males received significantly higher scores on most measures of mental rotation and Block Design. In the dyslexic subgroup FS+ males were superior on all most measures. The lowest ranking group on the PIQ and the Raven's were the FS- females. The lowest ranking group on the mental rotation measures were the F+.

Psychopathology

In the total sample FS+ females scored themselves significantly higher than all groups on one measure of depression and than both male groups on a measure of self-esteem and than the FS+ males on the measure of hyperactivity. They were ranked significantly more hyperactive/attentionally disordered than both male groups by parents on two measures and than the FS- females on one measure. In contrast the classroom teachers rated FS+ females lowest on a measure of hyperactivity.

In the dyslexic group, the FS+ females rated themselves or were rated by others, higher on measures of depression, self-esteem and hyperactivity/attention deficit disorder. FS+ males were rated higher than FS- females on the SNAP, a measure of ADD rated by parents.

VII. REGRESSION ANALYSES

The groups formed by sex, hand and FS variables were often significantly different in age as the left handed and females were older by approximately one year, than the non-left handed and males respectively. In the whole sample, the FS+ and FS- subjects did not differ significantly in age.

As 1. older subjects can receive lower achievement scores because there is more "room" for the score to deviate downward; and 2. ratings on measures of hyperactivity/ADD decrease with age normal subjects (Goyette, et al., 1978); and 3. in this sample, some measures of cognitive function decreased with age, it was necessary to ascertain and control the "age effect". Therefore, the independent variables of interest (age, hand, FS, and all possible two and three way interactions) were entered into stepwise regression analyses (SPSSX) as predictors of achievement variables to determine the relative contribution of age and the interactions.

Regressions of cognitive variables include: Bannatyne Factors (verbal, spatial, sequencing, and acquired knowledge) and the ACID Factor (Wechsler subtests: Information, Arithmetic, Digit Span, and Coding). The last section include regressions of selected psychopathological factors and measures.

The discrete variables hand, FS and sex were dummy coded. Hand was entered as right, left mixed and left and abbreviated as R, LM and L respectively. Other abbreviations were A (age), F (FS+=1, FS-=0), S (sex, male=1, female=2). For example, the interaction term FSLM refers to an interaction of family history of sinistrality, sex and left mixed

handedness. Analyses were rerun with and right, right mixed and left, R, RM and L respectively, to determine the effect of the right mixed handed. Only those analyses in which RM entered as a significant predictor are reported here.

Cell means of the components of the significant interaction terms in the regression analyses for achievement, Bannatyne Factors and psychopathological factors and/or measure were examined. To obtain these means, the components of these interactions were entered into ANOVAs as independent variables with the achievement measures as dependent variables. (The continuous variable age was dichotomized at the mean age for the group.) The table and graphs of cell means for each significant interaction for each dependent achievement variable are in Appendix VI. The following is a summary of these analyses.

ACHIEVEMENT MEASURES

GRAY ORAL READING TEST

Predictors	Corr.	MR	Rsq	ARsq	F	SigF.	RsqCh	FCh	SigCh
Age	-.689	.689	.475	.472	142.05	.000	.475	142.05	.000
FSLM	.124	.708	.502	.496	78.58	.000	.027	8.41	.000
RA	.042	.719	.517	.508	55.35	.000	.015	4.93	.028
SRA	-.045	.734	.536	.524	44.45	.000	.019	6.20	.014

Age predicted 47.2% of the variance. The significant interaction terms that entered into the equation accounted for another 5.2%. (This is obtained by subtracting the final adjusted R squared from the R squared, or variance, predicted by age alone.)

FSLM: There were no FS- LM females in this sample. (The unequal cell sizes may have affected the significance of this interaction term.) The major differences were between the FS- and the FS+ nonLM females and

between the FS- and FS+ LM males. FS+ nonLM females received lower scores than FS- nonLM females. FS+ LM males received higher scores than the FS- LM males.

RA: The right handed received higher scores than the non-right. Both the right and non-right groups received lower scores in the older age group.

SRA: Handedness appears to interact more with age in females than in males. Right handed females perform better than non-right handed females and both male groups in both the younger and older age groups. Right and non-right handedness does not differentiate Gray Oral Reading scores in males in either age group. However, the non-right handed females receive lower scores than the right handed females in both the age groups. The older right handed females do not fare as poorly with age as the right handed males and the non-right handed male and females.

SLOSSON ORAL READING TEST

Predictors	Corr.	MR	Rsq	ARsq	F	SigF.	RsqCh	FCh	SigCh
Age	-.690	.690	.477	.473	143.90	.000	.477	143.90	.000
FSLM	.087	.702	.493	.486	76.30	.000	.016	5.03	.026
LA	-.300	.710	.505	.495	52.99	.000	.012	3.73	.055

Age predicted 47.3% of the variance; interaction components, another 2.2%

FSLM: As in the sample of Gray Oral Reading Test scores, there were no FS- left mixed females in the sample for the Slosson and the unequal cell sizes may have contributed to the significance of the interaction. The major differences were in the FS- and the FS+ nonLM

STANFORD WORD SKILLS TEST

Predictors	Corr.	MR	Rsq	ARsq	F	SigF.	RsqCh	FCh	SigCh
Age	-.672	.672	.452	.447	96.46	.000	.452	96.46	.000
FLM	.192	.701	.492	.483	56.12	.000	.040	9.10	.003
FLA	-.404	.721	.519	.507	41.42	.000	.028	6.60	.011

Age predicted 50,7% of the variance, the significant interaction terms, 6%.

FLM: Similar to the findings for the Stanford Spelling Test, the FS- LM subjects received lower scores than the FS+ LM subjects and the FS- nonLM received higher scores than the FS+ nonLM subjects on the Stanford Word Skills Test.

FLA: In the FS- younger age group there is little difference in scores between the left and the nonleft. IN the FS- older age group, the non-left handed received lower scores than the left handed. However, in the FS+ groups, both the younger and the older left handed received lower scores than the non-left handed. This is consistent with the findings from the contrasts indicating that the FS+ left handed are more impaired than the FS- subjects.

STANFORD READING COMPREHENSION TEST

Predictors	Corr.	MR	Rsq	ARsq	F	SigF.	RsqCh	FCh	SigCh
Age	-.625	.625	.390	.383	53.72	.000	.390	53.72	.000
FLM	.206	.666	.444	.431	33.15	.000	.054	8.06	.006
FL	-.316	.681	.464	.445	23.68	.000	.020	3.07	.084

FLM: SIMilar to the findings for the Stanford Spelling Test and the Word Skill test, the FS- LM subjects received lower scores than the FS+ LM subjects. Dissimilarly, there was little difference between the scores of the FS- and the FS+ nonLM subjects. However, when the specific

contrasts are examined, the FS+ left handed received the lowest scores and these were significantly different from those of the FS+ mixed and right handed. FS+ right handed, however, received nonsignificantly higher scores than the FS- right handed.

FL: FS has differential effects on left and non-left subjects, There is little difference in the scores of the FS- left and the non-left. FS+ subjects have higher scores than FS- non-left subjects and the FS+ left handed subjects have lower scores than the FS- left handed.

MATH

Predictors	Corr.	MR	Rsq	ARsq	F	SigF.	RsqCh	FCh	SigCh
Age	-.455	.455	.207	.210	36.54	.000	.207	36.54	.000
FL	-.270	.477	.228	.217	20.49	.000	.021	3.73	.000

Age predicted 20.1% of the variance; the interaction FL predicted 1.7%.

FL: FS has differential effects on left handed subjects. FS+ left handed subjects have lower scores than FS- left handed subjects in Math.

The Bannatyne factors and age, sex, hand, FS, and all possible two and three way interactions of age, sex, hand and FS, were entered into a stepwise regression analysis (SPSSX) as predictors the achievement measures. In other words, the same predictors as entered in the above analyses plus the cognitive factors were included. For all but Math, the final Adjusted R Squared (total variance accounted for) was slightly less than the above reported analyses without the Bannatyne factors. (The increase in Adjusted R Squared for Math is probably largely because the Sequencing factor contains the Arithmetic subtest score.) The following abbreviations were used for the Bannatyne factors: Verbal=VER, Spatial=SPL, Sequencing=SEQ, Acquired Knowledge=ACQ.

GRAY ORAL READING TEST

Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh
Age	-.566	.566	.321	.311	33.50	.000	.321	33.50	.000
FSLM	.246	.628	.395	.378	22.83	.000	.074	8.59	.005
SEQ	.282	.654	.428	.403	17.19	.000	.033	3.97	.050

Age predicted 31.1% of the variance; the same FS by sex by left mixed handedness interaction entered this equation as in the above analysis without the Bannatyne factors. The sequencing factor entered and predicted 2.5% of the variance.

SLOSSON ORAL READING TEST

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.578	.578	.334	.325	36.13	.000	.334	36.13	.000
ACQ (IN)	.490	.643	.414	.397	25.05	.000	.080	9.64	.003
SEQ	.375	.661	.437	.413	18.13	.000	.024	2.92	.092
FSLM	.176	.683	.468	.437	15.15	.000	.030	3.95	.051
ACQ (OUT)		.673	.454	.431	19.40	.000	-.014	000	1.000

Age predicted 32.5% of the variance, the remaining variance, 10.6% was predicted by FSLM, as in the analysis without the Bannatyne factors, and the sequencing factor.

STANFORD SPELLING TEST

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.687	.687	.472	.464	58.95	.000	.472	58.95	.000
SEQ	.339	.717	.514	.499	34.36	.000	.042	5.63	.021
FR	-.032	.745	.554	.534	26.54	.000	.041	5.82	.019
SPL	-.031	.760	.578	.551	21.55	.000	.023	3.48	.067
FLMA	.159	.775	.601	.568	18.64	.000	.023	3.55	.064

Age predicted 47.2% of the variance; the remaining variance, 12.9%, by subject variables (not further examined) and the spatial factor.

STANFORD WORD SKILLS TEST

Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh
Age	-.600	.600	.360	.347	27.52	.000	.360	27.52	.000
ACQ	.538	.676	.456	.434	20.14	.000	.097	8.53	.005
SR	-.141	.709	.503	.471	15.85	.000	.047	4.41	.041

Age predicted 34.7% of the variance. Acquired knowledge and SR entered the equation and predicted the remaining 14.3%.

STANFORD READING COMPREHENSION TEST

Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh
Age	-.549	.549	.301	.288	22.81	.000	.301	22.81	.000
FSLM	.199	.611	.373	.350	15.52	.000	.073	6.05	.017

Age predicted 28.8% of the variance; FSLM the remaining 6.2%

MATH TEST

Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh
SEQ	.557	.557	.311	.300	28.38	.000	.311	28.38	.000
Age	-.317	.600	.360	.340	17.46	.000	.032	4.83	.032
SPL	.327	.631	.340	.368	13.43	.000	.037	3.79	.056

The sequencing factor predicted 55.7% of the variance; age, 4% and the spatial factor 2.8%.

COGNITIVE VARIABLES

The independent variables of interest (age, sex, hand, FS, and all possible two and three way interactions) were entered into a stepwise regression analysis (SPSSX) as predictors of the four Bannatyne factors: verbal, spatial, sequential and acquired knowledge.

Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh

VERBAL FACTOR									
Age	-.360	.360	.129	.121	15.90	.000	.129	15.90	.000

SPATIAL FACTOR no variables entered									

SEQUENTIAL FACTOR									
Left	-.178	.178	.032	.021	3.08	.083	.032	3.08	.083

ACQUIRED KNOWLEDGE FACTOR									
Age	-.397	.397	.157	.149	19.43	.000	.157	19.43	.000
FS x Sex	.288	.457	.209	.193	13.57	.000	.051	6.65	.011
FS x Left x Age	-.206	.480	.230	.207	10.15	.000	.021	2.84	.095

The findings that both the verbal and the acquired knowledge factor (both share the Vocabulary score) decrease with age suggests that learning disability is a cumulative disability. The negative correlation of left handedness and the sequencing factor is consistent with the above reported contrasts on which the left handed were the lowest performing group.

Acquired Knowledge Factor Interactions FS x Sex: FS had differential effects on males on the acquired knowledge factor; FS+ males received higher scores than the FS- males. The scores of the FS- and FS+ females were almost the same.

FS x Left x Age: The FS+ older nonleft handed received higher scores than the FS- older nonleft handed. Both the younger and the older FS+ left handed groups received lower scores than the FS- left

handed. This FS effect was most obvious in the older left handed group. (The FS+ younger nonleft handed also received lower scores than the FS-, but there were only two subjects in each cell.)

ACID FACTOR (Wechsler subtests: Arithmetic, Coding, Information, Digit Span)

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.213	.213	.046	.035	4.43	.038	.046	4.43	.038
FS x Left Mix.	.182	.275	.076	.056	3.76	.027	.030	3.00	.087
FS x Right	.174	.345	.119	.090	4.09	.009	.043	4.46	.037

FLM: FS+ subjects received higher ACID scores, indicating better performance on the Wechsler subtests Information, Arithmetic, Digit Span and Coding, than FS- subjects. This effect was greater in left mixed than nonleft mixed subjects.

FR: FS+ subjects received higher ACID scores than FS- subjects; this effect was greater in right handed subjects.

With Bannatyne Factors added to the subject variables:

ACID FACTOR

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Spatial Fact.	.348	.348	.121	.111	12.08	.001	.121	12.08	.001
FS x Right	.226	.406	.165	.146	8.58	.000	.044	4.58	.035
FS x Left Mix.	.143	.442	.195	.167	6.95	.000	.031	3.25	.075

With the Bannatyne Factors included as predictors, age was no longer entered as a significant predictor, but the spatial factor was. Without the Bannatyne factors 9.0% of of the variance was predicted; with Bannatyne factor, 16.7% of the variance was predicted.

PSYCHOPATHOLOGICAL MEASURES

The independent variables age, sex, hand, FS and all possible two and three way interactions were entered into stepwise regression analyses (SPSSX) as predictors of selected measures of psychopathology: All Self, SNAP, and All Psy. All Self is a factor equal to the mean of all z scores of psychopathological measures rated by the student. A minimum of three variables was necessary for the factor to be constructed for each student. All Psy is a factor equal to the mean of all z scores of all psychopathological measures; a minimum of 6 was required to construct this factor for each subject. Cell means were examined to assess the contributions of the components of the interactions. The cell means and the graphs are in Appendix VI.

ALL SELF FACTOR

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Sex x Age	-.234	.234	.055	.048	8.16	.005	.055	8.16	.005
Sex x Left x Age									
	-.192	.288	.078	.065	5.90	.003	.023	3.50	.064
Right x Age	-.098	.322	.104	.084	5.36	.002	.026	4.02	.047
Sex x Right	-.039	.373	.139	.114	5.58	.000	.036	5.69	.018

The total variance predicted was 13.9%.

SA: Females report more symptoms than males. Both sexes report less symptoms in the older group. Younger females report the most symptoms, older males, the least.

SLA: Older subjects reported less symptoms than the younger.

Independent of age, left handed females report the most symptoms, left handed males, the least.

RA: The nonright handed reported more symptoms in both age groups.

SR: The nonright handed reported more symptoms in both sexes.

ALL PYS FACTOR

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.301	.301	.091	.080	8.39	.005	.091	8.39	.005
Sex x Age	-.256	.357	.127	.106	6.05	.004	.037	3.47	.006

Age predicted 8.0% of the total variance; age x sex another 2.6%

Females received higher scores across age than males. The younger females, of which there were only four who received a score on this factor, had the highest scores; older males the lowest scores.

SNAP

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.293	.283	.080	.076	19.95	.000	.080	19.95	.000
FS x Right	.239	.355	.126	.118	16.48	.000	.046	12.06	.001
Sex x Left Mixed	.064	.377	.142	.131	12.60	.000	.016	4.35	.038

Age predicted 7.6% of the variance; interaction variables accounted for the remaining 6.2%.

FR: The parents of the FS- nonright handed reported less symptoms than in their children than the parents of the FS- right handed. The parents of the FS+ nonright handed reported more symptoms in their children than the parents of the FS+ right handed.

SLM: Parents of female left mixed handed reported less symptoms than parents of male left mixed handed or nonleft mixed subjects. However, there were only three left mixed females subjects.

The above mentioned independent variables and the Bannatyne Factors (verbal, spatial, sequential and acquired knowledge) were entered as predictors of the above mentioned dependent variables and All Psy.

Regressions with Bannatyne Factors included as predictors

ALL SELF FACTOR

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Spatial Fact.	-.281	.282	.080	.066	5.98	.017	.080	5.98	.017
Sex x Age	-.273	.381	.146	.120	5.79	.005	.066	5.23	.025

The spatial factor predicted 6.6% of the variance; sex x age, another 5.4%. The sex x age interaction was described above. The total predicted variance was 14.6%.

SNAP

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
FS	.310	.310	.096	.086	9.27	.003	.096	9.27	.003
FS x Sex x Age	-.139	.366	.134	.113	6.63	.002	.037	3.70	.058
Age	-.216	.406	.164	.135	5.57	.002	.031	3.14	.080
Left x Age	.006	.450	.203	.165	5.34	.001	.038	4.03	.048
ACQ	-.019	.483	.232	.187	5.04	.000	.030	3.26	.075
Sex X Left Mixed	.130	.510	.260	.205	4.79	.000	.027	2.96	.089

The total variance predicted was 20.5%.

FSA: Younger subjects received higher scores on the SNAP, indicative of more symptoms of Attention Deficit Disorder. FS+ younger males and females older females received higher scores than their FS- counterparts. FS did not differentiate the older male sample.

LA: The younger nonleft handed received higher scores than the left handed. The older groups had similar scores.

ACQ: Acquired knowledge entered as a negative correlated.

SLM: Female left mixed handed had lower scores than the male left mixed handed; however, there were only three subjects in the females group.

ALLPSY FACTOR

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Sex x Age	-.335	.335	.112	.089	4.92	.032	.112	4.92	.032
Left Mixed	.273	.491	.241	.201	6.04	.005	.129	6.47	.015
Left Mixed x Age									
	.211	.564	.318	.263	5.76	.002	.077	4.18	.048
VBF	-.280	.670	.384	.316	5.62	.001	.066	3.85	.058

The total variance predicted was 31.6%.

SA: Females received higher scores, indicative of more psychopathology, than males.

LMA: The younger left mixed handed subjects receive higher scores than the older left mixed handed subjects.

The verbal factor entered as a negative correlate.

VIII. COGNITIVELY DISPARATE GROUPS ON PSYCHOPATHOLOGICAL MEASURES

Groups were constructed based upon the relative Bannatyne verbal and spatial factor scores. Members of the Low Spatial group had higher verbal than spatial factor scores by approximately one standard deviation. The Low Verbal group had the higher spatial factor scores; and an Equal group was composed of subjects who had verbal and spatial factor scores which differed by less than one standard deviation.

The groups were contrasted on the All Self, All Psy and All ADD factors and the SCDI (Short Child Depression Inventory). Contrasts were run for the whole group and for each sex separately.

There were no differences between the groups on the ALL Self factor. The Low Verbal group was marginally higher, i.e., ($t=1.69$, $p<.094$), on the All Psy group, indicating more psychopathology in the Low Verbal group. The only difference between the groups on the SCDI was also within the analysis for males; the Low Verbal group was marginally higher than the Low Spatial group ($t=1.87$, $p<.064$).

However, the Low Verbal group was significantly higher on ALL ADD than the Equal group for the total sample ($t=2.88$, $p=.004$, N-K, S). For males only the results were in the same direction ($t=2.04$, $p<.043$) and also for females only ($t=2.58$, $p=.013$, N-K, S). The male Low Verbal group was also marginally higher than the Low Spatial group on the ALL ADD factor ($t=1.78$, $p<.078$). The female Low Verbal group was significantly higher than the Low Spatial group ($t=2.07$, $p<.043$).

DISCUSSION

In the first section of this chapter the hypotheses are restated and relevant findings are presented. The general discussion is the second section of this chapter.

HYPOTHESES

MAIN EFFECTS

I. HANDEDNESS

A. Subjects who are mixed or left handed will perform less well on measures of academic achievement and cognitive functions than subjects who are right handed.

Achievement: The mixed handed, as a group, did not perform less well than the right handed. The right mixed handed did receive significantly lower scores on three achievement tests than the right handed in the total sample, whereas the left mixed handed were one of the highest performing groups. The left handed subjects were the lowest performing group on all of the achievement tests in the total sample and in the dyslexic subgroup. The left handed were significantly lower than the right handed in two of the achievement tests in the total sample and one achievement test in the dyslexic sample.

Cognitive: When the handedness variable was divided into right, mixed and left groups, the left handed were the lowest performing group on six of the eight verbal tests and the majority of the spatial tests (some of these were composites of other tests, e.g. PIQ) in the total sample although none of the comparisons reached significance. The right mixed handed receive

significantly lower scores on Arithmetic and on the Bannatyne sequencing factor, which includes the Arithmetic subtest, than the right handed in the dyslexic subgroup.

B. Subjects who are mixed or left handed will receive higher scores on measures of psychopathology than right handed subjects.

As a group, the scores of the mixed handed were not significantly different from the right handed in the total sample. In the dyslexic subgroup, the mixed handed were marginally higher than the right handed on the Birleson and the long form of the Coopersmith Self-Esteem Inventory. In the dyslexic group they received the highest scores, more evidence of psychopathology, on six of the eight measures.

