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Neuropsychological subtypes of two groups of learning-disabled children: Those with internalized psychosocial problems and those with externalized psychosocial problems.

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NEUROPSYCHOLOGICAL SUBTYPES
OF TWO GROUPS OF LEARNING DISABLED CHILDREN:
THOSE WITH INTERNALIZED PSYCHOSOCIAL PROBLEMS
AND THOSE WITH EXTERNALIZED PSYCHOSOCIAL PROBLEMS

by
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A Dissertation
Submitted to the Faculty of Graduate Studies
Through the Department of Psychology
in Partial Fulfillment of the
Requirements for the Degree
of Doctor of Philosophy at the
University of Windsor

Windsor, Ontario, Canada
1995
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ABSTRACT

Two a priori psychosocial subgroups of learning disabled children aged 7 to 14 were selected from a clinical database by using a profile matching program designed by Fuerst (1991). There were 174 exhibiting Internalized Psychopathology (IP) and 164 demonstrating Externalized Psychopathology (EP) on the Personality for Children (PIC). They all attained at least one WISC IQ score at or above 80 along with a pattern of academic underachievement. They showed no evidence of sensory deficit, educational or cultural deprivation, or primary emotional disturbance.

The multivariate technique of cluster analysis was applied in the attempt to uncover in learning disabled children relationships between levels and patterns of psychopathology on the one hand, and cognitive and academic patterns on the other. Expectations were formulated in terms of higher-order strata such as IQ discrepancies, academic performance discrepancies, and categories of neuropsychological measures.

Separate k-means cluster analyses were performed on the neuropsychological-academic profiles of the IP and EP groups, identifying 3 subtypes in the IP group and 4 subtypes in the EP group. The k-means-derived neuropsychological subtypes were replicated using a variety of hierarchical agglomerative clustering techniques. Reliability was achieved for the IP
neuropsychological subtypes, but was not for the EP neuropsychological subtypes. The internal validity of both the IP and the EP neuropsychological subtypes became questionable when analyses of the nature of the subtypes and of the IP and EP groups revealed a resemblance between and across the neuropsychological subtypes of the IP and EP groups indicating a lack of distinctiveness between the subtypes.

Rather than finding distinct neuropsychological subtypes in each psychosocial group, a generalized neuropsychological pattern across all subtypes was observed: that of higher rote verbal facility relative to the ability to grasp novel linguistic relationships, higher mean WISC Performance IQs than Verbal IQs, and higher mean WRAT Reading than Arithmetic performance. Whether the co-occurrence of this neurocognitive pattern with the high levels of psychopathology (internalized and externalized) observed in this context represents a meaningful relationship, or whether it is artifactual and reflects the idiosyncrasies of the specific subject pool under investigation remains equivocal.

It was suggested that the methodological design employed in this study, in which psychosocial subtypes are selected and cluster analyses are performed on their neuropsychological functioning, albeit innovative, is less informative than the opposite, more traditional approach. This knowledge in itself is useful to neuropsychological investigators.
ACKNOWLEDGEMENTS

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I thank my director, Dr. Byron Rourke, who has been an influence on my professional development from the time that I began reading about his research when I was teaching learning disabled children. I had no idea, then, that years later I would gain the opportunity, as his student, to observe his seasoned method of investigation, comprehensive formulation of theory, and scrupulous way of working as a scientist, close at hand.
It was Dr. Annette Lynch, who offered me the experience in private practice which ultimately facilitated my transition from education into neuropsychology. I owe her a debt of gratitude. I also express my appreciation to Dolores Lefkowitz, Helen Fleming, June House, and Ephraim Levin — for their encouragement has been long and abiding.

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CHAPTER I
INTRODUCTION

Traditionally, the focus of concern in the neuropsychology of learning disabilities has been the specification of brain-behavior relationships, with particular attention to the perceptual and cognitive ability structures of learning disabled children. In recent years, interest has been steadily growing in the adaptive significance, for these children, of their various sensory-motor abilities, social perception and problem solving skills as they may relate to personality development and psychosocial functioning (e.g., Hooper & Willis, 1989; Loveland, Fletcher, & Bailey, 1990; Ozols & Rourke, 1985; Rourke, 1982; Rourke, 1987; Rourke, 1988a; Rourke, 1988b; Rourke, 1989; Rourke & Fuerst, 1993; Spreen, 1988, 1989; Strang & Rourke, 1985; White, Moffitt, & Silva, 1992; Williams, Gridley, & Fitzhugh-Bell, 1992). In accordance with this broader, more comprehensive sensibility, the present investigation is intended to further the inclination toward a more sophisticated understanding of children with learning disabilities, through theory-driven research that addresses the relationship between their various patterns of neuropsychological abilities and deficiencies, on the one hand, and their levels and patterns of social adjustment and personality on the other.