When the mixed group was divided it was usually the left mixed that received the highest ratings on measures of psychopathology. The left mixed received marginally higher scores on the Short Child Depression Inventory and the long form of the Coopersmith Self-Esteem Inventory than the right handed in the total group. In the dyslexic subgroup, the left mixed handed subjects received significantly higher scores than the right handed on the Birleson Depression Inventory and the long form of the Coopersmith.

In the total sample the left handed rated themselves highest on the Conners Hyperactivity Index. However, in the dyslexic sample the left handed were the lowest rated group on six of eight measures of psychopathology.

C. Subjects who are mixed or left handed will have more evidence of spatial deficits than right handed. There is no support for this hypothesis.

D. Mixed Handed

1. The mixed handed will receive scores on measures of achievement, cognitive function and psychopathology that are intermediate to those of the right and left handed.

Achievement: This hypothesis received partial support for achievement tests. In the total sample the performance of the mixed handed was intermediate to the right and left handed on five of the six achievement tests. In the dyslexic subgroup, the performance of the mixed handed was between the right and left handed in two of the six achievement tests. However, as discussed below, when the mixed group was divided into the right and left mixed this pattern is not maintained. The performance of the two mixed handed groups was quite different, and as discussed in the next section, right mixed may be a pathological group.

Cognitive: This hypothesis is not supported.

Psychopathology: This hypothesis is not supported.

2. The mixed handed will receive scores on measures of cognitive function, achievement and psychopathology inferior to those of the right and left handed. This hypothesis was not supported.

3. The mixed handed will perform superior to the right or left handed on reading and achievement tests.

This was not true of the undivided mixed group. However, the left mixed handed received the highest scores on achievement measures in both the total sample and the dyslexic subgroup. The performance of right mixed was among the two lowest in ten of the twelve achievement tests in both the total and dyslexic samples.

II. FAMILY HISTORY OF SINISTRALITY

A. FS+ subjects will perform less well on measures of cognitive functions and achievement than FS- subjects. This hypothesis received no support.

B. FS+ subjects will perform better on measures of achievement and cognitive measures than FS- subjects.

Achievement: This hypothesis received no support on achievement measures. The FS+ subjects received nonsignificantly lower scores on four of the six achievement tests. (They scored nonsignificantly higher on reading comprehension and math.)

Cognitive Measures: This hypotheses received support for cognitive measures. FS+ were significantly better than FS- subjects on VIQ, Arithmetic and Vocabulary and the Karnovsky Test of Mental Rotation. The FS+ scored nonsignificantly higher on seven of eight verbal measures and all but one of the spatial measures. FS+ received significantly higher scores on the Bannatyne acquired knowledge factor than the FS-

subjects.

C. FS+ subjects will receive higher scores on measures of psychopathology than FS- subjects.

This hypothesis received some support. FS+ subjects were rated as significantly more hyperactive/attention disordered by their parents. There was no distinction between the groups on questionnaires filled out by the child him/herself nor by the teachers or tutors.

III. SEX

Females will perform better on reading and spelling achievement measures and verbal tests. Males will perform better on math achievement and spatial measures.

Achievement and Verbal: Females in both groups performed better than males on 11 of the 12 achievement measures, including math, and significantly better on the Gray Oral Reading Test and Stanford Spelling test. Males in both groups, however, performed better on all verbal measures. Combining the total and the dyslexic group, the males were significantly better on eight spatial measures and the Bannatyne spatial and acquired knowledge factor.

Spatial: Males in the total group performed better on majority of the spatial measures, significantly so on Block Design. Males in the dyslexic group performed better on the majority of the spatial measures; significantly so on 9 of these. (Females in both groups were significantly better on Coding and nonsignificantly better on the Berea Gestalt.)

INTERACTIONS

IV. HAND AND SEX

A. Left handed males will receive lower scores on the spatial tests than right handed males. This hypothesis received no support.

B. Left handed males will perform better than right handed males and right handed females will perform better than left handed females on Karnovsky Mental Rotation Test measures.

In the total sample left handed males received nonsignificantly higher scores on all measures of the Karnovsky Test of Mental Rotation than right handed males. In the dyslexic sample the left handed males received nonsignificantly higher scores than the right handed males only on the Picture form of this test. In the total sample right handed females performed better on the majority of Karnovsky measures; in the dyslexic subgroup, the right handed females performed better than the left handed on all of Karnovsky measures. None of these differences reached significance. Therefore, although there was a general pattern of ML>MR and FR>FL, the differences were not significant.

C. Left handed males will receive higher scores than right handed males, and right handed females will receive higher scores than left handed females on spatial tests.

This hypothesis received some support. In the total and dyslexic groups, the left handed males received higher scores than the right handed males

on the majority of the spatial measures, but no contrast approached significance. Right handed females received higher scores than left handed females on the majority of the spatial measures in both samples. Right handed females were significantly superior on Coding and the Brea Gestalt in the total sample; no contrasts between these two groups were significant in the dyslexic subgroup.

D. Right handed males will receive higher scores than left handed males; and left handed females will receive higher scores than right handed females on spatial tests. This hypothesis was not supported.

E. Left handed males will receive higher scores than right handed males, and right handed females will receive higher scores than left handed females on verbal and achievement tests. This hypothesis is not supported.

V. HAND AND FS

A. The effects of personal and familial sinistrality will be additive: The scores of achievement and cognitive tests of the FS+ right handed subjects will be intermediate to those of the FS- right handed FS+ left handed, i.e., the pattern will be R->R+>L+.

Achievement: In the total group, the pattern R->R+>L+ was found on four of the five verbal (Gray Oral, Slosson Oral, Stanford Spelling, Stanford Word Skills) achievement tests. In the dyslexic group, this pattern was found on three of the five verbal achievement tests. On the other achievement tests, including math, the pattern was R+>R->L+.

Cognitive Tests: This hypothesis was not supported.

VI. SEX AND FS

A. FS+ males will receive lower scores on the visual-spatial perceptual cognitive tests than FS- males. FS+ females will receive higher scores on the visual-spatial cognitive tests than FS- females.

This hypothesis is not supported. In general, FS+ subjects, across sex, received higher spatial scores. However, see the following.

B. FS+ males will receive higher scores on the visual-spatial perceptual cognitive tests than FS- males. FS+ females will receive lower scores on the visual-spatial cognitive tests than FS- females.

FS+ females received marginally higher PIQ scores than FS- females in the total and dyslexic samples. In the total sample FS- females ranked higher than FS+ females on most measures of the Karnovsky Mental Rotation Test and FS- females were marginally higher than FS+ females on one measure of mirror errors on the picture form. This hypothesis is not supported, although there is some evidence that it may be true for mental rotation tasks.

In the total group, FS+ males received higher scores than FS- Males on the majority of the spatial measures; on three measures on the Karnovsky Test of Mental Rotation this difference was highly significant. In the dyslexic group, FS+ males also received higher scores than the FS- males on the majority of the spatial measures.

VII. PSYCHOPATHOLOGY AND COGNITIVE SKILLS

As there is evidence for an association between poor spatial skills and depression in learning disabled children (Rourke and Fisk, 1981; Strang, 1981), those subjects with lower spatial skills will have more evidence of psychopathology.

This hypothesis received some support. The Bannatyne factors were entered with age, sex, hand and FS and their two and three way interactions as predictors in stepwise regression analyses with the All Self factor of psychopathological measures that the student reported on themselves. The spatial factor was the first variable entered. It was negatively correlated with All Self (-.281) and accounted for 6.6% (adjusted R square) of the variance.

On the contrasts of the equal and unequal Bannatyne verbal and spatial factor groups, however, the low verbal group had the most evidence of psychopathology. These differences were primarily on the All ADD factor, i.e., measures of attention deficit disorder.

It may be that there is a weak negative correlation between the All Self factor and the spatial score as this factor includes the self-rated measures of depression and self-esteem as well as one measure of hyperactivity. It may be the more depressed subjects who have a negative correlation between their All Self scores and the more hyperactive/attention deficit disordered students who have relatively low verbal skills.

GENERAL DISCUSSION

Results of the analyses of the achievement, cognitive and psychopathological measures will be discussed respectively. Main effects and interactions will be reviewed within each section and discussed.

ACHIEVEMENT MEASURES - MAIN EFFECTS

AGE

Age accounted for the most variance in all achievement measures. The older subjects have larger discrepancies between their grade-expected-for age and their achievement measures grade equivalent scores. This is not unexpected as the scores of the older subjects have more "room" to deviate downward, and some scores of the younger students may represent a "floor" effect. This does suggest, however, that learning disabilities have a cumulative effect, i.e., the disabled become more divergent from their grade-expected-for-age performance as they get older. This interpretation is supported by the fact that the Bannatyne verbal and acquired knowledge scaled score factors are negatively correlated with age. It is also consistent with a recent review of eighteen follow-up studies of learning disabled children in which the preponderance of negative outcomes for academic skills, including reading, was noted (Schonhaut and Satz, 1983). Alternatively, it may be that the older subjects' scores represent more impaired subjects who remained longer at a school for the learning disabled. A longitudinal study would be necessary to differentiate between these interpretations.

HANDEDNESS

The left handed received lower scores on achievement testing than the right handed. Although there was evidence from the linear trend analysis that the mixed handed achievement performance was intermediate to that of the right and left handed, further analyses revealed that the left mixed handed received the higher scores in both the total and the dyslexic groups, and that the right mixed handed were one of the lowest performing groups. The rank order on most achievement tests was left mixed>right>right mixed>left (or left>right mixed). The first two groups were not significantly different from each other, nor were the last two; but one or both of the first two were often significantly different from one or both of the last two. Therefore, in this sample, the left mixed and the right handed received higher achievement scores than the left and the right mixed handed.

The high ranking of the left mixed group is of interest. Mixed left handedness may be approximately twice as common in the "normal" population than pure left handedness, although the exact proportion would depend on how handedness is assessed. For example, Newcombe and Ratcliffe (1973) found that only 3% of their sample were pure left handed on their seven task assessment. If this figure is subtracted from the common estimate of left handedness (by which left hand use for writing is generally meant) which is 10% - the resultant, 7%, represents the mixed left handed. In the present study 7.7% were left mixed and 10.9% were left handed. (It is possible that if a seven, instead of four, task assessment had been used for handedness assignment, some pure left handed may have been labeled mixed left handed in this study.) Therefore, while the left mixed in this

study represent approximately the same proportion of left mixed handed that could be expected in the general population, the pure left handed may over-represented by a factor larger than 3.5. This fact, coupled with the finding here that the mixed left handed are one of the highest performing groups and the pure left one of the lowest, suggests that mixed handedness in left handed writers may be less suspect of cerebral dysfunction than pure left handedness. It also suggests that pure left handedness in a learning disabled population may be suspect of cerebral pathology, and lends support to the observations and theory of Geschwind and Behan (1982) which hypothesizes impaired prenatal neuronal migration in the development of the left hemisphere of some learning disabled and some left handed. (The left handed in the Geschwind and Behan study were "strongly" left handed on the Annett Handedness Inventory.)

In this context, evidence of right hand use for one or more unimanual tasks in a left handed writer suggests some left hemisphere control which may be associated with some advantage on verbal skills in the mixed left handed. The individual hand use patterns of the left mixed will be examined for further clues.

On the other hand, the use of the left hand in the right handed may index cerebral pathology. Right mixed handedness is apparently rare. The right handed are more consistent in their use of their preferred hand than the left handed (Briggs and Nebes, 1975). In a study of normal subjects, McKeever and Van Deventer (1977) found no right hander reported any unimanual use of the left hand on an unspecified handedness inventory. Results of hand preference responses from right and left handed writers

also show that right handed writers are unlikely to use the left hand for the activities assessed in this study (Healey, Liederman and Geschwind, in press). However, right mixed handed were 10.3% of the total sample in the present study and they were consistently one of the lowest performing groups on contrasts of the achievement measures. Right mixed handed entered as a negatively correlated predictor on the Gray Oral, and as a negative correlate in interaction with FS on the Stanford Word Skills.

SEX

Females received higher achievement scores than males. This was not unexpected as females are under-represented in studies of the learning disabled. The difference in performance between the sexes was greatest on the spelling test in both the total and the dyslexic subgroup. This finding is of particular interest in light of the fact that the males received higher scores on most of the cognitive tests than the females in this sample.

FAMILY HISTORY OF SINISTRALITY

There was no main effect for FS on achievement measures. This is noteworthy as the FS+ subjects received higher scores on most cognitive measures than the FS-. The effect of FS as a moderating variable will be discussed below.

SUMMARY OF MAIN EFFECTS ON ACHIEVEMENT SCORES

In summary, the right handed and the left mixed handed received the highest achievement scores; the left handed and the right mixed handed received the lowest. Females received higher scores on achievement

measures than males and FS did not differentiate achievement scores.

ACHIEVEMENT MEASURES - INTERACTIONS

The groups with highest scores were the right handed females, FS-females, and FS+ left mixed handed males. The groups which performed the lowest were the FS+ pure left handed of both sexes. The characteristics of the groups that were least and the groups that were most impaired on achievement tests will be examined for clues to their relative cognitive strengths and deficits.

Least impaired groups:

Across age, right handed females received higher scores on the Gray Oral Reading Test than left handed females and than both right and left handed males. The effect was most notable in the older subjects. The finding that right handed females are one of the least impaired groups is not surprising as the literature suggests that both females and right handed are under-represented in learning disabled populations.

The FS-, the right handed and females are least impaired on most measures. In the total sample, these groups ranked highest on all achievement tests except math. In the dyslexic sample, the ranking of the FS- females was lower. However, only 35.3% of the FS- females met criteria for the dyslexic group, in contrast to the approximately 70 - 90% of the three other groups.

Although the differences between the scores of the FS+ and the FS-females was not significant, the FS- females consistently received higher

scores (except on math) and few of the FS- right handed females met the cutoff score in this study for "dyslexic subjects". As FS-, right handedness and femaleness may imply more lateralized anterior functions than FS+, left handedness or maleness (Hecaen et al.,1981; Kimura and Harshman, 1984) these factors may indicate a relative advantage for an important component of the reading process and/or some reading strategies. The most obvious candidate(s) for this component is one or more aspects of the phonetic decoding processes.

Alternatively, FS+ females may be impaired relative to the FS- females because of psychopathology. As will be discussed below, FS+ females report more dysphoria, and their parents rated them significantly more hyperactive/attention disordered than did the parents of the FS- females.

When a right handed female is reading disabled what type of strengths and limitations do these data suggest she might have? This least impaired and possibly under-represented group received relatively superior scores on the sequencing factor and low scores on spatial tests. In the total sample, right handed females (and the female left mixed handed who were very few in number and actually scored highest on achievement testing) were the highest ranking groups on the sequencing factor. (The right handed females are significantly different only from the left handed females, a group that is impaired on all measures). Right handed females receive their highest ranking on Coding. They are also second in ranking on Arithmetic and the Barea Gestalt. (They are low ranking on Digit Span which is probably why their sequencing scores are not significantly different from other groups.)

The most obvious weakness of right handed females is on spatial skills. The spatial skills on which females and right handed females are less impaired, the Coding and Barea Gestalt, may require more attention to detail and/or fine motor control than other Wechsler performance subtests. In the context of their comparatively high oral reading scores, it is suggested that these subjects may be relatively impaired on tasks which require integration or parallel processing. It will be argued below that reading comprehension of text may involve more integration and parallel or simultaneous processing than decoding or spelling. The finding that right handed females receive low spatial scores, except on Coding and the Barea Gestalt, is consistent with higher ranking of the dyslexic female right handed on oral reading and spelling tests than on silent reading comprehension. (The Gray Oral Reading Test, except on the highest level, does not require much comprehension, as only simple, factual questions are asked of subjects after he or she has read paragraphs aloud.)

If this analysis is correct, it suggests that the groups which score the highest on the achievement tests in this study, for which phonetic skills are presumably critical, have relatively stronger left anterior and weaker right hemisphere skills.

The FS+ left mixed handed also appear to be a relatively less impaired group. On the Gray Oral and the Slosson Oral, the FS+ males received higher scores than the FS- left mixed handed males. On the Stanford Spelling, Word Skills and Reading Comprehension Tests, the FS+ left mixed handed received higher scores than the FS- left mixed subjects.

(There were no FS- mixed left females in this sample. They may be too high or low functioning to appear on the rolls of a school for the learning disabled; or this may be a sampling bias.)

The finding that the FS+ left mixed handed are one of the least impaired groups was not expected. The cell sizes are small, so the effect may be spurious. FS+ left handed may have language skills more bilaterally organized than FS- left mixed handed (Hecaen, et al., 1981) which may confer an advantage for some language skills. McKeever and Van Deventer (1977) found FS+ left handed reported more use of the right hand (18.9%) than was reported for the FS- left handed (5.9%) suggesting more bilateral control of motor function in the FS+ left handed. Some bilateral language representation may be advantageous for reading. However, as language laterality was not assessed in this study, it cannot be concluded that differential brain organization was responsible for these findings.

Most impaired groups:

In the regression analyses, the right handed perform better than the non-right handed across age groups on the Gray Oral, and the non-left handed perform better than the left handed across age groups on the Slosson Oral. However, examination of the regression analyses of the other achievement measures suggests that the left handed with a positive family history of sinistrality may be the most impaired group. In addition, the FS+ left handed ranked the lowest on all the contrasts of the achievement measures. When the significant three way interaction FLA (FS. Left. Age) is examined for the Stanford Spelling and Work Skills Tests, the FS+ left handed received lower scores than the FS+ non-left handed across age.

When the two way interaction FL (FS and Left) is examined for Stanford Reading Comprehension and Math, the FS+ left handed received lower scores than the FS- non-left handed in the above the mean age group on the spelling and the word skills test. The FS- left handed received higher scores than the FS- non-left handed on the reading comprehension and the math tests.

These findings suggest that the putatively more bilaterally organized FS+ and left handed are at a disadvantage relative to the FS- and right handed on achievement tests.

COGNITIVE MEASURES - MAIN EFFECTS

HANDEDNESS

There are few differences on cognitive measures between the handedness groups. This is consistent with the literature reviewed (e.g. Hardyck et al., 1976).

SEX

In the total sample and in the dyslexic subgroup, males received higher scores on all verbal measures and almost all spatial measures than females, although females scored significantly higher than males on Coding. Analyses of the Bannatyne factors indicated that the greatest differences between the sexes was on the spatial and acquired knowledge factors. The superiority of males on spatial tasks and of females on Coding, is consistent with the literature, but the relatively poor performance of females on verbal measures is not (Maccoby and Jacklin,

1974). The inferior verbal skills of the females in this sample is interesting, especially since they received higher scores on achievement measures than males. The large disparity between males and females over all cognitive scores may be sampling bias, although Owen and Adams (1964) reported similar findings. This is consistent with the impression that there is no obvious relationship between the many commonly administered cognitive tests and achievement measures in the learning disabled. The female superiority on Coding which loads on the Bannatyne sequencing factor, may be an exception to this as discussed above.

If we assumed that reading deficits usually indexes a left hemisphere dysfunction, it may be this deficit that contributes to the relatively low spatial scores of the females. The work of Lansdell (1962), McGlone (1977) and Sherman (1978) suggests that females may use left hemisphere and/or verbal strategies more than males for spatial processing.

Another point worth noting is the superiority of the males on the acquired knowledge factor in the face of their poorer achievement scores. This suggests that either what they do read, attend to, or experience is more relevant to what this factor assesses than what the females read, attend to or experience. Alternatively, maybe males can remember better than females what they have read. The latter explanation is consistent with the finding that females have more symptoms of depression or low self-esteem. Depression may interfere with memory (Weingartner, Cohen, Murphy, Martello, and Gerdt, 1981), especially on tasks that require sustained effort (Cohen, Cohen, Weingartner, Smallberg, and Murphy, 1982; Reus, Silberman, Post and Weingartner, 1979).

FAMILY HISTORY OF SINISTRALITY

In the total sample and the dyslexic subgroup, the FS+ subjects received higher scores on individual verbal and spatial measures than FS- subjects. However, the only Bannatyne factor on which the FS groups differed significantly was acquired knowledge. As FS+ subjects were also rated as more hyperactive or attentionally disordered than FS- subjects by their parents, (to be discussed below) difficulty in attending to factual information, can not explain their superior performance.

Perhaps a family history of sinistrality confers a memory advantage which could account for the higher scores on the acquired knowledge factor. The subtests that load on this factor (Information, Arithmetic, Vocabulary) require recalling specific, relatively isolated or context-free information in "long term" memory, in contrast to the analysis and judgement required by Similarities and Comprehension or the recalling of figures in "short term" memory as in Digit Span or Coding. Perhaps the putative bilateral language representation in the FS+ is associated with enhanced verbal memory representation.

An item analysis of the SNAP may add to the understanding of the differences between the FS groups. Perhaps the higher scores of the FS+ do not reflect primary inattentiveness, but symptoms secondary to anxiety and frustrations associated with their academic failure. As there is a greater discrepancy between the FS+ subjects' scores on cognitive and achievement measures than those of the FS- subjects, the "smarter" FS+ may be more distressed by their learning disabilities than the FS- who may not perceive such a discrepancy. Support for this interpretation comes

from the finding that, in both the total sample and the dyslexic subgroup, the FS+ report less self-esteem than the FS-. The difference between the groups is significant only in dyslexic subgroup despite the smaller sample size. That is, the more achievement disabled FS+ themselves reported evidence for subjective distress than the achievement disabled FS- subjects.

Alternatively, perhaps if the FS+ subjects were not more symptomatic than FS- subjects, they would be able to perform better, i.e., more consonant with their superior cognitive skills, on measures academic achievement. It could be argued that individual tests of cognitive skills require less sustained attention than academic achievement testing and difficulty sustaining attention is a hallmark of ADD. In other words, the FS+ may be a superior group whose achievement performance is depressed by psychopathology related to their sinistral family history. Geschwind and Behan (1982) hypothesized that testosterone may depress prenatal thymic growth and neuronal migration in the left hemisphere predisposing the developing individual to autoimmune disease, left handedness and dyslexia. Kinsbourne and Bemporad (in preparation) found FS+ right handed to have an increased incidence of immune disease. The same mechanism may be responsible for the antecedents to psychopathology in the FS+.

INTERACTIONS

HAND AND SEX

In the total sample, most of the significant differences on the Bannatyne factors were on the sequencing and acquired knowledge factor. The ranking on the sequencing factor distinguishes the least impaired from the most impaired readers. There were no significant contrasts in either the total or dyslexic samples for the verbal factor.

HAND AND FS

The results of the hand and FS contrasts suggests that the FS+ effect is to enhance the cognitive skills of the left mixed and right handed subjects, but to depress the skills of the left handed. The FS- subjects were intermediate, i.e., there were lower ranked on the verbal, sequential and acquired knowledge factor than the left mixed and right handed, but higher ranked than the FS+ left handed. The exception to this is the FS+ right mixed, a group that is suspect of cerebral pathology.

In the hand and FS contrasts, the FS+ right and left mixed handed were the highest performing groups on the verbal, sequencing and acquired knowledge factor. There were no significant differences on the spatial factor. The FS+ left handed received the lowest scores on the verbal and acquired knowledge factor; the FS- and FS+ left handed and FS+ right mixed were lowest on the sequential factor. Among the dyslexic sample, there were no significant differences on the verbal, spatial and acquired knowledge factors. The FS+ left mixed were the highest performing, and the FS- right and left handed were the lowest functioning on the sequencing factor.)

SEX AND FS

The analyses of these subsets suggests that the effects of sex and FS on cognitive measures are additive. There were no significant differences for the Bannatyne verbal, spatial or sequencing factor for the total sample. The FS+ males received the highest scores on the acquired knowledge factor. In the dyslexic sample, there were no significant differences on the sequencing factor and FS+ males were the highest performing group on the other factors.

CONCLUSIONS: ACHIEVEMENT AND COGNITIVE MEASURES

With the single exception of the FS+ female left mixed handed, the entire group of hand and sex and FS subsets received lower scores on the sequencing than on the verbal factor. This and the regression analyses suggest that sequencing may be a sine qua non of effective reading.

Sequencing, the appreciation of the relative position in a series, is necessary to both temporal and spatial processing. Temporal sequencing deficits may be a limiting factor in many, if not all, of the language skills necessary to reading and to successful demonstration of reading competence. Adequate temporal analysis and production (input and output) is necessary (but perhaps not sufficient) to process formants, formant transitions in syllables, syllables within words, words within sentences, and sentences within paragraphs (Tallal and Stark, 1981; Corkin, 1974; Zurif and Bryden, 1969; Frith, 1980), and remembering phonetic segments (Fox and Routh, 1980; Liberman and Shankweiler, 1979; Mattingly, 1980) or phonological codes (Jorm, 1979). These individual skills may be

semi-autonomous, but primarily dependent on left hemisphere function. Subtypes of dyslexia based on one or more on these dysfunctions, e.g., expressive motor deficits (Denckla, 1977; Mattis, 1975, 1978; Myklebust, 1987), dysphonetic group (Boder, 1973), naming (Denckla, 1977; Mattis, 1975, 1978), memory (Denckla, 1977; Jorm, 1979; Torgeson, 1978-1979) and sequencing (Denckla, 1979; Mattis, 1978; Petrauskas and Rourke, 1979) may be generated depending on the tests administered and sampling biases.

Decoding, operating the rules that govern phoneme-grapheme relationships, may depend primarily on left hemisphere sequencing competence. Reading comprehension, simultaneously integrating the hierarchical organization of contextual relationships, may require only minimal decoding skills, and rely more on right hemisphere processing (Delis, Wapner, Gardner, and Moses, 1983; Wapner, Hamby and Gardner, 1981). It must certainly be necessary to have some phonetic analytic decoding skills to attack "new" words, but if a minimal sight vocabulary can be established with the aid of a competent visual memory, an adequate use of the context may help a poor phonetic reader to compensate. Such a reader may score better on tests of reading comprehension, especially silent reading, than on tests of phonetic analyses (e.g. Stanford Word Skills), spelling, oral reading of single words (e.g. Wide Range Achievement Test, Slosson Oral Reading), or even tests of reading comprehension that are orally tested (e.g., Gray Oral Reading Test).

This dichotomy (decoding and comprehension) may be why many investigators find two main types of reading disabled subjects (A third type is usually a combination of the other two) and why Keefe and Sweeney

(1979) find a bimodal distribution of auditory and visual lateralization scores for dyslexics in contrast to a normal curve for non-dyslexics. The dichotomy may well correspond to relative left and right dysfunctional hemisphere processing, but not necessarily to verbal versus spatial deficits, but to impaired sequential versus integrative or simultaneous processing. A similar conclusion has been drawn by Malatesha and Dougan (1982) who were able to differentiate dysphonetic from normal and dyseidetic readers, as well as dyslexics with good from those with poor phonetic skills on dichotic listening tasks.

If reading disability is defined only by a score on a decoding task, and the Wide Range Achievement Test (WRAT) is most commonly used, it may not be possible to distinguish a comprehension deficit subtype. The reading disabled with comprehension problems may not be caught by its net. Regardless of the inclusion criteria, it would be impossible to differentiate a comprehension subtype if comprehension is not assessed at all. The fact that often only a decoding test is used to define a dyslexic sample may explain why non-sequential spatial functions are irregularly associated with dyslexia. The visual-spatial disordered subset found by Mattis (1975, 1978) and Denckla (1977) constituted a small proportion of their samples; and Doehring et al. (1981) were unable to find this subtype at all. In fact, Gordon (1983) and Geschwind (1982) suggest that many dyslexics may possess relatively enhanced right hemisphere spatial (and other) skills. Note that, in this study, some of the poorest readers, the male left and right mixed handed, were superior to a relatively high reading group, the female right handed, on the Bannatyne spatial factor.

If this analysis is correct, the visual-spatial, but non-sequential, impairments that are reported in association with reading disabilities (Shankweiler, 1963; Mattis, 1975; Denckla, 1977; Myklebust, 1965) may predict reading comprehension difficulties. Impairment in spatial tasks (which do not also require fine motor skills) may be found in association with the same deficits that are limiting to higher order verbal processing. The impaired neurocognitive processes that result in spatial deficits may only lie next to the areas that result in deficits to reading comprehension in the brain, and, in analogy to the left hemisphere syndromes, if dysfunction is wide spread, neighboring functions may be affected. Alternatively, spatial deficits may be representative of fundamental dysfunction in some dyslexics, i.e., the ability to "see" patterns, to appreciate complex, nonlinear or non-sequential relationships, whether visual or verbal, may be a limiting factor in both non-sequential spatial deficits and reading comprehension tasks.

In summary, we may expect that there are two main types of disabled readers, and, since they are not mutually exclusive, that a third type which would have both deficits can exist. The two types correspond to major limiting factors in reading and are: 1. deficits at one or more levels or phonetic processing, which are primarily left hemisphere dependent, and 2. deficits in integrating verbal information in a hierarchically organized context which are primarily right hemisphere dependent. These are referred to here as decoding and comprehension problems. The third type would have both decoding and comprehension difficulties and would be the most impaired readers.

Now we may better understand an additional disadvantage of the pure left handed, left handed females and those with a positive family history of sinistrality. The left handed and females in the general population may have particular difficulty doing two different tasks simultaneously (Berry et al., 1980) because of their more diffuse brain organization. The functional cerebral distance theory (Kinsbourne and Hicks, 1978) predicts that simultaneously performed different tasks will be performed more efficiently the further apart their cerebral representations are. Therefore, the left handed may be doubly handicapped because of 1. weak sequencing/phonetic skills (perhaps due to prenatal influences) and 2. having to perform a task, reading, which requires simultaneous decoding and comprehending or integrating. Female left handed may be additionally stressed, if we assume that females may rely on their left hemisphere more than males for all functions and that the left handed have an impaired left hemisphere. If a positive family history of sinistrality also implies less focal organization, FS+ might impose yet another load on the simultaneous performance of different, e.g., decoding and comprehending, tasks.

PSYCHOPATHOLOGICAL MEASURES

MAIN EFFECTS

AGE

Age was one of the major predictors of psychopathological symptoms for measures of psychopathology. The younger subjects reported more symptoms than the older subjects. It is possible that the older students are less willing to disclose personal difficulties or are more concerned with giving socially desirable answers. The younger students may, in fact, be more symptomatic. An item analysis comparing the response profiles of age strata may improve the understanding of this finding.

There is a paucity of information on any measure of psychopathology, whether purporting to assess depression, self-esteem or hyperactive/attention deficit disorder that assesses subjects in a similar age range to this study. There are no norms nor studies of hyperactivity/attention deficit disorder in late adolescence despite the fact that this syndrome is currently believed by clinicians to continue into adulthood. The relevant literature on the non-learning disabled is conflicting and reports on widely varying methodology and age ranges. Piers and Harris (1964) who administered a self-esteem measure they had developed to third, sixth and tenth graders, who were unselected for pathology and described as covering a wide range of intelligence, social and economic groups, did not find an age effect when comparing third and tenth graders. (For reasons that are unclear, these investigators only reported on the "high" scores, which represented 363 subjects.) However, the sixth graders had lower scores, and greater variability than both groups. Sixth graders, if estimated to be approximately 11 years old,

are over two standard deviations below the mean age of this sample (Mean 15.11 years, Std. Dev. 2.56). Therefore, they would be comparable to the low end of the age spectrum of this study and the Piers and Harris findings are opposite to those reported here. Also, Kaplan, Hond and Weinhold (1984) obtained 385 completed Beck Depression Inventories from junior and senior high school students and found that the 11 - 13 year olds reported less symptomatology than the 14 -16 or 17 -18 year old groups. However, Albert and Beck (1975) compared findings from their study of seventh and eighth graders with a short form of the BDI to a study of depressive symptomatology in high school students and found significantly more symptoms in the seventh and eighth graders. (The Short Child Depression Inventory used in this study was adapted from the short form of the BDI.) Trites, Digas, Lynch and Ferguson (1979) found little variation in scores on the Conners Hyperactivity Index as rated by teachers on children 5 to 12 years old. Goyette et al. (1978) who reported on children 3 to 17 years old, found the older subjects received lower scores on the Conners Hyperactivity Index whether rated by teacher or parents.

In many ways this finding is surprising as we might expect the older and more academically impaired students to report more distress. However, the subjects in this study are at a school, identified as for the learning disabled, apart from the neighborhood friends and previous school mates, and for many students, this is a residential school, away from their families. This may be more difficult for the younger children.

HANDEDNESS

In the regression analyses of the All Self factor the right handed reported less symptomatology across age and sex. The left mixed handed reported more depression or low self-esteem in the total sample and depression in the dyslexic sample in the contrasts. The few psychiatric studies of handedness reported in the introduction did not differentiate between mixed left and left handedness. It may be only the left mixed handed that contribute this effect.

FAMILY HISTORY OF SINISTRALITY

FS differentiates ratings on parental report of hyperactivity\attention deficit disorder in the specific contrasts. The parents of the FS+ subjects reported more hyperactivity/attention deficit disorder in their children than the parents of FS- students. This is supported by the regression analyses of the SNAP in which FS is entered as a component in a significant interaction and which will be discussed below.

SEX

Sex differentiates self-ratings on measures of depression and self-esteem. In the total sample, females reported more evidence of low self-esteem; in the dyslexic group, females gave more evidence of depression and low self-esteem than males. This is supported by the regression analysis of the All Self factor on both significant interactions in which sex was a component. The interactions will be discussed below.

Adult females have more depressive illness than adult men, although recent studies suggest that social role is an important moderating variable, i.e., single women are less depressed than single men and married men (Weissman and Kleman, 1977). Kaplan et al. (1984), who found a trend for adolescent females to report more depressive symptomatology, note that there are no adequate epidemiological psychiatric studies of adolescents. A review of the literature finds that sex differences are not found in children and young adolescents on the Coopersmith Self-Esteem Inventory in the general population. Therefore, this finding may not represent sex differences in children nor adolescents

on measures of depression and low self-esteem in the general population.

There were not differences on the measures of hyperactivity/attention deficit disorders. This is in contrast to expectations as the literature and norms on the hyperactivity/attention deficit disorder measures report more symptoms among males, although as noted above there is little literature on this syndrome in adolescence. The differences between the sexes on scores on the Conners Hyperactivity Index narrows in the upper age ranges (12 - 17 years) in the Goyette et al. (1978) normative study. Further analyses, by age stratification, is necessary to compare these data with the norms that do exist.

INTERACTIONS

HAND AND SEX

On self-rated measures, left handed females had the most and left handed males the least evidence of depressive symptomatology in the contrasts. This is supported by the regression analyses for both age groups on the All Self factor. Male left mixed handed received higher scores than female left mixed handed in the regression analyses of the SNAP. (There were only three female mixed left handed, but their scores were quite low compared to the other groups.)

HAND AND FS

The FS+ left and mixed handed rated themselves most symptomatic on measures of depression and self-esteem in both the total and dyslexic sample; the parents of FS+ right handed rated their children the highest on hyperactive/attention deficit disorder on the contrasts. FS did not enter as a component in any predictor on the All Self factor, but did so on the SNAP. The FS+ non-right handed received higher scores than the FS-non-right handed.

SEX AND FS

The effects of FS and sex appear additive for females. The FS+ females are more depressed, have lower self-esteem and are more hyperactive/attention disordered than the other group.

The negative entry of the Bannatyne spatial factor as a predictor to the All Self factor lends some support to Rourke and Strang's observation that there is a negative relationship between spatial functioning and depression. It is also of interest that the FS- left handed males receive high spatial scores and generally low scores on measures of psychopathology and FS+ left handed females have the reverse pattern. Both spatial skills and depression have been associated with right hemisphere functions (for a review see Kinsbourne and Bemporad, 1984). Does right hemisphere dysfunction lead to depression and impaired spatial skills or does depression lead to depressed spatial skills? However, the only measure of depression or self-esteem that was negatively correlated with the Bannatyne spatial measure was the Birlson Depression Inventory.

The finding that the group that had the verbal factor on of more standard deviations less than their spatial factor (low verbal group) had higher All ADD scores than the group that had approximately equal verbal and spatial factors (equal group) suggests that hyperactivity/attention deficit disorder is associated with poor left hemisphere skills. Landau, Milich and McFarland (submitted) formed three groups defined by Verbal versus Performance IQ differences, low verbal, low spatial, and equal. They reported that the low verbal group received lower peer social status ratings and both the low verbal and equal groups received higher

hyperactivity ratings on the Conners Hyperactivity Index than the low spatial group. Does left hemisphere impairment underlie poor verbal skills and, also, sometimes, generate psychopathological symptomatology? Or, does ADD lead to impaired verbal skills? Possibly the dysrhythmia hypothesized to underlie ADD is related to the aberrant biological clock mechanisms that some hypothesize to underlie sequencing difficulties.

How can we understand the finding that FS+ subjects are reported more hyperactive than FS- subjects? Why are females, perhaps only academically disabled females, more distressed than similarly academically impaired males? Why are the left handed females particularly depressed? Does the relatively superior spatial functions of the left handed males (especially the FS- left handed males) imply a relatively intact right hemisphere which protects them against the symptomatology of the other sinistral groups? The literature suggests that the left handed, the FS+ and females are more diffusely lateralized for cognitive functions. Perhaps these groups have more difficulty modulating affect, and find emotions more disruptive, less manageable than the right handed, FS- and males. Possibly functional representation may not only be diffused on the lateral and anterior-posterior (Hecaen et al., 1981) cerebral axes, but also on the vertical axis. Diffuse lateralization may be related to difficulty separating not only cognitive functions, as described by cerebral functional distance theory, but affective and cognitive functions as well.

In conclusion, future studies of the learning disabled would profit from the a priori classification of subjects according to suspected indices of brain organization (e.g., sex, personal and familial handedness), as well as the classification of the type of processing difficulties underlying the disability or disabilities. This study suggests that subjects with presumed atypical patterns of brain organization may have specific information processing limitations which put them at risk for developing both learning and emotional problems.

APPENDIX I

TABLE I

Raw Scores of All Variables for All Subjects

Variable	N	Mean	Std.Dev.
Age	493	15.11	2.56
<u>Achievement Measures</u>			
Gray Oral Reading	316	54.02	22.79
Slosson Oral Reading	319	67.46	21.97
Stanford Spelling	293	57.08	20.21
Stanford Word Skills	232	54.59	23.24
Stanford Reading Comprehension	191	60.34	25.50
Math	278	73.22	29.86
<u>Cognitive Measures</u>			
Wechsler FSIQ	260	100.67	12.46
<u>Verbal Measures</u>			
Wechsler VIQ	266	99.63	12.33
Information	226	9.33	2.53
Similarities	225	10.85	2.89
Arithmetic	223	8.38	2.59
Vocabulary	223	9.61	2.60
Comprehension	227	10.92	2.96
Digit Span	202	8.04	3.03
Peabody Picture Vocab. Percentile	223	58.59	28.08
<u>Performance/Spatial Measures</u>			
Wechsler PIQ	265	101.38	15.15
Picture Completion	223	10.81	3.19
Picture Arrangement	221	11.08	2.69
Block Design	222	10.32	3.38
Object Assembly	217	10.74	3.65
Coding	221	8.08	3.37
Berea Gestalt Deviation	201	-6.36	2.95
Raven's Coloured Progressive Matrices Total Errors	166	6.00	4.87

Variable	N	Mean	Std.Dev.
Karnovsky Test of Mental Rotations:			
Picture Form:			
Mirror Errors	177	2.20	1.87
Total Errors	176	5.36	3.25
Shapes Form:			
Mirror Errors	178	3.05	2.43
Total Errors	177	6.43	3.40

Psychopathology

Variable	N	Mean	Std.Dev.
<u>Self-Report</u>			
Birleson Depression Inventory	350	10.35	4.51
Short Child Child			
Depression Inventory	243	7.47	7.16
Coopersmith Self-Esteem			
Inventory Long Form	256	76.30	15.74
Coopersmith Lie Scale	256	2.38	1.80
Coopersmith Self-Esteem			
Inventory Short Form	85	65.12	11.26
Conners' Hyperactivity Index			
by Self	341	8.39	4.68
<u>By Others</u>			
Conners' Hyperactivity Index:			
by Classroom Teacher	173	7.98	7.03
by Tutor	224	7.22	5.93
by Parents	285	9.93	6.38
SNAP	296	18.46	12.28

TABLE II
 SAMPLE DESCRIPTION BY HAND, SEX, FS

	FS-			FS+		
	Male	Female	Total	Male	Female	Total
RIGHT HANDED						
Total Sample	43	13		34	8	
Dyslexic Sample	23	5	84	32	7	81
LEFT HANDED						
Total Sample	3	3		6	2	
Dyslexic Sample	6	1	13	10	3	21
LEFT MIXED HANDED						
Total Sample	1	0		6	0	
Dyslexic Sample	5	0	8	5	3	14
RIGHT MIXED HANDED						
Total Sample	3	0		1	0	
Dyslexic Sample	5	0	6	4	3	8
TOTAL MIXED HANDED						
Total Sample	4	0		7	0	
Dyslexic Sample	10	0	14	9	6	22

Chi Square all nonsignificant, except * Chi Sq.=.05, .15 with Yates Correction

APPENDIX II-HANDEDNESS

The results, are presented for achievement, cognitive and psychopathological measures respectively. Within each division are the results for the contrasts of the right, mixed and left handed, followed by the analyses with the mixed handed category separated, i.e., for the right, right mixed, left mixed and left handed. The results for the total sample, all subjects, are presented in section A. The results for the dyslexic subjects, i.e., those who received a score on one or more reading tests equal or lower than three grade equivalents, is presented in section B.

A. ALL SUBJECTS

ACHIEVEMENT MEASURES

The following results are based on contrasts between right, mixed and left handed subjects. These were abbreviated RH, MH, LH.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	Right	203	-.0421	.969	RH>LH	2.387	.018 N-K
	Mixed	61	-.1415	1.027			
	Left	36	-.4713	1.080	RH>MH>LH		
Slosson Oral	Right	207	-.0445	.977	RH>LH	1.868	.063
	Mixed	61	-.2477	.926			
	Left	36	-.3741	1.062	RH>MH>LH		
Stanford Spelling	Right	190	-.0656	.973	RH>LH	2.052	.041
	Mixed	56	-.1228	1.041			
	Left	35	-.4424	1.066	RH>MH>LH		
Stanford Word Skills	Right	149	-.1236	.976	ns.		
	Mixed	49	-.2810	1.001			
	Left	27	-.3134	1.165	RH>MH>LH		
Stanford Reading Comprehension	Right	124	-.0517	.909	ns.	1.633	.104)
	Mixed	42	.0715	1.080	(MH>LH		
	Left	18	-.3783	1.181	MH>RH>LH		
Math	Right	178	.0210	1.022	(RH>LH	1.613	.108)
	Mixed	58	-.1235	.946			
	Left	31	-.2930	.969	RH>MH>LH		

Linear trends on the order right, mixed and left were of interest on the following:

Variable	Unweighted		Weighted		Deviation	
	F	p	F	p	F	p
Gray Oral	2.88	<.058	5.70	<.018	ns.	
Slosson Oral	3.49	<.063	4.64	<.032	ns.	
Stanford Spelling	4.21	<.041	3.55	<.061	ns.	