The hypothesis that socioemotional difficulties may be observed in learning disabled children has been well documented
in the learning disabilities literature (e.g., Breen & Barkley, 1984; Chapman, 1988; Esser, Schmidt, & Woerner, 1990; Rourke, 1989, Rourke & Fuerst, 1993; Spreen, 1989). One position that has been discussed in this respect is the hypothesis that socioemotional disturbance causes learning disabilities (LD). This hypothesis, designated as Hypothesis 1 after Rourke and Fuerst (1991), implies that the emotional problem predates the learning problem, and if resolved, academic progress eventuates (Rourke, Fisk, & Strang, 1986). Our concern, however, is with children whose learning disabilities are not the result of any primary emotional disturbance (or sensory handicap, mental retardation, educational, cultural, or linguistic deprivation). It is with this exclusionary definition of learning disability that we commence our review, with the consideration of another postulation, designated after Rourke and Fuerst (1991), as Hypothesis 2: the hypothesis that learning disabilities cause emotional disturbance.

We will begin by examining selected studies related to Hypothesis 2, those of historical interest as well as recent investigations in four basic domains that have been addressed in this literature: (1) general psychosocial functioning, (2) social status, (3) self-concept/self-esteem, and (4) social competence. Espoused relationships between these areas of psychosocial functioning and learning disabilities will be discussed within each of the aforementioned domains, followed by
a summary and discussion of the methodological limitations characterizing this literature.

Next, we will review investigations that examine more specific relationships between learning disability subtypes and psychosocial problems. Hypothesis 3, as designated by Rourke and Fuerst (1991) is addressed either implicitly or explicitly in these investigations: viz., that specific patterns of central processing abilities and deficits are causative vis-a-vis specific manifestations (subtypes) of learning disabilities and specific levels and forms of psychosocial disturbance. These studies involve the following domains: (1) learning disability subtypes and psychosocial functioning, (2) typologies based on classroom behavior, (3) the Windsor Laboratory classification studies: psychosocial typology, and (4) the Windsor Laboratory classification studies: linking LD subtypes and psychosocial disturbances to particular processing profiles. Following some conclusions based on this body of literature, the rationale, expectations, and methodology for the proposed investigation are presented.

We begin with the review of studies in general psychosocial functioning.
General Psychosocial Functioning

Behavioral Observation

In the studies examining psychosocial functioning that employed direct behavioral observation in the classroom, children with LD were shown to be different from normal peers on the dimension of distractibility (Feagans & McKinney, 1981; McKinney & Speece, 1983; Richey & McKinney, 1978; Tarver & Hallahan, 1974). A more recent study by Sprafkin and Gadow (1987), assessing male students aged 5 to 9 years old, demonstrated differences on the basis of compliance, with the boys with LD (learning disability) appearing more compliant and less aggressive than the boys with ED (emotional disturbance).

Rating Scales and Checklists

These findings of Sprafkin and Gadow (1987) are consistent with an earlier investigation employing checklists or rating scales, the McCarthy and Paraskevopoulos (1969) study. Based on the Behavior Problem Checklist (BPC; Quay & Peterson, 1975) factor scores of 36 students with LD, 100 students with ED and 41 normal students, it was revealed that the children with LD differed from those with ED in that their conduct problems were less severe. And whereas immaturity-inadequacy and neurotic behavior contributed equally to these problems in the learning disabled, immaturity-inadequacy was more important in the
emotionally disturbed children. Gajar (1979), who also used the BPC, found that the LD children exhibited fewer problems than the ED children as was reflected on the Conduct Disorder and Personality Problem factors.

Cullinan, Epstein, and colleagues conducted a number of studies using the BPC comparing LD children with other subgroups. Similar to Gajar's (1979) results, Cullinan, Epstein and Lloyd (1981) found that children with LD (6 to 18 years of age) differed from normal children on the Personality Problem dimension (e.g., in anxiety, depression, withdrawal, and self-confidence). These findings were extended in a later study (Epstein, & Cullinan, 1984) with male high school students. The learning disabled adolescent boys in this study performed halfway between the normal and behavior disordered groups, resembling the educable mentally retarded (MR) group except for a lower Inadequacy-Immaturity score. Because the older children in this study scored higher than the normal group on the Conduct Disorder dimension as well as the Personality Problem dimension, the authors concluded that the psychosocial functioning of LD boys appears to be viewed by teachers as becoming less adaptive as they grow older. Epstein, Cullinan, and Nieminen (1984) assessed LD girls (7 to 14 years old) using the BPC and found the Personality Problem dimension to be the one that differentiated LD girls from normal girls. Epstein, Cullinan, and Bursuck (1985) compared boys to girls aged 6 to 18 years and found significant differences for both gender and age. Aggressive
conduct problems (e.g., classroom disturbances) were more characteristic of boys than girls, particularly so of older boys. In contrast, the LD girls in this study tended to show increasing internalized problems with age.

In addition to the studies of general socioemotional functioning that have used the Behavior Problem Checklist, there are those that have employed the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983). Harris, King, Reifler, and Rosenberg (1984) compared the CBCL scores of 30 6- to 12-year-old boys with those of 30 matched ED boys. In general, the boys with ED displayed more behavior disturbance. At the same time, approximately 50% of the boys with LD obtained scores falling in the clinical range.

McConaughy and Ritter's (1986) study using the CBCL examined the scores of 123 6- to 11-year-old LD boys to CBCL normative data. The boys with LD showed higher rates of internalized and externalized psychosocial problems. These results were consistent with Michaels and Lewandowski's (1990) investigation with 59 LD boys aged 6 to 12. Similarly, Ritter's (1989) study showed elevations of the externalized and internalized problems in LD girls as compared to the normative group.

Schacter and colleagues (Schacter, Pless, & Bruck, 1991) used the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983) to assess 502 learning disabled children in a specialized learning center. Their average age was 10 years, and 70% of the
sample were boys. The prevalence of psychosocial dysfunction in this large sample was quite high: Forty-three percent of the girls and 44% of the boys exhibited behavior problems, which were not predominantly internalizing or externalizing for the girls or the boys or the children overall. One similarity with the Epstein, et al. (1985) study was that children between the ages of 12 and 16 were more likely to exhibit behavior problems as compared to children between 6 and 11.

Given the evidence for some association between learning disabilities and externalized personality problems, it is logical that there has been some concern regarding the potential relationship between LD and delinquency. Larson (1988) has reported estimates of prevalence of delinquency among youth with LD to range from 26% to 73%. The methodological problems pervading the studies in this domain, such as the inadequate definition of learning disability, however, appear to preclude even tentative conclusions in this area. It remains noteworthy that the majority of the LD children in the approximately 300 studies reviewed by Rourke & Fuerst (1993) did not evidence truly delinquent behavior.

Inventories

In contrast to checklists and rating scales, few well constructed inventories used in the personality and behavioral assessment of learning disabled children have been documented in the literature (Rourke & Fuerst, 1993). The Personality
Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977) is one of those few inventories with adequate domain coverage, norms, and actuarial interpretive guidelines, that has been well researched in this area. Its discriminant validity was supported in a study by Goh, Cody, and Dollinger (1984). The behavior of only 36% of the children with LD was indicative of psychopathology, versus 87% of the children with BD. The thirty LD and 30 BD 9-year-old children were clearly differentiated on the Cognitive Development and Conduct Disorder factors of the PIC. Data analysis employing a profile classification system (DeHorn, Lachar, & Gdowski, 1979) revealed that the Internalization factor was somewhat shared by both groups such that the learning disabled children who experienced internalized difficulties typically showed elevations on the Somatic Concern scale, whereas the behavior disordered with internalized problems showed elevations on the Depression, Anxiety, and Withdrawal scales. Forbes (1987) findings have been essentially consistent with these.

Clark, Kehle, and Bolluck (1987) used the PIC to discriminate among 70 learning disabled (LD), 47 emotionally disturbed (ED), and 24 intellectually handicapped (IH) (as assessed by an interdisciplinary team). Ages ranged from 8 to 16 years. Two approaches were used to analyze the data: analyses of variance (ANOVAs) and the application of Lachar and Gdowski's (1979) actuarial guidelines. All three groups demonstrated elevations on the scales measuring adjustment and cognitive
deficits. The IH children were more often depicted as having more serious intellectual deficits overall, and the ED children as having a greater incidence of psychopathology relative to the LD children and more hyperactivity in comparison to the IH children.