The mixed handed group was further subdivided into two groups: those subjects who wrote with their right hand (RM) and those that wrote with their left hand (LM).

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	RH	204	-.0421	.969	RH>LH	2.39	.018 N-K
	RM	38	-.2598	.290	LM>LH	1.98	.049
	LM	23	.0538	1.179			
	LH	36	-.4713	1.080	LM>RH>RM>LH		
Slosson Oral	RH	207	-.0445	.977	RH>RM	2.12	.035
	RM	38	-.4094	.912	RH>LH	1.87	.062
	LM	23	.0193	.905	LM>RM	1.67	.097
	LH	36	-.3741	1.062	LM>RH>LH>RM		
Stanford Spelling	RH	190	-.0656	.973	RH>LH	2.06	.041
	RM	34	-.2915	.982	LM>LH	2.14	.033
	LM	22	.1379	1.097			
	LH	35	-.4424	1.066	LM>RH>RM>LH		
Stanford Word Skills	RH	149	-.1236	.976	RH>RM	2.21	.028
	RM	31	-.5575	.796	LM>RM	2.55	.011
	LM	18	.1952	1.176	LM>LH	1.68	.094
	LH	27	-.3134	1.165	LM>RH>LH>RM		
Stanford Reading Comprehension				ns.			
							LM>RM>RH>LH
Math	RH	178	.0210	1.022	(RH>RM)	1.61	.109)
	RM	36	-.2726	.908	(RH>LH)	1.62	.107)
	LM	22	.1204	.776			
	LH	31	-.2930	.969	LM>RH>RM>LH		

COGNITIVE MEASURES

The following analyses contrasted RH, MH and LH groups.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ		251	100.46	12.53	ns. MH>RH>LH		
<u>Verbal Measures</u>							
VIQ		255	99.53	12.33	ns. MH>RH>LH		
Information		218	9.33	2.51	ns. MH>RH>LH		
Similarities	RH	143	11.01	3.04	RH>LH	1.70	.091
	MH	48	10.85	2.77			
	LH	26	9.96	2.37	RH>MH>LH		
Arithmetic		215	8.33	2.61	ns. RH>MH>LH		
Comprehension		219	10.87	2.93	ns. RH>MH>LH		
Vocabulary		215	9.62	2.61	ns. RH>MH>LH		
Digit Span		197	8.02	3.05	ns. RH>LH>MH		
Peabody Picture Vocab. Test Perc.		214	58.49	28.37	ns. LH>MH>RH		

Spatial Measures

PIQ		254	101.19	15.19	ns.		
					MH>LH>RH		
Picture Completion		215	10.83	3.19	ns.		
					MH>RH>LH		
Picture Arrangement		213	11.03	2.69	ns.		
					RH>MH>LH		
Block Design		214	10.28	3.41	ns.		
					MH>LH>RH		
Object Assembly		209	10.70	3.65	ns.		
					LH>MH>RH		
Coding		214	8.00	3.25	ns.		
					RH>MH>LH		
<u>Karnovsky Test of Mental Rotation</u>							
<u>Picture Form</u>							
Mirror Errors							LH>MH>RH
Total Errors							LH>RH>MH
<u>Shapes Form</u>							
Mirror Errors							RH>LH>MH
Total Errors							RH>MH>LH
Total Errors Both Forms							RH>LH>MH
<u>Raven's Coloured Progressive Matrices</u>							
Berea	RH	133	-6.27	2.98	MH>LH	1.68	.094
Gestalt	MH	35	-6.00	2.62			
Deviation	LH	24	-7.29	2.81	MH>RH>LH		

The following contrasts were on the handedness variables divided into RH, RM, LM, LH groups.

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ					LM>RH>RM>LH		
<u>Verbal Measures</u>							
VIQ					LM>RH>RM>LH		
Information					LM>RM>RH>LH		
Similarities	Total	217	10.85	2.91	RH>LH RH>LM>RM>LH	1.69	.092
Arithmetic	RH	143	8.46	2.65	RH>RM	1.68	.095
	RM	25	7.52	2.93	LM>RM	2.14	.034
	LM	22	9.14	2.26	LM>LH	1.87	.062
	LH	25	7.72	2.05	LM>RH>LH>RM		
Comprehension					RH>LM>RM>LH		
Vocabulary					LM>RH>RM>LH		
Peabody Picture Vocabulary Percentile					LH>LM>RM>RH		
<u>Spatial Measures</u>							
PIQ					LM>LH>RM>RH		
Picture Completion					LM>RH>RM>LH		
Picture Arrangement					RH>RM>LH>LM		
Block Design					LM>RH	1.83	.069
					LM>LH>RM>RH		
Object Assembly					LM>LH>RM>RH		
Coding					LM>RH>LH>RM		

 Karnovsky Test of Mental Rotation

Picture Form

 Mirror Errors LH>LM>RH>RM

 Total Errors LH>RH>LM>RM

Shape Form

 Mirror Errors LM>RH>LH>RM

 Total Errors LM>RH>LH>RM

 Both Forms: Total Errors LM>RH>LH>RM

 Raven's Coloured Progressive Matrices LM>RM>LH>RH

Berea	RH	133	-6.27	2.98	RM>LH	2.05	.042
Gestalt	RM	18	-5.44	2.23			
Deviation	LM	17	-6.59	2.94			
	LH	24	-7.29	2.81	RM>RH>LM>LH		

 BANNATYNE FACTORS:

 Verbal (Sim. + Vocab. + Compreh.) RH>LM>RM>LH

 Spatial (P.C.+ B.D. + O.A.) LM>RM>LH>RH

 Sequencing (Arith. + D.S. + Cod.) RH>LM>LH>RM

 Acquired Knowledge (Info. + Vocab. + Arith.)

LM>LH	1.72	.088
LM>RH>RM>LH		

PSYCHOPATHOLOGY

The following analyses contrasted right, mixed and left handed groups.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Report by Self</u>							
Birleson Depression Inventory					RH>MH>LH		
Short Child Depression Inventory					MH>LH>RH		
Coopersmith Self-Esteem Long Form					LH>MH>RH		
Coopersmith Self-Esteem Lie Scale					LH>RH>MH		
Coopersmith Self-Esteem Short Form					LH>RH>MH		
Conners	RH	239	-.0434	.978	LH>RH	1.70	.098 N-K
Hyperactivity	MH	66	-.0473	.852			
Index by Self	LH	34	.3149	1.176	LH>RH>MH		
<u>Report by Others</u>							
Conners HI Index by Classroom Teacher					MH>RH>LH		
Conners HI Index by Tutor					MH>LH>RH		
Conners HI Index by Parents					RH>MH>LH		
SNAP					MH>LH>RH		

PSYCHOPATHOLOGY

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Report by Self</u>							
Birleson Depression Inventory	Total	349	-.0061	1.006	ns. LM>RH>LH>RM		
Short Child Depression Inventory	RH	172	-.0077	1.026	LM>RH	1.79	.075
	RM	30	-.1497	.647	LM>RM	1.97	.050
	LM	18	.4304	.943			
	LH	23	-.0554	1.084	LM>RH>LH>RM		
Coopersmith Self-Esteem Long Form	RH	184	-.0422	.999	LM>RH	1.92	.056
	RM	30	-.0141	.920			
	LM	18	.4278	.875			
	LH	24	.1967	1.078	LM>LH>RM>RH		
Coopersmith Self-Esteem Short Form	RH	60	-.0063	.943	RM>LM	2.49	.027
	RM	6	.4298	.605	LH>LM	1.98	.066
					RM>LH>RH>LM		
Conners Hyperactivity Index by Self	RH	239	-.0434	.978	LH>LM	1.84	.070
	RM	37	.0491	.801	LH>RH	1.70	.098
	LM	29	-.1703	.912			
	LH	34	.3149	1.176	LH>RM>RH>LM		
<u>Report by Others</u>							
Conners HI by Classroom Teacher	Total	169	-.0301	.973	ns. LM>RM>RH>LH		
Conners HI by Tutor					RM>RH	1.68	.094
					RM>LH>RH>LM		
Conners HI by Parents					ns. LM>RH>LH>RM		
SNAP					ns. LM>RH>RM>LH		

B. DYSLEXIC SUBJECTS

These subjects met a strict criteria for reading disability. They were selected if they received scores on the Gray Oral or the Slosson Oral or the Stanford Reading Test that were equal or less than three grade equivalents below their expected for age grade.

ACHIEVEMENT MEASURES

The results are based on contrasts of right, mixed and left handed subjects. Based on the figures obtained from the Gray Oral Reading Test, the dyslexic group was composed of: 69.6% of the right handed, 84.2% of the right mixed handed, 82.6% of left mixed handed and 83.3% of the left handed from the total sample.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	RH	142	-.3892	.835	RH>LH	1.91	.058
	MH	51	-.3783	.870	MH>LH	1.72	.087
	LH	30	-.7183	.947	MH>RH>LH		
Slosson Oral	RH	144	-.3510	.952			
	MH	51	-.4142	.837	ns.		
	LH	30	-.5132	1.077	RH>MH>LH		
Stanford Spelling	RH	131	-.3291	.920	RH>LH	2.02	.045
	MH	46	-.3150	.932	MH>LH	1.80	.087 N-K
	LH	30	-.7009	.842	MH>RH>LH		
Stanford Word Skills	RH	111	-.3289	.881			
	MH	43	-.3174	1.025	ns.		
	LH	22	-.5291	.987	MH>RH>LH		
Stanford Reading Compreh.	RH	97	-.2833	.791	MH>LH	2.13	.035
	MH	35	-.1385	.966	RH>LH	1.75	.082
	LH	15	-.6937	.893	MH>RH>LH		
Math	RH	121	-.1126	1.046			
	MH	49	-.1808	.943	ns.		
	LH	25	-.3629	.991	RH>MH>LH		

The mixed handed group was further subdivided into RM and LM groups. All handedness groups were contrasted.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	RH	142	-.3892	.835	RH>LH	1.91	.058
	RM	32	-.4185	.845	(LM>LH	1.62	.107)
	LM	19	-.3107	.930			
	LH	30	-.7183	.947	LM>RH>RM>LH		
Slosson Oral					LM>RH>LH>RM		
Stanford Spelling	RH	131	-.3291	.920	RH>LH	2.02	.045
	RM	28	-.4245	.888	LM>LH	2.05	.042
	LM	18	-.1447	.998			
	LH	30	-.7009	.842	LM>RH>RM>LH		
Stanford Word Skills	RH	111	-.3289	.881	RH>RM	1.87	.063
	RM	27	-.5829	.793	LM>RM	2.47	.015
	LM	16	.1306	1.228	LM>LH	2.19	.030
	LH	22	-.5291	.987	LM>RH>LH>RM		
Stanford Reading Comprehension	RH	97	-.2833	.791	RM>LH	1.73	.087
	RM	21	-.1991	1.024	RH>LH	1.75	.083
	LM	14	-.0473	.902	LM>LH	2.05	.042
	LH	15	-.6937	.893	LM>RM>RH>LH		
Math					LM>RH>RM>LH		

COGNITIVE MEASURES

The following analyses were based on the handedness categories right, mixed and left.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ					LH>MH>RH		
<u>Verbal Measures</u>							
VIQ					MH>RH>LH		
Information					MH>LH>RH		
Similarities					MH>RH>LH		
Arithmetic					RH>LH>MH		
Comprehension					RH>LH>MH		
Vocabulary					RH>LH>MH		
Digit Span					RH>LH>MH		
Peabody Picture Vocabulary Percentile					LH>MH>RH		
<u>Spatial Measures</u>							
PIQ					LH>RH>MH		
Picture Completion					MH>RH>LH		
Picture Arrangement					RH>LH>MH		
Block Design					MH>LH>RH		
Object Assembly	RH	80	10.71	3.91	LH>MH	1.95	.059
	MH	36	10.64	3.20	LH>RH	2.03	.050
	LH	14	12.07	1.90	LH>RH>MH		
Coding					RH>LH>MH		

 Karnovsky Test of Mental Rotation

Picture Form

 Mirror Errors MH>LH>RH

 Total Errors MH>LH>RH

Shape Form

 Mirror Errors MH>RH>LH

 Total Errors MH>RH>LH

 Total Errors Both Forms MH>RH>LH

 Raven Coloured Progresssive Matrices MH>RH>LH

 Berea Gestalt Deviation MH>RH>LH

COGNITIVE MEASURES

The following analyses were done with the handedness category divided into RH, RM, LM, LH.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ					RM>LH>RH>LM		
<u>Verbal Measures</u>							
VIQ					RM>LM>RH>LH		
Information					LM>LH>RM>RH		
Similarities					RM>RH>LM>LH		
Arithmetic	RH	85	8.25	2.41	RH>RM	2.23	.027
	RM	21	6.95	2.09	LM>RM	2.62	.010 N-K
	LM	16	9.00	2.53			
	LH	14	8.14	2.18	LM>RH>LH>RM		
Comprehension					RH>LH>RM>LM		
Vocabulary					RH>RM>LH>LM		
Digit Span					RH>LM>LH>RM		
Peabody Picture Vocabulary Percentile					LH>LM>RM>RH		
<u>Spatial Measures</u>							
PIQ					LH>RM>RH>LM		
Picture Completion					RM>RH>LH>LM		
Picture Arrangement					RM>RH>LH>LM		
Block Design					LM>LH>RM>RH		
Object Assembly	RH	80	10.71	3.91	LH>RH	2.03	.050
	RM	20	11.00	3.37	LH>LM	2.07	.048
	LM	16	10.19	3.02			
	LH	14	12.07	1.90	LH>RM>RH>LM		
Coding					RH>LH>LM>RM		

 Karnovsky Test of Mental Rotation

Picture Form

 Mirror Errors RM>LH>LM>RH

 Total Errors RM>LH>RH>LM

Shape Form

 Mirror Errors LM>RH>RM>LH

 Total Errors LM>RM>RH>LH

 Total Errors-Both Forms RM>LM>RH>LH

 Raven's Coloured Progressive Matrices RM>LM>RH>LH

Berea	RH	69	-6.58	3.10	RM>LH	2.16	.033
Gestalt	RM	14	-5.36	2.37			
Deviation	LM	12	-7.17	3.16			
	LH	15	-7.73	2.52	RM>RH>LM>LH		

 BANNATYNE FACTORS:

 Verbal (Sim. + Vocab. + Compreh.) RM>RH>LH>LM

 Spatial (P.C.+ B.D. + O.A.) LH>RM>LM>RH

 Sequencing (Arith. + D.S. + Cod.)

RH	24.14	5.98	RH>RM	2.09	.038
RM	20.84	6.44			
LM	23.80	6.13			
LH	22.75	6.38			

 RH>LM>LH>RM

 Acquired Knowledge (Info. + Vocab. + Arith.)

 LM>LH>RH>RM

PSYCHOPATHOLOGY

The results are based on contrasts of right, mixed and left handed dyslexic subjects.

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability	
<u>Report by Self</u>								
Birleson	RH	114	-.0245	.949	MH>RH	1.65	.100	
Depression	MH	42	.2756	1.161	MH>LH	2.11	.037	
	LH	20	-.2996	.973	MH>RH>LH			
Short Child Depressssion Inventory					ns.			
					MH>RH>LH			
Coopersmith	RH	91	-.1367	.976	MH>RH	1.68	.095	
Self-Esteem	MH	33	.1955	.950				
Inv. Long	LH	15	.0283	1.002	MH>LH>RH			
Conners Hyperactivity Index by Child					ns.			
174					MH>LH>RH			
<u>Report by Others</u>								
Conners	RH	63	.0989	.961	MH>LH	1.91	.059	
Hyperact. Index	MH	23	.2113	1.085	RH>LH	1.78	.079	
	LH	7	-.5857	.409				
by Classroom Teacher					MH>RH>LH			
Conners HI by Tutor					ns.			
110					MH>RH>LH			
Conners by Parents	HI	RH	78	.1297	1.109	RH>LH	1.94	.054
		MH	34	-.1366	.840			
		LH	23	-.3403	.935	RH>MH>LH		
SNAP					ns.			
142					RH>MH>LH			

In the following analyses, the mixed group was divided into RM and LM and all handedness groups were contrasted.

PSYCHOPATHOLOGY

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Report by Self</u>							
Birleson	RH	114	-.0245	.949	LM>RH	2.59	.010 N-K
Depression	RM	26	.0360	1.044	LM>RM	1.99	.049
Inventory	LM	16	.6651	1.269	LM>LH	2.88	.004 N-K S
	LH	20	-.2996	.973	LM>RM>RH>LH		
Short	RH	84	.0106	1.048	LM>RM	1.58	.095
Child	RM	20	-.1476	.652			
Depression	LM	13	.4394	.924			
Inventory	LH	13	-.1652	.958	LM>RH>RM>LH		
Coopersmith	RH	91	-.1367	.976	LM>RH	2.10	.037
Self-Esteem	RM	20	.0181	1.000			
Long Form	LM	13	.4685	.830			
	LH	15	.0283	1.002	LM>RM>LH>RH		
Coopersmith Self-Esteem Inventory					LH>RH>RM>LM		
Short Form							
Conners Hyperactivity Index					LM>RM>LH>RH		
by Self							
<u>Report by Others</u>							
Conners	HI				RM>LH	1.82	.073
by Classroom					RH>LH	1.77	.080
Teacher					RM>LM>RH>LH		
Conners	HI				LM>RH>RM>LH		
by Tutor							
Conners	HI				RH>RM	1.69	.094
by Parents					RH>LM>RM>LH		
SNAP					ns.		
					RH>LM>RM>LH		

APPENDIX III - HAND AND SEX INTERACTIONS

The interactions were assessed with the handedness variable in divided into right, mixed and left groups. Male right, mixed and left handed are abbreviated: MR, MM, ML; females are FR, FM, FL.