Another inventory that has been used in this domain, besides the PIC, is the Classroom Behavior Inventory (CBI; Schaefer & Edgerton, 1978). Margalit (1989) used the CBI to examine 31 boys with LD and 52 boys with BD divided into two subgroups: boys showing hyperactive behavior (BDH) and boys not showing hyperactivity (BDNH). A multivariate analysis of variance (MANOVA) revealed significant differences among the three groups of boys who ranged in age from 6 to 11 years. Three measures contributed to this difference: Hostility versus Consideration, Extroversion versus Introversion, and Independence versus Dependence. The boys with LD demonstrated more introversion than the two groups with behavior disorders. The BDH group revealed similar levels of dependency on others relative to the LD group, as distinguished from the BDNH group who were rated as more independent.

Meta-Analysis

We have reviewed studies that employed various procedures in assessing general socioemotional functioning in learning disabled children. Meta-analysis has also been used in order to integrate the results of 25 such studies comparing the classroom behavior
of LD children to children without LD using observational procedures, teacher rating scales/checklists, and inventories. Through meta-analysis Bender and Smith (1990) found that across these studies the learning disabled children demonstrated significant deficiencies compared to their nondisabled peers across five domains: on-task behavior, off-task behavior, conduct disorder, distractibility, and shy/withdrawn behavior.

**Longitudinal Studies**

In addition to meta-analysis, another approach that can provide investigations of broader scope is one which proceeds across time. A number of such longitudinal studies predicated upon the hypothesis that learning disabilities cause socioemotional problems have been undertaken in order to test the possibility that those problems may, along with increasing adaptive demands, worsen as time goes on.

In a follow-up study of 21 young adults with LD (16 to 23 years old, diagnosed through standardized testing) that interviewed these subjects 10 to 19 years after the initial contact, Fafard and Haubrich (1981) found that the majority of these individuals were functioning adequately with no significant degree of psychopathology. Most had completed high school and were gainfully employed, as well.

Levin, Zigmond, and Birch's (1985) study is particularly interesting, for they followed up 34 learning disabled ninth graders (diagnosed by the school system), 11 (30%) of whom had
dropped out of school 4 years later. Seven (60%) of those 11 students had been dismissed because of behavior problems. Two (18%) of the 11 dropouts were employed, and 8 (73%) were participating in general equivalency diploma programs or vocational programs. The self-concept scores of the dropouts, which were in the normal range in the ninth grade, had increased at the 4-year follow-up, demonstrating good psychosocial outcome, despite the vocational concerns.

McGee and colleagues (McGee, Williams, Share, Anderson, & Silva, 1986) followed three groups of boys (reading disabled, reading backward [reading not below expectation based on PIQ], and general comparison groups) in New Zealand for 6 years, by using parent and teacher ratings at 5, 7, 9, and 11 years of age. Both groups with reading difficulties exhibited problems at school entry which became worse over time. At age 11, 57% of the reading disabled and 47% of the reading backward boys met the criteria for psychiatric disorder (e.g., Attention Deficit Disorder, Conduct Disorder, and/or Oppositional Disorder), as measured by the Diagnostic Statistical Manual of Mental Disorders (DSM-III), and compared to 18% of the comparison group. It was concluded that since the boys with reading difficulties had evidenced socioemotional problems before entering school, the problems could not have been primarily generated by their reading difficulties.

In a longitudinal study in Germany by Esser, Schmidt, and Woerner (1990), 356 out of 399 8-year-old children were
reassessed at age 13 years using an adapted version of Conner's scale. In the 8-year-olds, learning disabilities and adverse family conditions emerged as correlates of psychosocial disturbance. Approximately 90% of the subjects with both high Family Adversity Index (FAI; Rutter & Quinton, 1977) scores and LD were judged to be psychiatrically disordered at age 8. Further, multiple discriminant analyses suggested that the development of psychopathology in children who were initially healthy at age 8 appeared to be related to prior learning disabilities, family problems, and stressful life events.

The results of an extensive longitudinal study in Canada found some association between learning disabilities and psychosocial disturbance: that of Spreen and colleagues (Spreen, 1988), which followed 203 LD and 52 nondisabled children into adulthood, spanning 15 years. In Phase I, the LD group (identified by standardized tests and exclusionary criteria) and the control group were followed up 9 years after intake (average age: 19 years), using a structured interview, behavior rating scale, and a personality inventory (Bell, 1962). At this stage the learning disabled young adults evidenced greater psychosocial disturbance than their nondisabled peers, with the exception that there was no greater delinquency.

In Phase II, 6 1/2 years after Phase I, the learning disabled subjects, who were now in their 20's (average age: 25 years), showed no greater delinquency but did manifest greater psychosocial maladjustment. Spreen (1988) concluded that the
long-term psychosocial outcome for learning disabled children on the average is rather poor, even though some of these children become productive and well-adjusted adults.