A. ALL SUBJECTS

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	MR	163	.0644	.936	FR>MR	3.05	.003 N-K
	MM	51	.0366	1.059	FR>MM	2.68	.008 N-K
	ML	29	-.2885	1.059	FR>ML	3.05	.002 N-K S
	FR	41	.5868	.995	MR>ML	1.79	.075
	FM	10	.2248	.882			
	FL	7	-.1909	1.278	Rank Order: FR>FM>MR>MM>FL>ML		
Slosson Oral	MR	166	.1255	.982	FR>ML	2.40	.017
	MM	51	-.0609	.960	FR>MM	2.16	.031
	ML	29	-.1886	1.131			
	FR	41	.3877	.945			
	FM	10	.1332	.738			
	FL	7	-.0512	.800	Rank Order: FR>FM>MR>MM>FL>ML		
Stanford Spelling	MR	150	.0039	.923	FR>MR	3.51	.001 N-K S
	MM	46	-.0192	1.031	FR>MM	3.00	.003 N-K S
	ML	29	-.3093	1.048	FR>ML	3.88	.000 N-K
	FR	40	.6094	1.016	FM>ML	2.16	.032
	FM	10	.4650	1.040			
	FL	6	-.0773	1.286	Rank Order: FR>FM>MR>MM>FL>ML		
Stanford Word Skills	Total	225	.1144	1.005	Rank Order: FM>MR>FL>FR>ML>MM		
Stanford Reading Comprehension	MR	106	.0116	.896	FM>ML	2.37	.034
	MM	36	.0745	1.098			
	ML	13	-.4118	1.100			
	FR	18	.1464	1.019			
	FM	6	.6972	.872			
	FL	5	.1133	1.415	Rank Order: FM>FR>FL>MM>MR>ML		
Math	MR		.1428		FR>ML	1.99	.048
	MM		.0292		FR>MM	1.84	.067
	ML		-.0907				
	FR		.4338				
	FM		.1861				
	FL		-.2191		Rank Order: FR>FM>MR>MM>ML>FL		

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	MR	139	101.06	12.80	MR>FL	2.41	.036
	MM	41	101.29	12.34	MM>FL	2.16	.045
	ML	22	101.18	11.55	ML>FL	1.91	.070
	FR	34	97.41	13.92	FM>FL	2.45	.029
	FM	7	103.00	6.40			
	FL	8	95.50	7.05			
					Rank Order: FM>MM>ML>MR>FR>FL		

VERBAL MEASURES

VIQ	MR	141	100.45	12.52	MR>FL	4.07	.001
	MM	42	100.86	11.73	MM>FL	3.26	.002
	ML	22	98.45	9.28	ML>FL	2.06	.049
	FR	34	97.09	15.49			
	FM	7	96.14	7.86			
	FL	9	93.56	3.97			
					Rank Order: MM>MR>ML>FR>FM>FL		
Information	MR	113	9.53	2.59	MR>FR	2.65	.009 N-K
	MM	42	9.69	2.46	MM>FR	2.54	.012
	ML	17	9.53	2.27	ML>FR	1.79	.075
	FR	30	8.17	2.38	MR>FL	1.66	.099
	FM	7	10.00	2.24	MM>FL	1.74	.084
	FL	9	8.11	1.69	FM>FR	1.76	.079
					Rank Order: FM>MM>ML=MR>FR>FL		

Similarities	Total	217	10.85	2.91	ns.	
					Rank Order: FR>MM>MR>ML>FM>FL	

Arithmetic	MR	113	8.45	2.73	MR>FL	3.56	.004
	MM	40	8.25	2.61	MM>FL	2.88	.010 N-K
	ML	16	8.56	1.75	ML>FL	3.25	.005
	FR	30	8.50	2.36	FR>FL	3.18	.005
	FM	7	8.42	3.60			
	FL	9	6.22	1.72			
					Rank Order: ML>FR>MR>FM>MM>FL		

Vocabulary	Total	215	9.62	2.61	ns.	
					Rank Order: MR>MM>ML>FR>FM>FL	

Comprehension	Total	219	10.87	2.93	ns.	
					Rank Order: FR>MR>MM>ML>FL>FM	

Digit Span	Total	197	8.02	3.05	ns.	
					Rank Order: MR>ML>MM>FL>FR>FM	

Peabody	MR	117	60.09	28.17	ML>FR	2.84	.005	N-K
Picture	MM	37	60.76	29.26	ML>FL	3.13	.002	N-K
Vocabulary	ML	16	72.88	20.21	MR>FL	2.46	.015	
Percentile	FR	31	48.61	27.42	MM>FL	2.38	.018	
	FM	6	54.83	29.98	MR>FR	2.05	.042	
	FL	7	33.57	26.28	MM>FR	1.80	.074	
					MM>MR	1.73	.085	
					Rank Order: ML>MM>MR>FM>FR>FL			

SPATIAL MEASURES

PIQ								
	Total	253	101.19	15.19	Rank Order: FM>ML>MM>MR>FR>FL			

Picture Completion								
	Total	214	10.83	3.19	ns. Rank Order: MR>MM>FM>FR>ML=FL			

Picture Arrangement								
	Total	213	11.03	2.69	ns. Rank Order: ML>MR>MM>FM>FR>FL			

Block Design	MR	111	10.39	3.68	ML>FR	2.54	.012	
	MM	41	11.07	3.04	MM>FR	2.87	.005 N-K	
	ML	17	11.35	2.91	MR>FR	2.37	.019 N-K	
	FR	27	8.73	2.98	MM>FL	1.89	.060	
	FM	7	9.86	2.79	ML>FL	1.90	.059	
	FL	8	8.63	2.20	Rank Order: ML>MM>MR>FM>FR>FL			

Object	MR	109	10.83	3.72	ML>FR	1.71	.090	
Assembly	MM	40	10.83	3.64	MR>FR	1.88	.061	
	ML	17	11.29	3.58				
	FR	29	9.38	3.57				
	FM	6	11.83	3.82				
	FL	8	11.00	2.88	Rank Order: FM>ML>FL>MR=MM>FR			

Coding	MR	113	7.67	2.81	FR>ML	2.12	.035 N-K	
	MM	41	7.26	3.53	FR>MM	3.60	.001 N-K S	
	ML	17	7.88	4.73	FR>MR	4.03	.000 N-K S	
	FR	27	9.93	2.61	FM>MR	2.23	.061	
	FM	7	10.71	3.55	FM>MM	2.38	.042	
	FL	8	7.38	2.92	FR>FL	2.23	.048	
					FM>FL	1.97	.072	
					Rank Order: FM>FR>ML>MR>FL>MM			

Raven's Coloured Progressive Matrices Errors								
	Total	165	-0.0546	.948	ns. Rank Order by Performance: FM>ML>MM>MR>FR>FL			

Berea	MR	102	-6.41	2.98	MR>FL	1.71	.088	
Gestalt	MM	30	-6.00	2.75	MM>FL	1.93	.055	
	ML	18	-6.89	2.81	FR>FL	2.08	.039	
	FR	31	-5.81	2.98				
	FM	5	-6.00	1.87				
	FL	6	-8.50	2.66	Rank Order by Performance: FR>MM=FM>MR>ML>FL			

 Karnovsky Test of Mental Rotations

Picture:	MR	92	-.0194	.973	ML>FR	2.030	.045
Mirror Errors	MM	30	-.0229	1.085	ML>MR	1.72	.079
	ML	16	-.4943	.729			
	FR	20	.1791	1.102			
	FM	8	.0678	.682			
	FL	9	.1435	1.044			

Rank Order by Performance: ML>MM>MR>FM>FL>FR

Picture:	MR	92	-.1066	.981	ML>FR	2.07	.040
Total Errors	MM	30	.0427	.989	MR>FR	1.68	.095
	ML	15	-.3928	1.015			
	FR	20	.3007	1.018			
	FM	8	.0541	.962			
	FL	9	.2221	.984			

Rank Order by Performance: ML>MR>MM>FM>FL>FR

Shape: Mirror Errors					ML>FL	1.93	.055
Total		176	-.0167	1.010			

Rank Order by Performance: ML>MR>FR>MM>FM>FL

Shape:	MR	92	-.1212	1.013	MR>FL	2.07	.040
Total Errors	MM	31	.0007	.851	ML>FL	2.16	.032
	ML	14	-.3171	.937			
	FR	21	.0667	1.100			
	FM	8	.1336	.963			
	FL	9	.5961	1.048			

Rank Order by Performance: ML>MR>MM>FR>FM>FL

Both Forms	MR	90	-.1353	.986	MR>FL	1.70	.092
Total Errors	MM	29	-.0092	.939	ML>FL	1.89	.061
	ML	13	-.3597	1.038	ML>FR	1.66	.098
	FR	20	.2258	1.029			
	FM	8	.0969	1.075			
	FL	9	.4523	.975			

Rank Order by Performance: ML>MR>MM>FM>FR>FL

PSYCHOPATHOLOGICAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
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Self Report Measures

Birleson Depression Inventory	Total	349				ns.	
							Rank Order: FL>FM>FR>MR>MM>ML

Short Child Depression Inventory

Total	243					ns.	
							Rank Order: FL>FR>FM>MM>MR>ML

Coopersmith	MR	158	-.1163	.933	FR>MR	2.03	.051
Self-Esteem	MM	40	.0626	.912	FM>MR	2.23	.055
Inventory	ML	16	-.0041	1.106	FL>MR	2.06	.073
Long Form	FR	26	.4082	1.262			
	FM	8	.5966	.878			
	FL	8	.5983	.961			Rank Order: FL>FM>FR>MM>ML>MR

Coopersmith Lie Scale	Total	256					ns.
							Rank Order: FL>MM>MR>ML>FR>FM

Coopersmith	MR	43	-.1466	.959	FR>MM	2.57	.018
Self-Esteem	MM	11	-.5070	.879	FR>MR	2.00	.054
Inventory	ML	8	.3648	1.380	FM>MM	1.83	.071
Short Form	FR	17	.3483	.825	FL>MM	1.73	.088
	FM	4	.5418	1.249			
	FL	1	1.2682	-			Rank Order: FL>FM>ML>FR>MR>MM

Conners Hyperactivity Index by Self	Total	339					ns.
							Rank Order: FL>ML>FR>FM>MM>MR

Report by Others

Conners HI by Classroom Teacher	Total	169	-.0301	.973	MM>ML	1.77	.077
							Rank Order: FL>MM>MR>FR>FM>ML

Conners HI by Tutor	Total	220					ns.
							Rank Order: FM>ML>MM>FR>FL>MR

Conners HI by Parent					FR>ML	1.66	.098
					FL>ML	1.78	.076
Total	279		-.0101	1.013			Rank Order: FL>FM>FR>MR>MM>ML

SNAP	Total	290					ns.
							Rank Order: FL>FM>FR>MR>MM>ML

B. DYSLEXIC SUBJECTS

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	MR	119	-.2289	.826	FR>ML	2.17	.031
	MM	41	-.2693	.847	FM>FL	1.96	.036
	ML	25	-.4714	.976	FM>ML	2.18	.030
	FR	23	.0616	.840	FR>FL	1.97	.052
	FM	10	.2248	.882			
	FL	5	-.7612	.817			

Rank Order: FM>FR>MR>MM>ML>FL

Slosson							
Oral	Total	225	-.1706	.941	ns.		
							Rank Order: FM>FR>MR>MM>ML>FL

Stanford Spelling	MR	109	-.1878	.916	FR>ML	2.37	.019
	MM	36	-.2971	.836	MR>ML	1.74	.084
	ML	25	-.5334	.886	FM>MR	2.20	.029
	FR	22	.0873	.895	FM>MM	2.37	.019
	FM	10	.4650	1.040	FM>ML	2.98	.003 N-K
	FL	5	-.5324	.717	FM>FL	2.03	.044

Rank Order: FM>FR>MR>MM>FL>ML

Stanford Word Skills					FM>MM	1.67	.097
					FM>ML	1.67	.093
					FM>FR	1.79	.075
	Total	176	-.0614	.926			Rank Order: FM>MR>MM>ML>FR>FL

Stanford Reading Comprehen.	MR	85	-.1781	.796	FM>MR	2.46	.015 N-K
	MM	29	-.1934	.934	FM>MM	2.35	.020
	ML	12	-.5643	.995	FM>ML	3.00	.003 N-K
	FR	12	-.2792	.852	FM>FR	2.31	.022
	FM	6	.6972	.872	FM>FL	2.21	.029
	FL	3	-.6197	.187			

Rank Order: FM>MR>MM>FR>ML>FL

Math					FR>FL	1.86	.063
	Total	195	.0138	1.012			Rank Order: FR>FM>MR>MM>ML>FL

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	MR	79	100.42	12.98	ML>FR	3.28	.007
	MM	30	99.20	11.28	MM>FR	2.63	.012
	ML	14	102.00	10.47	MR>FR	2.25	.001
N-K	FR	14	92.14	6.14	MR>FL	2.50	.077
	FM	6	101.33	5.08	ML>FL	2.44	.049
	FL	3	91.67	5.51	FM>FR	3.42	.005
					FM>FL	3.80	.059

Rank Order: ML>FM>MR>MM>FR>FL

VERBAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
VIQ	MR	80	99.08	11.78	MR>FR	2.31	.023
	MM	31	99.13	11.77	MM>FR	2.09	.039
	ML	14	99.00	9.82	ML>FR	1.75	.083
	FR	14	91.57	7.37			
	FM	6	95.00	7.95			
	FL	4	91.75	3.77			

Rank Order: MM>MR>ML>FM>FL>FR

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability	
Information	MR	71	9.32	2.51	ML>FR	3.40	.001	N-K S
	MM	33	9.45	2.51	MM>FR	3.82	.000	N-K S
	ML	11	9.82	2.64	MR>FR	3.98	.000	N-K S
	FR	14	6.50	1.22	FM>FR	2.57	.011	
	FM	6	9.50	1.97				
	FL	4	8.25	1.50				

Rank Order: ML>FM>MM>MR>FL>FR

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Similarities	Total	138	10.57	2.97	ns.		

Rank Order: MM>MR>ML>FM>FR>FL

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Arithmetic	MR	71	8.25	2.59	ML>FL	2.53	.040
	MM	31	7.77	2.20	MR>FL	2.22	.085
	ML	10	8.90	1.91			
	FR	14	8.07	1.27			
	FM	6	8.16	3.87			
	FL	4	6.25	1.70			

Rank Order: ML>MR>FM>FR>MM>FL

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Vocabulary	MR	68	9.81	2.61	MR>FR	2.18	.031
	MM	33	9.39	2.57	MR>FL	5.71	.000
	ML	11	9.91	2.07	MM>FL	3.11	.004
	FR	14	8.21	1.93	ML>FR	1.68	.094
	FM	6	8.83	1.17			
	FL	4	8.00	0.00			

Rank Order: ML>MR>MM>FM>FR>FL

Comprehension	MR	71	10.96	2.86	MR>FR	2.13	.035
	MM	33	10.72	2.73	MM>FR	1.68	.095
	ML	11	10.82	2.44			
	FR	14	9.29	1.59			
	FM	6	9.83	1.83			
	FL	4	10.25	2.99			
Rank Order: ML>MR>MM>FM>FR>FL							
Digit Span	MR	64	8.33	3.29	MR>FR	2.03	.044
	MM	31	7.68	3.00			
	ML	11	8.09	2.47			
	FR	12	6.33	2.96			
	FM	6	7.17	2.23			
	FL	2	5.00	5.66			
Rank Order: MR>ML>MM>FM>FR>FL							
Peabody	MR	68	58.09	27.54	ML>MM	2.54	.016
Picture	MM	27	56.89	28.59	ML>FR	6.23	.000 N-K S
Vocabulary	ML	11	75.10	15.19	ML>MR	3.00	.006
Percentile	FR	12	32.17	17.89	MM>FR	3.28	.002 N-K
	FM	5	52.40	32.85	MR>FR	4.21	.000 N-K
	FL	3	37.67	26.35	ML>FL	2.18	.031
Rank Order: ML>MR>MM>FM>FL>FR							

SPATIAL MEASURES

PIQ	MR	79	101.78	17.59	ML>FR	2.44	.022
	MM	32	100.16	13.78	MR>FR	2.27	.030
	ML	14	105.29	13.64			
	FR	14	94.29	9.89			
	FM	6	102.33	11.80			
	FL	3	93.33	11.37			
Rank Order:							
ML>FM>MR>MM>FR>FL							

Picture Completion							
	Total	135	11.00	3.25	MR>FR	1.82	.071
Rank Order: MR>MM>FL>ML>FM>FR							

Picture Arrangement							
	Total	133	11.11	2.78	MR>FR	1.85	.066
Rank Order: MR>ML>MM>FM>FL>FR							

Block	MR	70	10.31	3.97	MR>FL	3.24	.023
Design	MM	32	11.16	2.90	MM>FL	4.15	.007
	ML	11	11.55	3.05	ML>FL	3.42	.006
	FR	14	7.71	3.05	ML>FR	2.67	.009
	FM	6	9.33	2.66	MM>FR	3.02	.003 N-K
	FL	3	7.67	1.15	MR>FR	2.50	.014 N-K
Rank Order: ML>MM>MR>FM>FR>FL							

Object	MR	67	10.97	3.85	ML>FR	2.15	.033
Assembly	MM	31	10.58	3.19			
	ML	11	12.55	1.75			
	FR	13	9.38	4.11			
	FM	5	11.00	3.61			
	FL	3	10.33	1.53			
Rank Order: ML>FM>MR>MM>FL>FR							

Coding	MR	70	7.54	2.70	MR>MM	1.98	.052
	MM	32	6.31	11.77	FR>MR	3.34	.003 N-K
	ML	11	8.18	4.12	FR>MM	4.38	.000 N-K S
	FR	13	9.85	2.19	FM>MM	2.51	.040 N-K
	FM	6	10.50	3.83			
	FL	3	6.67	4.93			
Rank Order: FM>FR>ML>MR>FL>MM							

Raven's	MR	46	.0449	1.013	FM>MR	2.56	.027
Coloured	MM	20	-.0357	.974	FM>MM	1.77	.095
Progressive Matrices	ML	10	-.0076	.761	FM>FL	2.54	.082
	FR	6	.1346	1.430			
	FM	4	-.5124	.317			
	FL	3	.6192	.723			
Rank Order by Performance: FM>MM>ML>MR>FR>FL							

Berea	MR	57	- 6.89	3.06	FR>ML	2.04	.044
Gestalt	MM	22	- 6.10	3.08	FR>MR	1.90	.060
Deviation	ML	12	- 7.58	2.54	FR>FL	1.70	.092
	FR	12	- 5.08	3.00			
	FM	4	- 6.75	.96			
	FL	3	- 8.33	2.89			

Rank Order: FR>MM>FM>MR>ML>FL

Karnovsky Test of Mental Rotation

Picture:	MR	45	-.0069	.891	ML>FR	2.34	.022
Mirror Errors	MM	22	-.2253	.983	MM>FR	2.14	.036
	ML	12	-.3992	.773	MR>FR	1.68	.097
	FR	9	.5666	1.220	MR>FL	1.82	.072
	FM	6	.1650	.688	MM>FL	2.15	.034
	FL	3	.9983	.978	ML>FL	2.34	.022

Rank Order by Performance: ML>MM>MR>FM>FR>FL

Picture:	MR	45	-.0275	.907	ML>FR	2.56	.012
Total Errors	MM	22	-.1404	.987	MM>FR	2.78	.007 N-K
	ML	11	-.1877	1.062	MR>FR	2.67	.009 N-K
	FR	9	.8779	.656	MR>FL	1.80	.076
	FM	6	.3638	.971	MM>FL	1.94	.056
	FL	3	.9618	.606	ML>FL	1.91	.059

Rank Order by Performance: ML>MM>MR>FM>FR>FL

Shape:	MR	46	-.1335	.989	MR>FL	2.93	.004 N-K
Mirror Errors	MM	22	-.1894	.868	MM>FL	2.94	.004 N-K
	ML	11	-.0029	.628	ML>FL	2.46	.016
	FR	9	.3316	.934	FR>FL	1.86	.066
	FM	6	.3089	.927	FM>FL	1.79	.077
	FL	3	1.4716	.950			

Rank Order by Performance: MM>MR>ML>FM>FR>FL

Shape:	MR	46	-.1634	.919	ML>FR	1.72	.089
Total Error	MM	22	-.2262	.779	MM>FR	2.99	.004 N-K
	ML	11	.1164	.705	MR>FR	3.05	.003 N-K
	FR	9	.8055	.993	MR>FL	2.83	.006 N-K
	FM	6	.3923	.985	MM>FL	2.86	.005
	FL	3	1.3130	.737	ML>FL	2.08	.041

Rank Order by Performance: MM>MR>ML>FM>FR>FL

Both Forms	MR	45	-.1081	.905	ML>FR	2.07	.042
Total Errors	MM	21	-.2424	.880	MM>FR	3.34	.001 N-K
	ML	9	.0772	.898	MR>FR	3.25	.002 N-K
	FR	9	.9331	.658	MR>FL	2.61	.011
	FM	6	.4144	1.063	MM>FL	2.76	.007
	FL	3	1.2682	.751	ML>FL	2.02	.047

Rank Order by Performance: MM>MR>ML>FM>FR>FL

PSYCHOPATHOLOGICAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Self Report Measures</u>							
Birleson	MR	95	-.1249	.843	MM>MR	1.72	.087
Depression	MM	33	.2183	1.175	MM>ML	2.01	.046
Inventory	ML	17	-.3762	1.033	FR>ML	2.73	.007
	FR	17	.5482	1.300	FR>MR	2.59	.011
	FM	9	.4859	1.152	FM>MR	1.77	.079
	FL	3	.1342	.362	FM>ML	2.11	.037
						Rank Order: FR>FM>MM>FL>MR>ML	
Short	MR	74	-.0181	1.040	MM>ML	2.40	.024
Child	MM	28	-.0025	.812	FR>ML	1.92	.078
Depresssion	ML	10	-.5324	.503	MR>ML	2.68	.017
Inventory	FR	10	.2225	1.139	FL>MR	1.90	.060
	FM	5	.5663	.681	FL>MM	1.81	.073
	FL	3	1.0590	1.204	FM>ML	2.08	.040
						Rank Order: FL>FM>FR>MM>MR>ML	
Coopersmith	MR	79	-.2033	.906	FM>MR	4.57	.002 N-K
Self-Esteem	MM	27	.0426	.961	FL>MR	4.11	.026
Inventory	ML	12	-.2353	.923	FM>MM	2.97	.010
Long Form	FR	12	.3017	1.317	FL>MM	2.98	.037
	FM	6	.8835	.526	FM>ML	3.27	.005
	FL	3	1.0830	.512	FL>ML	3.31	.015
						Rank Order: FL>FM>FR>MM>MR>ML	
<u>Coopersmith Lie Scale</u>							
Total		139	.0507	.9812	ns.		
						Rank Order: FM>FR>MR>ML>MM>FL	
Coopersmith	MR	19	.0849	1.081	FR>MM	4.13	.008
Self-Esteem	MM	5	-.3691	.825	FR>MR	4.17	.000
Inventory	ML	3	.3541	1.705			
Short	FR	4	1.2219	.225			
	FM	4	.5418	1.249			
	FL	0					
						Rank Order: FR>FM>ML>MR>MM	
<u>Conners Hyperactivity</u>							
Index by Self				Total	174	ns.	
						Rank Order: ML>MM>FM>MR>FL>FR	

Report by Others

Conners	MR	51	.0842	.965	MM>ML	2.00	.049
HI by	MM	19	.3352	1.140	MR>FL	2.83	.027
Classroom	ML	5	-.6581	.478	MM>FM	1.94	.079
Teacher	FR	12	.1615	.979	MM>FL	2.62	.018
	FM	4	-.3774	.517	FR>FL	1.87	.086
	FL	2	-.4049	.153			

Rank Order: MM>FR>MR>FM>FL>ML

Conners	MR	67	-.0635	1.016	FR>MR	2.10	.055
HI by	MM	15	.1271	1.403	FR>ML	2.41	.025
Tutor	ML	9	-.2855	.922	MR>FL	2.08	.078
	FR	11	.4576	.586	FR>FL	4.03	.003
	FM	5	.0521	.594			
	FL	3	-.4554	.245			

Rank Order: FR>MM>FM>MR>ML>FL

Conners	MR	64	.0850	1.132	FR>ML	2.19	.030
HI by	MM	27	-.1992	.843	FR>MR	2.02	.046
Parent	ML	18	-.4685	.887			
	FR	14	.3343	.981			
	FM	7	.1051	.848			
	FL	5	.1210	1.062			

Rank Order: FR>FL>FM>MR>MM>ML

SNAP

Total	142	.0031	1.032				
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ns.