Of the results of studies that have examined the issue of general socioemotional functioning by using behavioral observation, checklists, rating scales, personality inventories, meta-analysis, and longitudinal approaches, it is apparent that children who have learning disabilities are somewhat at risk, as a group, for the development of psychosocial problems. At the same time, it is evident that some have average and above average levels of adjustment, and that the relationship between LD and psychopathology is not so simple.

Social Status

One approach that has been employed as a way of shedding some light upon this less than transparent issue has been to explore the social status of learning disabled youngsters, since it may be considered to be at least one indication of their socioemotional functioning. Two basic methods have been used to assess social status: peer nomination techniques and rating scales.
Peer Nomination Techniques

In peer nomination techniques, the subjects are asked to indicate which children in their class they tend to accept or reject. Siperstein, Bopp, & Bak (1978) employed a peer nomination procedure that required 22 learning disabled and 155 nondisabled children in grades 5 and 6 to name those same-gender peers that were liked the best. In addition, they were asked to nominate who they thought was the smartest, best-looking, and most athletic. Whereas the children with learning disabilities were shown to be significantly less popular than the nondisabled, their incidence rate among the isolates was similar to that of the other children.

Scranton and Ryckman (1979) in another early study used a peer nomination technique to investigate the social status of 42 learning disabled and 42 matched control students from grades 1 to 3 in a school that practiced the “open concept” service delivery model. Such a setting, in which the students moved from class to class, was thought to be less stigmatizing for students with special needs. The results showed there to be no significant difference between the LD and nonLD boys. The LD girls less often received positive nominations and more often received negative ones. A number of studies have not found such gender differences (Weiner, 1987).

More recently, a study by Weiner, Harris, and Shire (1980) examined the relationship between IQ, achievement and social
status in LD children. The subjects were 90 9- to 12-year-old learning disabled children and 94 nondisabled children in grades 4, 5, and 6. Seventy-six of the LD children were in self-contained classrooms, and 14 were in regular classrooms for most of the school day. The measures comprised a composite positive and negative nomination procedure and the Social Behavior Nomination scale adapted from Dodge (1983).

As in previous studies, the LD children were less popular and more rejected and neglected than the comparison children. They were also less often nominated as cooperative, humorous, or as leaders. No significant correlations were found between peer acceptance and Full Scale IQ for the LD children or for the comparison group. However, significant negative correlations were demonstrated between peer acceptance and reading, as measured by the Wide Range Achievement Test-Revised (WRAT-R; Jastak & Wilkinson, 1984) and the Woodcock Mastery Test (WMRT; Woodcock, 1973).

Separate analysis of the data of the 76 self-contained special class LD children revealed a similar pattern of significant negative correlations. Weiner and colleagues (1990) interpreted these findings as possibly reflective of the deficiencies in social interaction skills that characterize an LD subtype that resembled one identified by Rourke and associates, viz., Group A children (e.g., Strang & Rourke, 1985). This investigation by Weiner, Harris, and Shirer (1980) exemplifies the limitations of a study that employs a contrasting-groups
approach with a heterogeneous group that, now and again, presents and idiosyncratic finding that begs interpretation and requires a more sophisticated methodology.

Rating Scales

Peer rating scales have an inherent advantage over nomination techniques since every child is required to rate every other child on various attributes through statements that are rated on a Likert scale that ranges from strong acceptance to strong rejection. Not only do peer rating scales provide information on every child, they also have greater reliability, in general, than peer nomination techniques (Asher & Hymel, 1981). Bruininks (1978) used the Peer Acceptance Scale (Bruininks, Rynders, & Gross, 1974) in order to measure social status as well as perceived social status in 23 learning disabled and 139 comparison students of elementary school age. The results indicated that the LD students had significantly lower social status than their normally achieving peers, and they rated themselves significantly higher than their actual status.

Other studies using rating scales have generated results suggesting that not all learning disabled children have low social status. Sabornie and Kauffman (1986) employed a “don’t know them” option that took into account the issue of familiarity. Their findings showed no differences in social acceptance between the groups.
Hoyle and Serifica's (1988) results revealed that the learning disabled students were not less familiar or less liked, but they were less often named "best friend" than their normal peers. It is notable that the LD students were less active in extracurricular activities, and spent more time with their parents.