Rank Order: FR>FM>MR>MM>FL>ML

APPENDIX IV - HAND AND FAMILY HISTORY OF SINISTRALITY

Six hand by FS groups were contrasted. Subject groups with a positive family history of sinistrality (FS+) and who were right, mixed and left handed were abbreviated R+, M+ and L+ respectively. Similarly those with FS- were abbreviated R-, M- and L-.

A. ALL SUBJECTS

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	R-	50	.0250	.894	R->L+	2.63	.009
	M-	11	-.4484	.859	R+>L+	2.04	.043
	L-	10	-.3634	1.088	M+>L+	2.74	.007
	R+	55	-.1445	.920	M->L+	1.79	.075
	M+	18	.1972	.930			
	L+	15	-.7048	1.136			
Rank Order: M+>R->R+>L->M->L+							
Slosson Oral	R-	51	.0965	.944	R->L+	2.55	.012
	M-	11	-.2117	.752	M+>L+	2.42	.017
	L-	10	-.2793	1.111	R+>L+	1.75	.083
	R+	55	-.1399	1.041			
	M+	18	.1908	.713			
	L+	15	-.6382	1.168			
Rank Order: M+>R->R+>M->L->L+							
Stanford Spelling	R-	49	-.0218	.888	M+>L+	3.23	.002 N-K
	M-	10	-.2174	.988	R->L+	2.64	.009
	L-	9	-.2160	1.334	M+>R+	2.02	.045
	R+	50	-.2118	.873	R+>L+	1.96	.052
	M+	17	.3194	.892			
	L+	15	-.7521	1.044			
Rank Order:							
M+>R->R+>L->M->L+							
Stanford Word Skills	R-	33	-.1594	1.118	M+>L+	3.06	.003 N-K
	M-	8	.0296	1.118	L->L+	2.34	.021 N-K
	L-	9	.1138	1.432	R+>L+	2.15	.034 N-K
	R+	44	-.2096	.738	R->L+	2.22	.028
	M+	15	.2848	1.171	M->L+	2.09	.038
	L+	10	-.9559	.728	M+>R+	1.67	.098
Rank Order: M+>L->M->R->R+>L+							

Stanford	R-	22	-.1088	.846	M+>L+	3.02	.003	N-K
Reading	M-	6	-.1804	.978	R+>L+	1.97	.052	
Comprehension	L-	7	.0117	1.341	M+>R+	1.96	.053	
	R+	33	-.0783	.915	M+>R-	1.93	.057	
	M+	13	.5265	.896	R->L+	1.85	.069	
	L+	5	-.9696	.993	L->L+	1.78	.079	
Rank Order: M+>L->R+>R->M->L+								
Math	R-	43	-.1661	1.032	R+>L+	2.34	.021	
	M-	11	-.1933	.915	R->L+	1.68	.096	
	L-	9	-.0782	.746				
	R+	49	.0444	1.044				
	M+	17	-.1252	.996				
	L+	13	-.6931	1.065				
Rank Order: R+>L->M+>R->M->L+								

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	R-	36	97.58	11.81	M+>R-	2.01	.047
	M-	10	98.80	11.20			
	L-	9	100.44	13.69			
	R+	46	104.49	15.81			
	M+	16	105.69	10.68			
	L+	7	95.71	12.09			
Total		123	101.37	13.62	Rank Order: M+>R+>L->M->R->L+		

VERBAL MEASURES

VIQ	R-	36	97.33	11.20	R+>R-	2.23	.029
	M-	10	99.90	10.02	M+>R-	1.92	.066
	L-	9	98.78	12.30	R+>L+	3.81	.000
	R+	46	104.02	15.92	M+>L+	3.18	.005
	M+	16	103.94	11.60			
	L+	8	93.88	3.56			
Total		125	100.73	13.18	Rank Order: R+>M+>M->L->R->L+		

Information	R-	30	8.87	2.54	M+>R-	2.12	.036
	M-	10	10.10	2.72	M->L+	2.10	.038
	L-	8	9.38	2.00	R+>L+	2.16	.033
	R+	39	9.72	2.97	M+>L+	2.68	.009
	M+	16	10.56	2.03			
	L+	7	7.43	1.51			
					Rank Order: M+>M->R+>L->R->L+		

Similarities

Total		110	11.12	3.12	ns.		
					Rank Order: M+>R+>R->L->M->L+		

Arithmetic	R-	29	7.38	2.09	R+>R-	3.41	.001 N-K
	M-	10	8.40	2.45	R+>L+	2.32	.022
	L-	8	8.38	2.06			
	R+	40	9.60	3.31			
	M+	15	8.80	2.54			
	L+	6	6.83	2.56			

Rank Order:

R+>M+>M->L->R->L+

Comprehension

Total		111	11.05	3.08	ns.		
					Rank Order:		

R+>M+>L->R->M->L+

Vocabulary	R-	29	9.41	2.19	M+>R-	1.86	.074
	M-	10	8.80	1.87	R+>L+	1.83	.081
	L-	8	9.63	2.77	M+>L+	2.18	.041
	R+	39	10.44	3.58			
	M+	16	10.94	2.84			
	L+	7	9.00	1.41			
Rank Order: M+>R+>M->L->R->L+							

Digit Span	Total	103	8.29	2.92	ns.		
Rank Order: M->R+>L+>R->M+>L-							

Peabody Picture Vocabulary Test Percentile	Total	84	59.59	29.48	R+>R-	1.71	.091
Rank Order: M->R+>L->M+>R->L+							

<u>SPATIAL MEASURES</u>							

PIQ	Total	123	101.42	16.00	ns.		
Rank Order: M+>R+>L->L+>R->M-							

Picture Completion	Total	108	10.92	3.58	M+>L+	1.70	.092
Rank Order: M+>R->R+>L->M->L+							

Picture Arrangement	Total	107	11.16	2.85	R+>R-	1.81	.075
Rank Order: L->R+>M+>L+>R->M-							

Block Design	Total	106	10.51	3.51	ns.		
Rank Order: L->R+>L+>M->M+>R-							

Object Assembly	Total	102	10.66	3.93	ns.		
Rank Order: M+>R+>L->L+>R->M-							

Coding	Total	107	7.91	3.16	ns.		
Rank Order: M+>L+>R+>R->M->L-							

Raven's Coloured Progressive Matrices Error Score	Total	75	-.1738	.8846	M+>M-	1.79	.078
Rank Order: M+>R+>L->R->L+>M-							

Berea Gestalt Deviation Score	Total	97	-6.53	2.89	ns.		
Rank Order: M+>L->L+>R+>M->R-							

Karnovsky Test of Mental Rotation (Rank Order by Performance)

Picture form:

Mirror Errors	R-	23	.3204	1.071	M+>R-	2.08	.042
	M-	7	.1844	1.215	L->R-	2.62	.027
	L-	9	-.5546	.625	R+>R-	2.34	.022
	R+	23	-.3569	.840			
	M+	9	-.4820	.894			
	L+	8	.0154	1.280			

Rank Order: L->M+>R+>L+>M->R-

Total Errors

Total	79	-.1217	1.030	Rank Order: L->M+>R+>L+>R->M-
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Shape form:**Mirror Errors**

Total	80	-.0375	1.089	ns.
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Rank Order: M->R+>L+>R->L+>M+

Total Errors

Total	80	-.1007	1.026	R+>L-	1.75	.085
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Rank Order: R+>M->R->L+>M+>L-

Both forms:

Total Errors	Total	78	-.1099	1.048	ns.
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Rank Order: R+>M+>M->R->L+>L-

PSYCHOPATHOLOGY MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Self-Report Measures</u>							
Birleson Depression Inventory	Total	152	-.0071	1.011	ns.		
					Rank Order: M->R->R+>L->M+>L+		
Short Child Depression Inventory	R-	31	-.0659	.707	M+>L-	1.95	.068
	M-	8	.2910	.798			
	L-	8	-.4121	.841			
	R+	39	-.0305	.767			
	M+	10	.3926	.903			
	L+	5	.3884	1.290			
					Rank Order: M+>L+>M->R+>R->L-		
Coopersmith Self Esteem Inventory Long Form	R-	34	-.1301	.854	M+>R-	2.06	.042
	M-	7	.0354	.936	M+>R+	1.72	.088
	L-	8	-.1228	.977			
	R+	42	-.0122	.872			
	M+	11	.5188	1.093			
	L+	5	.5421	1.055			
					Rank Order: L+>M+>M->R+>L->R-		
Coopersmith Lie Scale	Total	107	-.1350	.918	ns.		
					Rank Order: L+>R+>R->M->L->M+		
Coopersmith Self Esteem Inventory Short Form	Total	43	-.1089	1.031	ns.		
					Rank Order: L+>R+>R->M+>M->L-		
Connors Hyperactivity Index	R-	44	.0288	.913	M+>R+	1.94	.076
	M-	11	-.0848	.811	L+>R+	1.66	.100
	L-	10	-.1033	1.448			
	R+	55	-.2266	.879			
	M+	18	.2031	.964			
	L+	9	.3316	.786			
					Rank Order: L+>M+>R->M->L->R+		

Report by Others

Conners	R-	23	-.0146	1.038	R->L+	2.63	.014
Hyperactivity	M-	4	-.1356	1.682	R+>L+	2.48	.020
Index	L-	5	-.2136	.755	M+>L+	2.12	.058
by Classroom	R+	30	-.1445	.945			
Teacher	M+	9	-.0131	.844			
	L+	5	-.6572	.255			

Rank Order: M+>R->M->R+>L->L+

Conners HI	Total	101	-.0829	.984	ns.		
by Tutor							

Rank Order: L->R->L+>R+>M+>M-

Conners	R-	79	-.3353	.803	R+>M+	1.77	.078
Hyperactivity	M-	14	-.1045	.897	R+>L+	3.03	.003 N-K
Index	L-	13	.1417	1.052	R->L-	1.66	.099
by Parents	R+	79	.3445	1.093	R+>R-	4.45	.000 N-K S
	M+	22	-.0659	.903			
	L+	21	-.3692	1.013			

Rank Order: R+>L->M+>M->R->L+

SNAP	R-	83	-.3320	.762	M+>R-	1.77	.077
	M-	14	.0258	.634	R+>L+	2.39	.018
	L-	13	.0540	.924	R+>R-	4.02	.000 N-K S
	R+	79	.2507	1.099			
	M+	22	.0656	1.038			
	L+	21	-.2966	.938			

Rank Order: R+>M+>L->M->L+>R-

B. DYSLEXIC SUBJECTS

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	R-	27	-.5050	.673	M+>L+	3.00	.003 N-K
	M-	10	-.5840	.771	M+>L-	1.88	.064
	L-	7	-.7520	.882	M+>R+	1.80	.075
	R+	39	-.5177	.739	R+>L+	1.84	.068
	M+	15	-.1086	.645	R->L+	1.80	.075
	L+	13	-.9596	.942			
Rank Order: M+>R->R+>M->L->L+							
Slosson Oral	R-	28	-.2722	.935	M+>L+	2.32	.022
	M-	10	-.3022	.727	M+>R+	1.72	.089
	L-	7	-.3957	1.244	R->L+	1.74	.084
	R+	39	-.4881	1.004			
	M+	15	.0084	.591			
	L+	13	-.8297	1.131			
Rank Order: M+>R->M->L->R+>L+							
Stanford Spelling	R-	37	-.3443		M+>L+	3.47	.001 N-K S
	M-	9	-.2893		R->L+	2.39	.019
	L-	7	-.5345		M+>R+	2.10	.038
	R+	37	-.4536		R+>L+	2.10	.039
	M+	14	.1023		M->L+	2.01	.047
	L+	13	-1.0243				
Rank Order: M+>M->R->R+>L->L+							
Stanford Word Skills	R-	21	-.4330	1.033	M+>L+	3.14	.002 N-K
	M-	7	-.0934	1.045	M+>R-	1.99	.050
	L-	6	-.0417	1.328	M->L+	2.04	.044
	R+	33	-.4076	.675	L->L+	2.06	.043
	M+	13	.2191	1.241	M+>R+	2.03	.045
	L+	9	-1.0616	.686	R->L+	1.85	.068
				R->L+	1.68	.097	
Rank Order: M+>L->M->R+>R->L+							
Stanford Reading Comprehension	R-	16	-.3854	.684	M+>R-	2.52	.015 N-K
	M-	5	-.5034	.642	M+>R+	2.59	.012 N-K
	L-	5	-.4416	.954	M+>L+	3.27	.002 N-K
	R+	25	-.3496	.695	M+>M-	2.12	.038
	M+	11	.3517	.793	M+>L-	1.97	.054
	L+	5	-.9696	.993	R+>L+	1.69	.096
Rank Order: M+>R+>R->L->M->L+							
Math	R-	23	-.3609	1.087	R+>L+	1.81	.074
	M-	10	-.1603	.958			
	L-	6	-.2775	.560			
	R+	34	-.0930	1.133			
	M+	14	-.1554	1.079			
	L+	11	-.7646	1.100			
Rank Order: R+>M+>M->L->R->L+							

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	R-	21	95.48	13.27	R+>R-	1.73	.090
	M-	9	99.67	11.52	M+>R-	1.73	.088
	L-	6	102.17	15.41			
	R+	24	102.71	15.11			
	M+	12	103.92	10.59			
	L+	4	101.00	12.71			

Rank Order: M+>R+>L->L+>M->R-

VERBAL MEASURES

VIQ	Total	78	98.19	11.97	ns.		
							Rank Order: M+>M->L->R+>R->L+
Information	R-	18	8.50	2.73	M+>R-	2.12	.038
	M-	9	10.00	2.87	M->L+	1.80	.075
	L-	5	9.00	2.44	M+>L+	2.22	.030
	R+	23	9.04	2.72			
	M+	12	10.50	1.83			
	L+	4	7.25	.50			
							Rank Order: M+>M->R+>L->R->L+
Arithmetic	R-	18	7.00	2.20	R+>R-	2.34	.023
	M-	9	8.44	2.60	R+>L+	1.81	.075
	L-	5	8.80	2.38			
	R+	23	8.91	2.91			
	M+	11	8.54	2.80			
	L+	3	6.00	2.00			
							Rank Order: R+>L->M+>M->R->L+
Similarities	Total	71	10.75	3.26	ns.		
							Rank Order: L->M+>R+>R->L+>M-
Comprehension	Total	71	10.79	2.90	ns.		
							Rank Order: L->M+>R+>M->R->L+
Vocabulary	Total	70	9.70	2.58	ns.		
							Rank Order: M+>R+>R->M->L->L+
Digit Span	R-	16	8.38	2.94	L+>L-	2.26	.027
	M-	7	8.71	2.56			
	L-	5	5.80	2.77			
	R+	22	8.05	3.32			
	M+	12	7.83	2.62			
	L+	3	10.67	1.53			
							Rank Order: L+>M->R->R+>M+>L-

Peabody	R-	18	44.50	27.73	L->R-	1.68	.099
Picture	M-	8	64.25	29.44	R+>R-	1.98	.054
Vocabulary	L-	5	68.80	29.17			
Test	R+	19	63.11	28.81			
Percentile	M+	12	58.92	24.88			
	L+	3	55.33	35.80			

Rank Order:L->M->R+>M+>L+>R-

SPATIAL MEASURES

PIQ	Total	76	102.30	16.96	ns.		
					Rank Order:	L->L->R->M->M->R-	
Picture Completion	Total	68	11.22	3.63	ns.		
					Rank Order:	M->L->R->M->L->R-	
Picture Arrangement	R-	18	10.39	2.97	R->M-	1.84	.072
	M-	9	10.22	3.07	R->R-	2.10	.041
	L-	5	12.60	1.52			
	R+	21	12.38	3.09			
	M+	11	11.82	1.83			
	L+	3	11.67	4.51	Rank Order:	L->R->M->L->R->M-	
Block Design	R-	18	9.00	4.35	L->R-	1.93	.059
	M-	9	11.22	2.39	R->R-	1.82	.074
	L-	5	12.60	2.51			
	R+	22	11.14	3.70			
	M+	11	10.45	3.30			
	L+	3	11.33	5.13	Rank Order:	L->L->M->R->M->R-	
Object Assembly	R-	17	9.12	4.38	R->R-	1.94	.059
	M-	8	10.38	4.03			
	L-	5	11.60	2.07			
	R+	20	11.65	3.90			
	M+	10	11.20	3.39			
	L+	3	12.67	2.52	Rank Order:	L->R->L->M->M->R-	
Coding	R-	18	7.35	3.08	L->M-	1.72	.091
	M-	9	6.78	3.49			
	L-	5	6.60	5.46			
	R+	21	8.48	2.50			
	M+	11	7.91	4.04			
	L+	3	10.67	4.73	Rank Order:	L->R->M->R->M->L-	
Raven's Coloured Progressive Matrices Error Score	R-	7	-.6785	.3274	R->M-	1.71	.096
	M-	6	.0806	.8721	R->L+	2.81	.008
	L-	5	-.1202	.7495	R->L+	2.06	.048
	R+	13	-.2132	1.0511	M->L+	2.26	.030
	M+	5	-.4867	.3045			
	L+	4	.7246	.6644			
					Rank Order by Performance:	R->M->R->L->M->L+	
Berea Gestalt Deviation	R-	17	-6.12	2.91			
	M-	7	-6.14	3.53	all ns.		
	L-	5	-7.00	3.08			
	R+	18	-7.60	3.48			
	M+	9	-7.56	2.51			
	L+	3	-7.00	2.65	Rank Order:	R->M->L+=L->M->R-	

Karnovsky Test of Mental Rotation

Picture form:

Mirror Errors	Total	44	-.1020	1.003	ns.
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Rank Order by Performance: L->M+>R+>R->M->L+

Total Errors	Total	44	.0232	.9813	L->L+ 1.77 .085
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Rank Order by Performance: L->M+>M->R+>R->L+

Shape form:

Mirror Errors	Total	44	-.0011	1.052	ns.
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Rank Order by Performance: M->R->R+>M+>L+>L-

Total Errors	R-	10	-.1067	1.343	M->L+ 2.12 .041
	M-	6	-.5632	.546	
	L-	4	.3300	.590	
	R+	12	.0102	1.047	
	M+	7	.1193	.750	
	L+	5	.7509	1.208	

Rank Order by Performance: M->R->R+>M+>L->L+

Both Forms:

Total Errors	Total	43	.0567	.999	M->L+ 1.69 .099
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Rank Order by Performance: M->M+>L->R->R+>L+

PSYCHOPATHOLOGY MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
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Self-Report Measures

Birleson Depression

Inventory	Total	80	.0369	1.039	M->L+	1.76	.082
					Rank Order: M->R->M+>R+>L->L+		

Short Child	R-	13	.0042	.933	M+>L-	1.79	.079
Depresssion	M-	6	.1496	.885			
Inventory	L-	4	-.6079	.406			
	R+	21	.1101	.905			
	M+	9	.3956	.957			
	L+	5	.3884	1.290			
					Rank Order: M+>L+>M->R+>R->L-		

Coopersmith	R-	15	-.4049	.500	M+>R-	2.37	.021
Self-Esteem	M-	5	-.2768	.919	L+>R-	2.21	.031
Inventory	L-	5	-.3895	.762	M+>L-	1.73	.089
Long Form	R+	24	-.0846	.835	L+>L-	1.77	.082
	M+	10	.3983	1.072			
	L+	5	.5421	1.055			
					Rank Order: L+>M+>R+>M->L->R-		

Coopersmith Lie Scale

Total	64	-.0012	.953	ns.			
					Rank Order: L+>M->R->R+>M+>L-		

Coopersmith

Self-Esteem

Short Form	Total	16	.0173	1.222	ns.		
					Rank Order: L->M->R+>R->M+		

Conners	R-	19	.3782	.661	R->L-	3.37	.001	N-K
Hyperactivity	M-	9	-.1311	.852	R->R+	2.97	.004	N-K
Index by Self	L-	7	-.8057	.784	M+>L-	3.21	.002	N-K
	R+	27	-.3287	.783	L+>L-	1.98	.051	
	M+	13	.3935	.967	M+>R+	2.69	.009	
	L+	5	.1183	.770	M->L-	1.68	.097	
					Rank Order: M+>R->L+>M->R+>L-			

Report by Others

Conners'	R-	11	.0845	1.094	R->L+	1.93	.077
Hyperactivity	M-	4	-.1356	1.682	R+>L+	1.84	.088
Index	L-	3	-.5559	.631			
by Classroom	R+	17	-.0465	1.103			
Teacher	M+	8	.0204	.895			
	L+	3	-.6398	.310			

Rank Order: R->M+>R+>M->L->L+

Conners							
HI by Tutor	Total	49	-.2014	.938	ns.		
					Rank Order:	R->R+>M+>L->L+>M+	

Conners	R-	27	-.3476	.829	R+>R-	3.23	.002 N-K
Hyperactivity	M-	10	-.0325	.947	R+>M+	1.90	.060
Index	L-	7	-.1371	1.027	R+>L+	3.20	.002 N-K
by Parents	R+	38	.4627	1.197			
	M+	15	-.1154	.819			
	L+	13	-.5625	.848			

Rank Order: R+>M->M+>L->R->L+

SNAP	R-	28	-.3574	.732	M+>R-	1.77	.077
	M-	10	.0324	.734	R+>L+	2.51	.014
	L-	7	-.1628	.807	R+>R-	4.02	.000 N-K
	R+	39	.3360	1.179			
	M+	15	-.0052	.908			
	L+	13	-.4311	.866			

Rank Order: R+>M->M+>L->R->L+

APPENDIX V - SEX AND FAMILY HISTORY OF SINISTRALITY

Four groups of subjects categorized by sex and family history of sinistrality were contrasted. Males and female FS+ groups were abbreviated M+ and F+ respectively. Similarly the FS- groups were M- and F-. The results of all subjects are in section A, the results of dyslexic subjects are in section B.