In a more recent study by Stone and La Greca (1990), 57 mainstreamed students with LD and 490 nonhandicapped students in grades 4, 5, and 6 were given a play rating scale and a peer nomination measure. The children with LD were found to be disproportionately represented in the rejected and neglected sociometric groups and underrepresented in the popular and average groups. Over half (54%) of the learning disabled children were classified into one of the low status categories, with approximately equal numbers in the rejected (28%) and neglected (26%) groups. The peer rating scores of the LD girls were consistently lower than those obtained by the LD boys. However, with only 19 girls with LD in the sample (i.e., 3%), these gender differences must be viewed with caution.

Stone and La Greca (1990) discussed possible implications of their findings with respect to the two subgroups of LD children: those who were rejected and those who were neglected. They noted that rejected children are more likely to demonstrate aggressive and disruptive behaviors (Coie, Dodge, & Coppotelli, 1982; Dodge, Coie, & Brakke, 1982), and seem to be at risk for negative outcomes (Coie, 1985). Neglected children are more likely to be
withdrawn (Coie & Kuperschmidt, 1983; Dodge, 1983) and appear to be at risk for internalized problems (La Greca, Dandes, Wick, Shaw, & Stone, 1988). Stone and La Greca (1990) suggested the need for early identification of these two subgroups in order that appropriate intervention programs could be instituted, if necessary.

Vaughn, Hogan, Kouzekanani, and Shapiro (1990) creatively employed a prospective longitudinal design to address social status in young learning disabled students using a peer rating scale. The learning disabled students were assessed prior to identification (LDPI) and compared with low-achieving (LA), average-achieving (AA), and high-achieving (HA) students in the fall and spring of kindergarten. There were 40 subjects: 10 in each group.

The results of this investigation showed that as early as two months after their first formal school experience, kindergarten children who would later be identified as learning disabled (LDPI) received lower peer acceptance ratings than their (LA, AA, HA) classmates. Since the low peer acceptance of the LDPI children occurred so early in their scholastic experience, the authors interpreted these findings as support for the hypothesis that their low social status is not merely a function of history of low achievement or low teacher acceptance.
In summary, the evidence from the studies using peer nomination techniques and rating scales suggests that as a group, children with learning disabilities seem to be at risk for lower social status than their normally achieving peers, and that this lower peer acceptance may become manifest as early as kindergarten. Some studies have shown that girls are more at risk than boys, in this respect, whereas other studies have not revealed such gender differences.

The finding, in one study, that peer acceptance and reading performance were negatively correlated in the LD children was possibly attributable to a particular subtype (Group A, e.g., Strang & Rourke, 1985) that demonstrates deficiencies in social intercourse. Conclusive interpretation of such a finding, however, is precluded by the context of studies dedicated to a contrasting-groups approach.

Self-Concept

In addition to social status, a domain centrally related to the socioemotional functioning of children with LD is self-concept/self-esteem and other related issues: domain-specific self-perceptions and attributions/locus of control.
Self-Concept/Self-Esteem and Self-Perceptions

The studies in the domain of self-concept/self-esteem are based on the hypothesis that children with learning disabilities may be at risk for repeated academic failure and lower social acceptance, and consequently may be at risk for reduced self-esteem.

An early study by Sobol, Earn, Bennett, and Humphries (1983) investigated the self-esteem and self-perceptions of learning disabled children that related to peer acceptance. Three groups of 24 children participated in the study: learning disabled (LD), low acceptance (LA; matched with the LD group on age, gender, and social acceptance), and high acceptance (HA; matched with both groups on age and gender) children. They ranged in age from 7 to 12 years old. The measures used in this study comprised an open-ended interview, a questionnaire measuring expectancy of social success, and a questionnaire measuring peer related self-esteem adapted from the Coopersmith Self-Esteem Inventory (Coopersmith, 1967; Kokenes, 1974).

The results of the Sobol and colleagues (1983) investigation indicated that the LD children more frequently used luck to explain social outcomes, whereas the nonLD groups more often offered personality as a reason for outcomes in social situations. The expectation for social success was lowest in the LD children. The LA and LD children both had lower self-esteem scores than did the HA group. Taken together, these findings
provide some support for the hypothesis that peer acceptance may be related to self-esteem in LD children.

A more recent study in Israel by Priel and Lesham (1990) examined the self-perceptions regarding peer acceptance and cognitive ability in 44 LD children and 36 nondisabled classmates aged 6 to 7 years old from mainstreamed classes (integrated classes). The measures employed were a peer nomination procedure and Harter and Pike’s (1984) Pictorial Scale of Perceived Competence and Social Acceptance with its parallel Teacher Rating Scale.

A main finding of this study was that the LD children’s self-evaluations of cognitive competence were more negative when compared to their normally achieving classmates’ self-perceptions. In contrast, self-perceptions of peer acceptance among the LD children were similar to those of the normal achievers, despite significantly lower social status and teacher evaluations of social status. Priel and Lesham (1990) interpreted these results as reflective of a clear demarcation of failure experiences in the cognitive domain in the context of a more ambiguous experience in the social domain for the LD children.

Another possible reason for more ambiguous results in the social domain could be due to differences in placement. Some investigators have proposed that self-esteem is enhanced by mainstreaming. The children in the latter investigation were mainstreamed but there was no comparison group in order to fully
test this hypothesis. Placement and its impact on self-esteem, was further analyzed in a more recent study by Bear, Clever, and Proctor (1991). Bear and colleagues (1991) used an interesting scheme of comparison groups to examine the impact of placement on global self-esteem and well as domain-specific self-perceptions. There were three groups: 124 nonintegrated nonhandicapped (NNH), 163 integrated nonhandicapped (INH), and 52 integrated learning disabled (ILD). The measures for the study included the Teacher-Child Rating Scale (TCRS; Hightower, Spinell, & Lotyczewski, 1987) and the Self-Perception Profile for Children (SPPC; Harter, 1985).

The results of the Bear and colleagues (1991) study showed the integrated LD children to have poorer self-perceptions of their scholastic competence and behavioral conduct than the nonhandicapped groups as well as poorer overall self-esteem. Furthermore, the LD girls had lower self-perceptions than the boys on the majority of the measures. These findings challenge the assumption that the self-concepts of learning disabled children are enhanced when placed in full-time integrated classrooms. At the same time, the use of a comparison group of nonintegrated LD children could have further clarified this issue. It is still possible that the integrated LD children might have shown higher self-esteem in comparison to nonintegrated learning disabled peers.

Another issue, in addition to placement, that needed to be addressed systematically was socioeconomic status (SES).
DeFrancesco and Taylor (1985) addressed the issues of gender and SES as they examined normal and learning disabled (identified by standardized testing) children and assessed their global self-concept using a self-report scale. They found a significant correlation between SES (based on parental education, occupation, and residence) and self-concept. Although the LD children had significantly lower self-concepts, SES was a significant covariate that accounted for some of this difference. In contrast to the Bear and colleagues (1991) study, gender was not found to be a significant factor in this investigation.

Indeed, there are some investigators that have not found any differences in self-concept/self-esteem at all when comparing learning disabled with normally achieving students. Silverman and Zigmond (1983) assessed self-concept in a large sample of middle and high school students using a standardized self-concept measure. Whereas some individual LD children demonstrated lower self-concept scores, this was not the case for the group as a whole. Silverman and Zigmond (1983) replicated these findings and concluded that the positive findings in other studies may reflect the bias of academic self-concept in skewing the measurement of global self-concept.

**Attributions and Locus of Control**

The rationales underlying the studies concerning attributions involve tests of attribution theory (Heider, 1958) and how this theory relates to achievement motivation (Weiner,
1979, 1980) in children with learning disabilities. The studies related to locus of control have examined the application of Rotter's (1954) social learning theory to LD children. Weiner's extension of Heider's (1958) model has also incorporated Rotter's (1954) conceptualization of locus of control. Weiner proposed that the causes that students use to explain academic success or failure are subsumed into two basic dimensions: the stability of the cause (stable vs. unstable) and the locus of the cause (internal to the student vs. external). When the locus of the cause of an outcome is believed to be contingent on how one behaves, it is an internal locus, whereas when one attributes an outcome to events external to oneself, the event is said to have an external locus (Rotter, 1954). Over time, one's past reinforcement history may help an individual to internalize certain types of outcomes and externalize others. These attributional patterns are thought to play a crucial role in the pursuit of goals and in the performance of tasks that relate to the completion of those goals (Rotter, 1954).

One investigation that compared the attributions of LD and nonLD children was conducted by Jacobsen, Lowery, and DuCett (1986) in the context of two related studies. In Study 1 the subjects were 37 learning disabled (LD) students and 67 normally achieving (NA) students in grades 7 and 8. A structured interview elicited the students' attributions in three domains: an academic context, a social situation, and a random event.
The results revealed that the NA group used ability to explain success more than the LD group did. The LD group used both task difficulty and luck to explain success to a greater extent than the NA group. A finding of major importance was that the LD group used more effort attributions (viz., lack of effort) than did the NA group. They particularly used effort attributions to a greater extent than did the NA students in explaining failure.