A. ALL SUBJECTS

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	M-	56	-.0485	.899	F->M+	2.22	.028
	M+	70	.0506	1.041	F->F+	1.96	.051
	F-	17	.6199	.810	F->M-	2.55	.012 N-K
	F+	18	-.0085	.805			
Rank Order: F->M+>F+>M-							
Slosson Oral	M-	57	.1341	.990	F->M+	2.40	.021
	M+	70	.0792	1.087	F->F+	2.35	.025
	F-	17	.5726	.657	F->M-	2.12	.040
	F+	18	-.0062	.798			
Rank Order: F->M->M+>F+							
Stanford Spelling	M-	54	-.0024	.905	F->M+	2.30	.023
	M+	64	-.0745	1.010	F->M-	1.99	.048
	F-	16	.5341	1.007			
	F+	18	.2136	.758			
Rank Order: F->F+>M->M+							

Stanford Word Skills							
	Total	120	.1474	1.015	ns.		
Rank Order: F->F+>M->M+							

Stanford Reading Comprehension							
	Total	87	-.0351	.969	ns.		
Rank Order: F->F+>M+>M-							

Math	Total	144	-.1333	1.008	ns.		
Rank Order: F+>F->M+>M-							

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	M-	45	98.87	12.26	M+>M-	2.01	.047
	M+	55	104.29	14.85	M+>F-	1.88	.063
	F-	10	95.60	9.82			
	F+	13	102.08	13.42			
Rank Order: M+>F+>M->F-							

VERBAL MEASURES

VIQ	M-	45	98.36	11.52	M+>M-	2.05	.042
	M+	56	103.70	14.13	M+>F-	1.84	.069
	F-	11	95.82	8.74			
	F+	14	99.43	15.34			
Rank Order: M+>F+>M->F-							
Information	M-	38	9.47	2.52	M+>F-	2.11	.038
	M+	49	10.08	2.72	M+>F+	2.40	.018
	F-	10	8.20	2.25			
	F+	13	8.15	2.34			
Rank Order: M+>M->F->F+							
Similarities	M-	38	10.89	3.01	ns.		
	M+	49	11.49	3.39			
	F-	10	10.30	2.31			
	F+	13	11.00	3.03			
Rank Order: M+>F+>M->F-							
Arithmetic	M-	37	7.70	2.38	M+>M-	2.64	.010
	M+	48	9.25	3.03	M+>F-	2.12	.041
	F-	10	8.00	1.25			
	F+	13	8.69	3.64			
Rank Order: M+>F+>F->M-							
Vocabulary	M-	37	9.54	2.12	M+>M-	1.98	.050
	M+	49	10.76	3.19	M+>F+	1.91	.059
	F-	10	9.50	2.59			
	F+	13	9.08	3.20			
Rank Order: M+>M->F->F+							
Comprehension	M-	38	10.50	2.54	ns.		
	M+	49	11.49	3.46			
	F-	10	10.90	3.57			
	F+	14	11.07	2.67			
Rank Order: M+>F+>F->M-							
Digit Span	M-	35	8.54	2.77	M->F-	1.79	.077
	M+	47	8.34	3.18			
	F-	8	6.50	2.51			
	F+	13	8.54	2.40			
Rank Order: M-=F+>M->M+							

Peabody	M-	40	59.00	28.86	M+>F-	1.92	.058
Picture	M+	45	65.09	28.92	M+>F+	1.95	.055
Vocabulary	F-	9	44.67	30.58			
Percentile	F+	11	46.00	30.38			
Rank Order: M+>M->F+>F-							

SPATIAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
PIQ	M-	45	99.93	15.30	M+>F-	1.71	.100
	M+	55	103.11	18.07	F+>F-	1.79	.087
	F-	11	96.09	10.92			
	F+	13	104.15	11.06			
Rank Order: F+>M+>M->F-							
Picture Completion	M-	38	10.87	3.93	ns.		
	M+	47	11.11	3.61			
	F-	10	10.50	3.60			
	F+	13	10.77	2.62			
Rank Order: M+>M->F+>F-							
Picture Arrangement	M-	38	10.87	2.91	M+>F-	1.69	.094
	M+	46	11.67	2.94			
	F-	10	10.00	2.11			
	F+	13	11.08	2.69			
Rank Order: M+>F+>M->F-							
Block Design	M-	37	10.57	3.83	M+>F-	1.97	.052
	M+	47	11.09	3.57			
	F-	10	8.70	2.31			
	F+	13	9.58	2.57			
Rank Order: M+>M->F+>F-							
Object Assembly	M-	36	9.89	3.92	M+>M-	1.67	.099
	M+	45	11.36	4.37			
	F-	10	10.20	3.12			
	F+	11	10.72	2.33			
Rank Order: M+>F+>F->M-							
Coding	M-	38	7.32	3.10	F+>M+	2.25	.026
	M+	49	7.86	2.98	F+>M-	2.71	.008 N-K
	F-	9	7.89	3.38			
	F+	11	10.18	3.34			
Rank Order: F+>F->M+>M-							
Ravens	M-	30	-.0066	.969			
Coloured	M+	30	-.3420	.883			
Progressive	F-	7	-.3244	.637			
Matrices	F+	8	-.0376	.721	ns.		
Rank Order by Performance: M+>F->F+>M-							
Berea	M-	37	-6.46	2.68	ns.		
Gestalt	M+	39	-6.77	3.22			
Deviation	F-	10	-5.30	3.20			
	F+	113	-7.00	1.95			
Rank Order: F->M->M+>F+							

Karnovsky Test Of Mental Rotation

Picture form:

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Mirror	M-	31	.3104	1.197	F->F+	1.72	.090
Errors	M+	29	-.6065	.824	M+>M-	3.58	.001 N-K S
	F-	9	-.2966	.908	M+>F+	3.06	.003 N-K S
	F+	11	.4696	.795			

Rank Order: M+>F->M->F+

Total Errors	M-	31	.1010	1.037	M+>M-	2.57	.012 N-K
	M+	29	-.5615	1.041	M+>F+	3.17	.002 N-K S
	F-	9	-.0442	1.081			
	F+	11	.5596	.635			

Rank Order: M+>F->M->F+

Shapes:

Mirror Errors	M-	32	-.0262	1.009	M+>F+	2.24	.028
	M+	29	-.3206	1.095			
	F-	9	.1941	1.153			
	F+	11	.5240	1.085			

Rank Order: M+>M->F->F+

Total Errors	M-	32	-.1473	.916	M+>F+	2.44	.025
	M+	29	-.3644	.953	M->F+	1.83	.085
	F-	9	.3411	1.434			
	F+	11	.4490	.940			

Rank Order: M+>M->F+>F-

Both Forms:

Total Errors	M-	30	.0269	.985	M+>M-	2.10	.039 N-K S
	M+	29	-.5265	1.034	M+>F+	3.01	.004 N-K S
	F-	9	.1630	1.171	M+>F-	1.79	.078
	F+	11	.5518	.867			

Rank Order: M+>M->F->F+

PSYCHOPATHOLOGICAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
<u>Self-Report Measures</u>							
Birleson Depression Inventory							
	Total	152	-.0071	1.011		ns.	
						Rank Order: F->F+>M->M+	
Short Child	M-	37	-.0463	.778	F+>F-	2.78	.006 N-K
Depression	M+	44	-.0824	.737	F+>M-	3.19	.002 N-K S
Inventory	F-	13	-.1300	.713	F+>M+	3.38	.001 N-K S
	F+	10	.8304	.945			
						Rank Order: F+>M->M+>F-	
Coopersmith	M-	39	-.1381	.907	F+>F-	1.71	.091
Self-Esteem	M+	46	-.0046	.847	F+>M+	2.35	.021
Inventory	F-	10	.0229	.724	F+>M-	2.76	.007
Long Form	F+	12	.6765	1.137			
						Rank Order: F+>F->M+>M-	
Coopersmith Lie Scale							
	Total	107	-.1350	.918			
						Rank Order: F+>F->M+>M-	
Coopersmith	M-	17	-.4009	1.099	F+>F-	1.95	.059
Self-Esteem	M+	15	-.1094	.923			
Inventory	F-	3	.0567	.784			
Short Form	F+	8	.4506	1.078			
						Rank Order: F+>F->M+>M-	
Conners	M-	53	-.0183	.900	F+>M+	2.20	.037
Hyperactivity	M+	63	-.1988	.848			
Index	F-	12	.0224	1.328			
by Self	F+	19	.3525	.990			
						Rank Order: F+>F->M->M+	

Report by Others

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Conners	M-	23	-.0793	1.134	F->F+	1.83	.094
Hyperactivity	M+	35	-.0688	.950	M->F+	2.02	.053
Index by	F-	10	-.0680	.858	M+>F+	2.82	.007
Classroom	F+	9	-.5924	.281			
Teacher							
Rank Order: F->M+>M->F+							
Conners HI by Tutor							
Total		102	-.0884	.981	F+>M+	1.69	.094
Rank Order: F+>F->M->M+							
Conners	M-	85	-.2707	.854	F+>F-	2.15	.033
HI by	M+	98	.0732	1.084	F+>M-	3.13	.002 N-K S
Parents	F-	23	-.1860	.850	M+>M-	2.39	.018 N-K
	F+	26	.4118	.987			
Rank Order: F+>M+>F->M-							
SNAP	M-	89	-.2294	.775	F+>F-	1.85	.071
	M+	99	.0883	1.049	F+>M-	1.99	.055
	F-	23	-.2723	.811	M+>M-	2.38	.019 N-K
	F+	25	.2530	1.139			
Rank Order: F+>M+>M->F-							

B. DYSLEXIC SUBJECTS

ACHIEVEMENT MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
Gray Oral	Total	112	-.3276	.762	ns.		Rank Order:
							F+>F->M+>M-
Slosson Oral	Total	113	-.1610	.960	ns.		Rank Order:
							F->M->F+>M+
Stanford	M-	38	-.1600	.917	F+>M+	2.16	.033
Spelling	M+	48	-.4013	.868			
	F-	6	-.2851	.736			
	F+	16	.1388	.772			
							Rank Order: F+>M->F->M+
Stanford Words Skills	Total	89	-.0523	.974			Rank Order: F+>M->M+>F-
Stanford Reading Comprehension	Total	67	-.3076	.793	F+>F-	1.84	.071
							Rank Order: F+>M->M+>F-
Math	Total	99	-.0798	1.059	ns.		Rank Order: F+>M->M+>F-

COGNITIVE MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
FSIQ	M-	31	98.55	13.87	M+>F-	3.86	.001
	M+	32	104.22	14.33	F+>F-	1.79	.099
	F-	5	92.00	4.24	M->F-	2.09	.048
	F+	8	97.63	7.07	M+>F+	1.85	.076
Rank Order: M+>M->F+>F-							

VERBAL MEASURES

VIQ	M-	31	97.61	11.60	M+>F-	2.72	.015
	M+	33	100.85	13.33	M->F-	1.80	.095
	F-	5	92.20	4.87	M+>F+	1.89	.073
	F+	9	93.78	8.77			
Rank Order: M+>M->F+>F-							

Information	M-	27	9.41	2.68	M+>F-	2.44	.017
	M+	30	9.73	2.45	M->F-	2.15	.035
	F-	5	6.80	1.92	M+>F+	1.95	.055
	F+	9	7.89	2.20			
Rank Order: M+>M->F+>F-							

Similarities	Total	71	10.75	3.26	ns.		
Rank Order: M+>M->F+>F-							

Arithmetic	Total	69	8.16	2.68	ns.		
Rank Order: M+>F->F+>M-							

Vocabulary	M-	26	9.69	1.87	M+>F-	3.23	.004
	M+	30	10.37	3.18	M->F-	2.93	.014
	F-	5	8.00	1.00	M+>F+	2.13	.045
	F+	9	8.44	2.07			
Rank Order: M+>M->F+>F-							

Comprehension	Total	71	10.79	2.90	ns.		
Rank Order: M+>M->F+>F-							

Digit Span	Total	65	8.11	2.96	ns.		
Rank Order: M+>M->F+>F-							

Peabody							
Picture	M-	27	58.19	28.65	M+>F-	2.98	.004 N-K S
Vocabulary	M+	27	64.93	25.79	M->F-	2.51	.015 N-K
Percentile	F-	4	22.00	8.12	M+>F+	1.70	.095
	F+	7	45.57	29.57			
Rank Order: M+>M->F+>F-							

SPATIAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
PIQ	M-	31	100.16	17.78	M+>F-	2.79	.012
	M+	32	105.81	18.50	F+>F-	2.14	.058
	F-	5	93.60	6.50			
	F+	8	102.00	7.46			
					Rank Order: M+>F+>M->F-		
Picture Completion	M-	27	11.04	4.22	M+>F-	2.51	.031
	M+	28	11.93	3.54			
	F-	5	9.20	1.92			
	F+	8	10.63	2.00			
					Rank Order: M+>M->F+>F-		
Picture Arrangement	M-	27	10.85	3.05	M+>M-	2.34	.023
	M+	27	12.63	2.82	M+>F-	2.08	.042
	F-	5	9.80	1.64	M+>F+	1.89	.063
	F+	8	10.50	2.20			
					Rank Order: M+>M->F+>F-		
Block Design	Total	68	10.59	3.70	ns.		
					Rank Order: M+>M->F+>F-		
Object Assembly	M-	25	9.80	4.28	M+>M-	1.87	.066
	M+	26	11.81	3.88			
	F-	5	10.20	2.28			
	F+	7	10.86	2.19			
					Rank Order: M+>F+>F->M-		
Coding	M-	27	6.89	3.36	F+>M+	1.96	.054
	M+	29	7.93	2.89	F+>M-	2.74	.008 N-K
	F-	4	8.25	4.92			
	F+	8	10.50	3.55			
					Rank Order: F+>F-M+>M-		
Berea Gestalt Deviation	Total	59	-6.92	3.07	ns.		
					Rank Order: F->M->F+>M+		
Raven's Coloured Progressive Matrices	Total	40	-.1793	.841	ns.		
					Rank Order by Performance: M+>F+>M->F-		

 Karnovsky Test of Mental Rotation

 Picture Form:

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
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 Mirror Errors

Total		45	-.0267	1.113	M->F+	1.72	.093
					Rank Order: M->M->F->F+		

 Mirror Errors

Total		45	-.0267	1.113	M->F+	1.72	.093
					Rank Order: M->M->F->F+		

Total Errors	M-	17	-.0940	1.084	M->F+	1.93	.060
	M+	16	-.1738	1.079	M->F+	1.77	.085
	F-	4	.5858	.720			
	F+	8	.6615	.657			

 Rank Order: M->M->F->F+

 Shapes:

Mirror Errors	M-	17	-.3100	.745	M->F+	2.46	.018
	M+	16	-.1386	1.106	M->F+	1.98	.048
	F-	4	.4784	1.407			
	F+	8	.7375	1.106			

 Rank Order: M->M->F->F+

Total Errors	M-	17			M->F+	2.49	.017
	M+	16					
	F-	4					
	F+	8					

 Both Forms:

Total Errors	M-	16	-.1821	.903	M->F+	2.22	.032
	M+	16	-.1326	1.068	M->F+	2.11	.042 N-K
	F-	4	.7899	.954	M->F-	1.81	.078
	F+	8	.7449	.847	M->F-	1.72	.094

 Rank Order: M->M->F->F-

PSYCHOPATHOLOGICAL MEASURES

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability
----------	-------	---	-------	----------	-----------	---------	-------------

Self-Report Measures:

Birleson Depression Inventory

Total		80	.0369	1.039	F+>M+	1.76	.082
					Rank Order: F+>F->M->M+		

Short Child	M-	19	-.0426	.946	F+>F-	2.70	.009 N-K
Depression	M+	28	-.0338	.835	F+>M-	3.62	.001 N-K S
Inventory	F-	4	-.1677	.263	F+>M+	3.62	.001 N-K S
	F+	7	1.2514	.705			

Rank Order: F+>M+>M->F-

Coopersmith	M-	20	-.4447	.649	F+>F-	2.51	.027 N-K
Self-Esteem	M+	30	-.1151	.800	F+>M+	2.70	.020 N-K S
Inventory	F-	5	-.1020	.438	F+>M-	3.57	.004 N-K S
Long Form	F+	9	.9017	1.045			

Rank Order: F+>F->M+>M-

Coopersmith Lie

Scale	Total	64	-.0012.	.953	ns.		
					Rank Order: M->M+>F+>F-		

Coopersmith Self-Esteem
Inventory Short

Form	Total	16	.0173	1.222	ns.		
					Rank Order: F->F+M->M+		

Conners Hyperactivity Index by Self

Total		80	-.0350	.866	ns.		
					Rank Order: F+>M->F->M+		

Report by Others

Variable	Group	N	Means	Std.Dev.	Contrasts	T Value	Probability

Conners	HI by Classroom Teacher						
	Total	46	-.0832	1.039		ns.	
						Rank Order: F->M+>M->F+	

Conners	HI by Tutor						
	Total	49	-.2014	.938	F->M+	1.79	.080
						Rank Order: F->F+>M->M+	

Conners	HI						
by Parents	M-	39	-.2320	.919	F+>M-	2.00	.048
	M+	50	.0485	1.139			
	F-	6	-.3371	.443			
	F+	16	.3823	1.081			
						Rank Order: F+>M+>M->F-	

SNAP	M-	40	-.1802	.404	F+>F-	2.11	.047
	M+	51	.0679	1.070	M+>F-	2.45	.026
	F-	6	-.4766	.404			
	F+	16	.2474	1.202			
						Rank Order: F+>M+>M->F-	

APPENDIX VI

CELL MEANS OF INTERACTION TERMS

COGNITIVE, ACHIEVEMENT, PSYCHOPATHOLOGICAL MEASURES

Cell means of the components of the significant interaction terms in the regression analyses for achievement measures were examined. To obtain these means the components of these interactions were entered into ANOVAs as independent variables with the achievement measures as dependent variables. (The continuous variable age was dichotomized at the mean age for the group.) The y-axis of the graphs represents the scores of the achievement measure being assessed. Summary tables of the regression analyses is included here for clarity and completeness.

ACHIEVEMENT MEASURES

GRAY ORAL READING TEST

Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh
Age	-.689	.689	.475	.472	142.05	.000	.475	142.05	.000
FSLM	.124	.708	.502	.496	78.58	.000	.027	8.41	.004
RA	.042	.719	.517	.508	55.35	.000	.015	4.93	.028
SRA	-.045	.734	.536	.524	44.45	.000	.019	6.20	.014

CELL MEANS OF INTERACTION TERMS

FSLM (FS x sex x left mixed hand)

NonLM FSLM	(All other hand groups)		LM	FEMALE	MALE
	FEMALE	MALE			
FS-	-3.12 (16)	-4.36 (30)	-3 I I -4 I I -5 I I -6 I I	0 (0)	-6.19 (5)
FS+	-5.14 (15)	-4.58 (62)		-4.16 (3)	-2.99 (8)

FS- FS+

RA (Right Hand x Age)

Age	<15.00	>15.00	
			-3 I
			-4 I
Nonright	-3.73 (24)	-6.20 (30)	-5 I
Right	-3.02 (62)	-5.44 (43)	-6 I

SRA (sex x right hand x age)

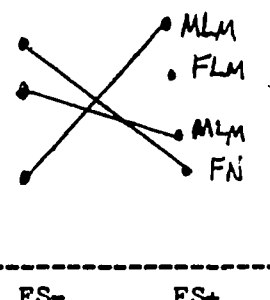
Age	<15.00 years			>15.00 years	
			-3 I		
			I		
	Nonright	Right	-4 I		Nonright
Female	-4.10 (5)	-2.84 (12)	I	FR	-6.19 (7)
			-5 I		Right
Male	-3.64 (19)	-3.06 (50)	I	MR	-5.83 (10)
			-6 I	FNR MNR	-6.20 (23)
					-5.83 (33)

SLOSSON ORAL READING TEST

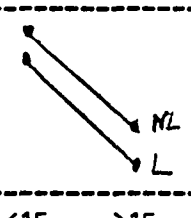
Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.690	.690	.477	.473	143.90	.000	.477	143.90	.000
FSLM	.087	.702	.493	.486	76.30	.000	.016	5.03	.026
LA	-.300	.710	.505	.495	52.99	.000	.012	3.73	.055

CELL MEANS OF INTERACTION TERMS

FSLM (FS x sex x left mixed hand)

NonLM	(All other hand groups)				LM	
	FEMALE	MALE			FEMALE	MALE
FS-	-1.90 (16)	-2.69 (51)	-1.5 I I -2.5 I -3.5 I -4.5 I I		0 (0)	-4.41 (5)
FS+	-3.87 (15)	-3.14 (62)			-2.59 (3)	-1.89 (8)

LA (left hand x age)

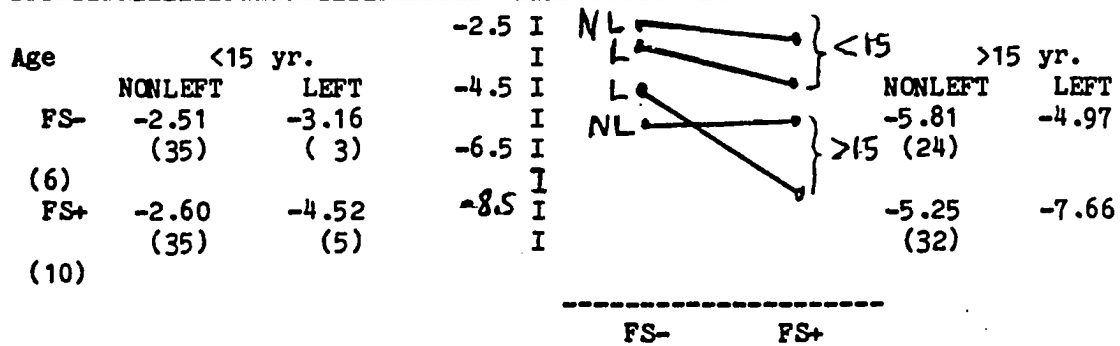
Age	<15.00	>15.00		
Nonleft	-1.53 (78)	-4.13 (57)	-1.5 I -2.5 I -3.5 I -4.5 I -5.5 I	
Left	-2.37 (9)	-5.55 (16)		

 STANFORD SPELLING TEST

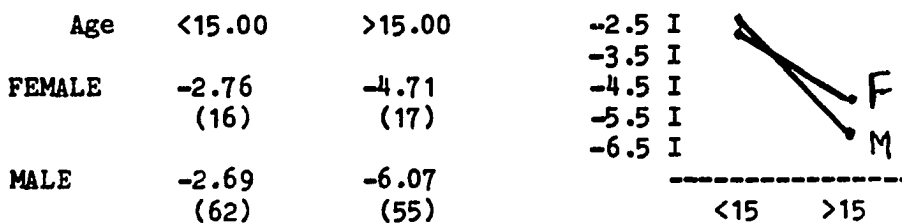
Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.746	.746	.556	.553	185.29	.000	.556	185.29	.000
FLA	-.345	.759	.576	.570	99.85	.000	.020	6.95	.009
SA	-.335	.770	.593	.584	70.84	.000	.017	6.10	.015
FLM	.102	.779	.606	.596	55.83	.000	.014	4.99	.027

 CELL MEANS OF INTERACTION TERMS

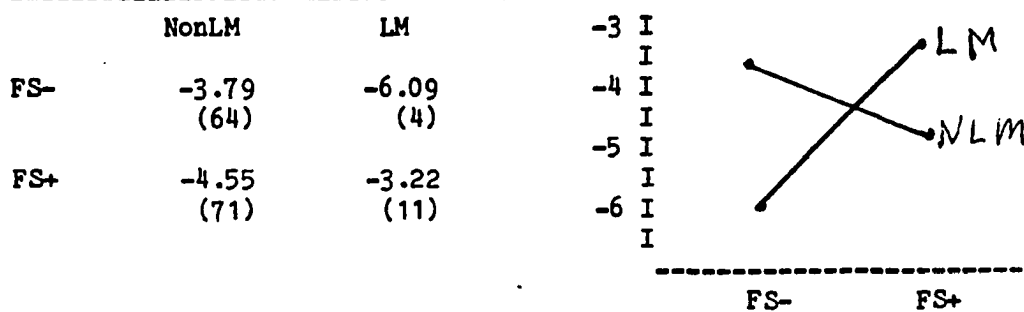
FLA (FS x left x age)



SA (sex x age)



FLM (FS x left mixed)

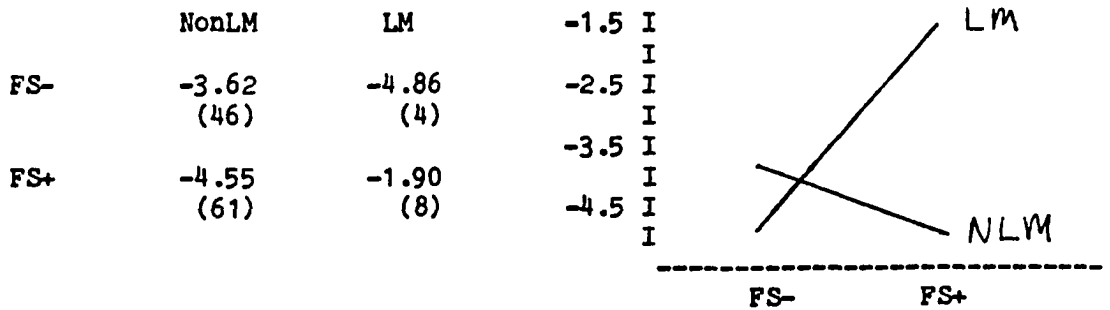


 STANFORD WORD SKILLS TEST

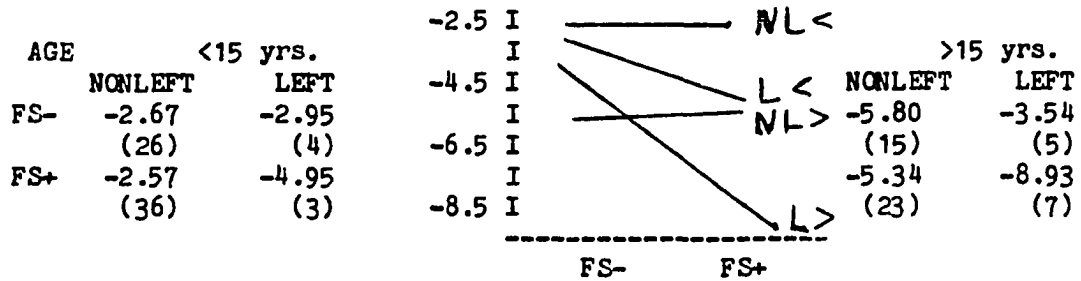
Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.672	.672	.452	.447	96.46	.000	.452	96.46	.000
FLM	.192	.701	.492	.483	56.12	.000	.040	9.10	.003
FLA	-.404	.721	.519	.507	41.42	.000	.028	6.60	.011

 CELL MEANS OF INTERACTION TERMS

FLM (FS x left mixed)



 FLA (FS x left x age)

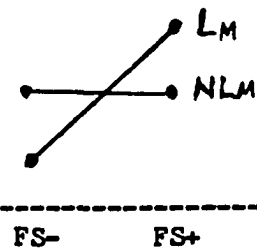


STANFORD READING COMPREHENSION TEST

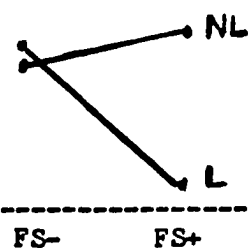
Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.625	.625	.390	.383	53.72	.000	.390	53.72	.000
FLM	.206	.666	.444	.431	33.15	.000	.054	8.06	.006
FL	-.316	.681	.464	.445	23.68	.000	.020	3.07	.084

CELL MEANS OF INTERACTION TERMS

FLM (FS x left mixed)

	NonLM	LM		
FS-	-4.08 (32)	-6.23 (3)	-2 I I -4 I I -6 I I	
FS+	-4.15 (43)	-2.11 (8)		

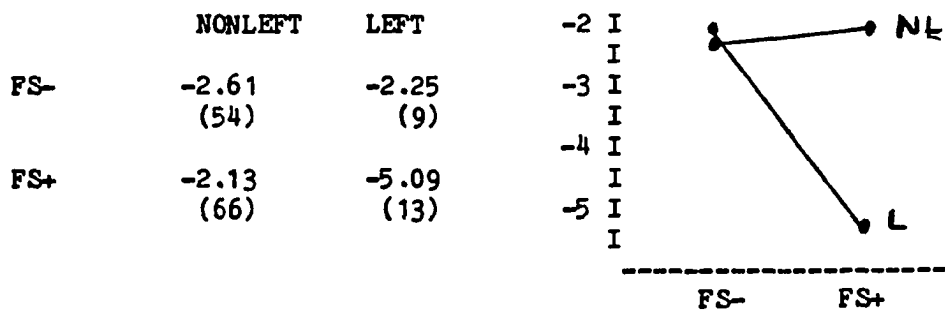
FL (FS x left)

	NONLEFT	LEFT		
FS-	-4.35 (28)	-3.94 (7)	-3 I I -5 I I -7 I I	
FS+	-3.41 (46)	-7.75 (5)		

MATH

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.455	.455	.207	.201	36.54	.000	.207	36.54	.000
FL	-.270	.477	.228	.217	20.49	.000	.021	3.73	.055

CELL MEANS OF INTERACTION TERMS

FL (FS x left)


COGNITIVE MEASURES

ACQUIRED KNOWLEDGE FACTOR (BANNATYNE)

CELL MEANS OF INTERACTION TERMS

FS x Sex

	FEMALE	MALE			
			30	I	
				I	
FS-	25.70 (10)	26.83 (36)	28	I	
				I	
			26	I	
FS+	25.92 (13)	30.23 (47)		I	
			24	I	
				I	

FLA (FS x left x age)

AGE	<15 yrs.				>15 yrs.	
	NONLEFT	LEFT			NONLEFT	LEFT
			33	I		
				I		
FS-	27.05 (21)	25.00 (2)	29	I		
				I		
			25	I		
FS+	32.07 (27)	27.00 (2)		I	25.65 (17)	28.17 (6)
			21	I	27.89 (27)	21.25 (4)
				I		

CELL MEANS OF INTERACTION TERMS-PSYCHOPATHOLOGICAL VARIABLES

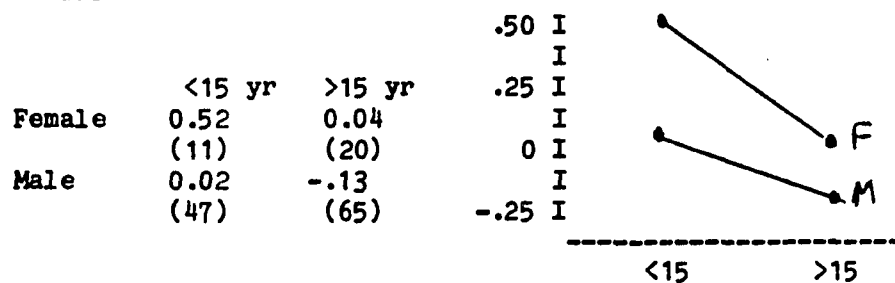
Cell means of the components of the significant interaction terms in the regression analyses for psychopathological measures were examined. To obtain these means the components of these interactions were entered into ANOVAs as independent variables with the psychopathological measures as dependent variables. (The continuous variable age was dichotomized at the mean age for the group.) The y-axis of the graphs represents the scores of the psychopathological measure being assessed. Summary tables of the regression analyses is included here for clarity and completeness.

ALL SELF FACTOR

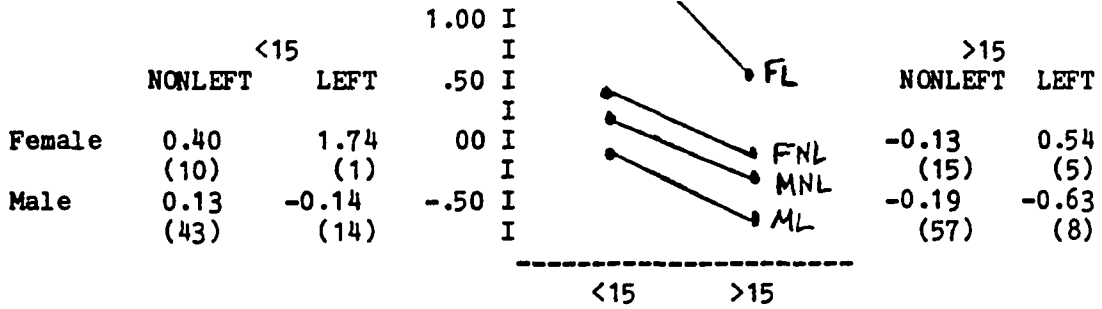
Predictors	Corr.	MR	Rsqr	AdjRsqr	F	SigF	RsqrCh	FCh	SigCh
Sex x Age	-.234	.234	.055	.048	8.16	.005	.055	8.16	.005
Sex x Left x Age									
	-.192	.288	.078	.065	5.90	.003	.023	3.50	.064
Right x Age	-.098	.322	.104	.084	5.36	.002	.026	4.02	.047
Sex x Right	-.039	.373	.139	.114	5.58	.000	.036	5.69	.018

 CELL MEANS OF INTERACTION TERMS

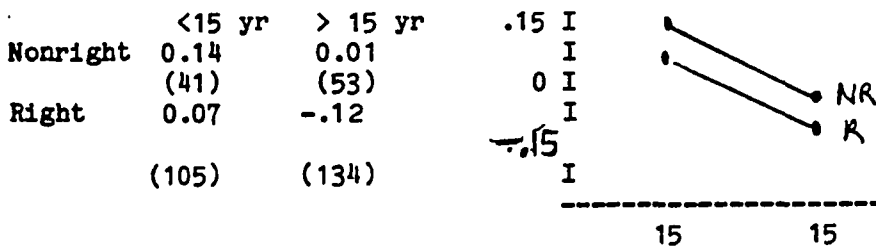
Sex x Age



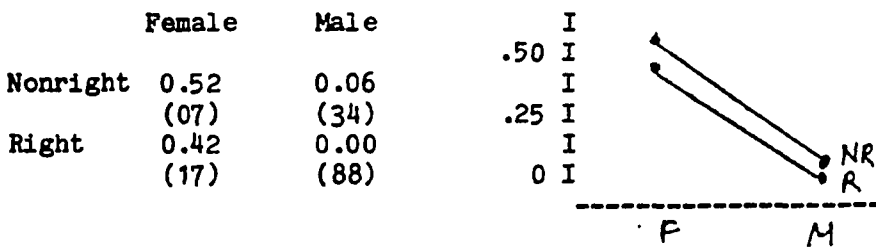
Sex x Left x Age



Right x Age



Sex x Right

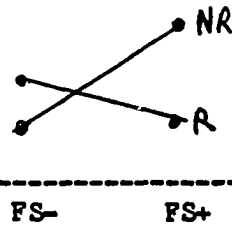


SNAP

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Age	-.293	.283	.080	.076	19.95	.000	.080	19.95	.000
FS x Right	.239	.355	.126	.118	16.48	.000	.046	12.06	.001
Sex x Left Mixed									
	.064	.377	.142	.131	12.60	.000	.016	4.35	.038

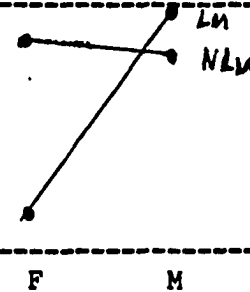
FR (FS x Right)

	Right	Nonright	I
FS-	18.48	14.71	22 I
	(27)	(83)	18 I
FS+	16.47	21.85	14 I
	(43)	(79)	



Sex x Left Mixed Handedness

	NonLM	LM	I
FEMALE	18.95	10.67	20 I
	(44)	(3)	18 I
MALE	17.49	20.59	16 I
	(168)	(17)	14 I
			12 I
			10 I



The same subject variables and the Bannatyne factor were entered as predictors for the same dependent psychopathological measures.

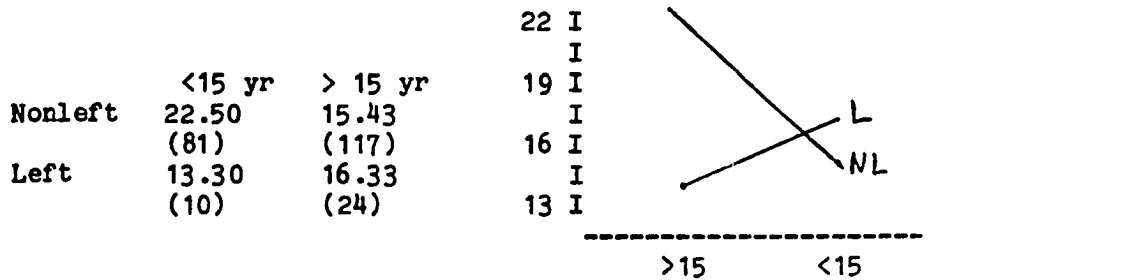
ALL SELF FACTOR

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
SPL	-.282	.282	.080	.066	5.97	.017	.080	5.97	.017
Sex x Age	-.273	.381	.146	.120	5.79	.005	.066	5.23	.025

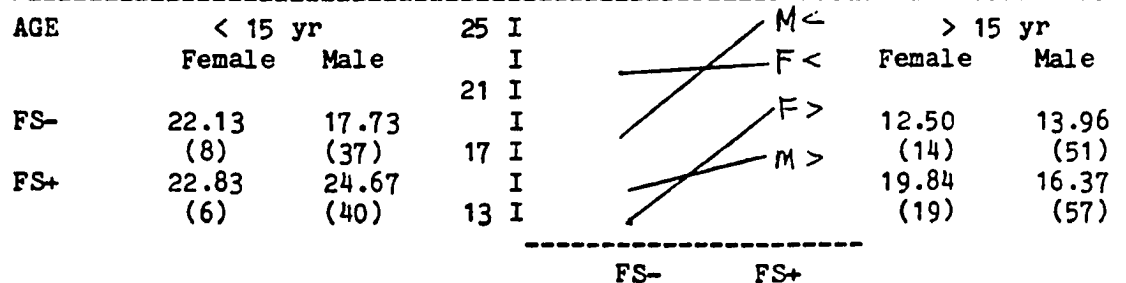
SNAP

Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
FS	.310	.310	.096	.086	9.27	.003	.096	9.27	.003
FS x Sex x Age									
Age	-.139	.366	.134	.113	6.63	.002	.037	3.70	.058
Age	-.216	.406	.164	.135	5.57	.002	.031	3.14	.080
Left x Age	.006	.450	.203	.165	5.34	.001	.038	4.03	.048
ACQ	-.019	.483	.232	.187	5.04	.000	.030	3.26	.075
Sex X Left Mixed	.130	.510	.260	.205	4.79	.000	.027	2.96	.089

Left x Age



FS x Sex x Age

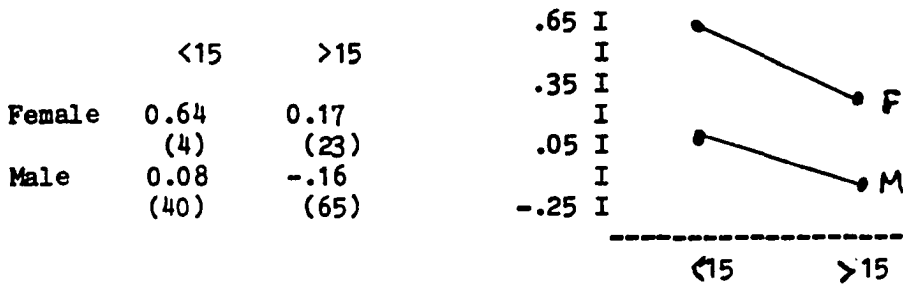


ALLPSY FACTOR

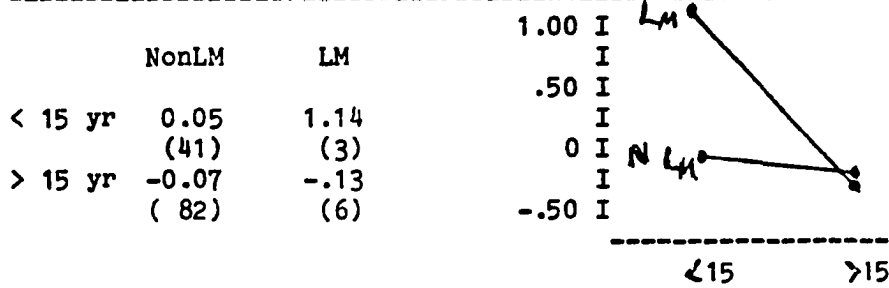
Predictors	Corr.	MR	Rsq	AdjRsq	F	SigF	RsqCh	FCh	SigCh
Sex x Age	-.335	.335	.112	.089	4.92	.032	.112	4.92	.032
Left Mixed	.273	.491	.241	.201	6.04	.005	.129	6.47	.015
Left Mixed x Age									
	.211	.564	.318	.264	5.76	.002	.077	4.18	.048
Verbal Factor	-.280	.670	.384	.316	5.62	.001	.066	3.85	.058

CELL MEANS OF INTERACTION TERMS

Sex x Age



Left Mixed x Age



APPENDIX VII

FORMS USED IN THIS STUDY

Children's Forms:

Personal Handedness Inventory

Birleson Depression Inventory

Short Child Depression Inventory (SCDI)

Coopersmith Self-Esteem Inventory-Long form

Coopersmith Self-Esteem Inventory-Short form

Conners Hyperactivity Index

Parents' Forms:

Familial Handedness Inventory

Conners Hyperactivity Index

SNAP

Medical History

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