In Study 2 by Jacobsen et al. (1988), the subjects were 75 LD and 36 NA children between the ages of 9 and 17 years old. The structured interview consisted of the subject's estimates of success in two achievement domains (schoolwork and physical education) and two social domains (relationships with peers and teachers), and causal attributions for success/lack of success in those domains.

Effort, in Study 2, was the cause chosen most frequently by both groups to explain the extent of their success. This finding was interpreted as indicating that the LD children were no more "helpless" than their peers. Their attributional pattern seemed to be inconsistent with "learned helplessness" (Seligman, 1975). The less positive result of the LD students' attributional patterns was their perception of the causes of failure. The LD students used lack of effort and lack of ability more often to explain failure than did the NA children.

Jacobsen and colleagues (1988) concluded that not only did it seem that these students take more responsibility for failure,
there is often more failure for which to be responsible. Further, even though the LD children used effort as their most frequent attribution to explain their success, they more often used external causes to explain success than did the NA children. The LD children frequently credited their success to luck and task ease, which, combined with their tendency to internalize failure, might limit their self-concept or self-esteem, the authors asserted.

This potential relationship between the LD child's self-concept and the attributions made about academic success and failure was examined by Cooley and Ayres (1988). There were 46 students with learning disabilities (LD) and 47 normally achieving students (NA) in their study. Results from the Piers-Harris Children's Self-Concept Scale (Piers, 1984) indicated that the pre- and early adolescent children with learning disabilities have poorer self-concepts than their nonhandicapped peers. As was consistent with Silverman and Zigmond's (1988) contention, however, the lower overall self-concepts in the students were primarily due to differences in academic self-concept. The results also suggested that the children with lower self-concepts were more likely to attribute their academic successes to external factors and their failures to lack of ability.

The relationship between self-concept, locus of control, and anxiety has been investigated in learning disabled children by Margalit and Zak (1984). One hundred LD (identified by psychological testing) and 118 nonLD children aged 8 to 13 years
old participated in this Tel Aviv study. The Child Anxiety Scale (CAS; Gillis, 1980) and a short form of the Piers-Harris Self-Concept Scale (Bagley & Mallick, 1978) were used to assess anxiety and self-concept, respectively.

Significantly higher pawning anxiety and lower self-esteem were demonstrated in the learning disabled children. Anxiety and self-concept were inversely correlated with each other in each group. Interestingly, in the LD children pawning anxiety, specifically, was related to low self-esteem. The LD children exhibited higher levels of anxiety related to their feeling of being pawns in a game, such that events seemed beyond their control. There was, however, no difference between the LD and NonLD children in terms of the anxiety related to competency issues.

Palmer, Drummond, Tollison, and Zinkgraff (1982) conducted a study that examined learning disabled and normally achieving students' attributions, expectancies, and affect with respect to performance outcomes. There were 30 LD and 30 NA boys aged 7 to 12 years old. The experimental measures employed in this study included a coding task, attribution measure, expectancy procedure, affect measures, and a persistence task. The students were randomly assigned to three performance conditions: completion, noncompletion, and control.

Whereas the LD and the NA students similarly attributed their successes to their ability, the LD students more often than the NA students attributed their failures to their lack of
ability. It was also reported that the LD students were less persistent on difficult tasks than the NA students. However, repeated failure, in this study, did not affect the LD or NA students' expectancies or affective responses. Thus, although these learning disabled students attributed failure differently from their normally achieving peers, repeated failure on tasks within the context of this study did not cause their attributional style to deteriorate into learned helplessness (Seligman, 1975). Still, the developmental aspects of this model needed to be fully tested within the context of a longitudinal design.

Longitudinal Studies

One group of investigators -- Kistner, Osbourne, and Le Verrier (1988) -- sought to clarify the relationship between causal attributions and academic progress through a longitudinal approach. A modification of the Effort-Ability-External Scale (EAX; Nicholls, 1979; Pearl, 1982) and the Intellectual Achievement Responsibility Scale were the measures of causal attributions employed. These measures used hypothetical school success and failure situations to assess attributions. The achievement tests included the Peabody Individual Achievement Test (PIAT; Dunn & Markwardt, 1970) and the Child Comprehensive Test of Basic Skills (CTBS; 1981). The Child Behavior Inventory (CBI; Schaefer, Edgerton, & Aronson, 1977) and the Teachers' Perceptions of Student Competence Scale (Harter, 1982) were used
to assess the teachers' ratings of the students' behavior and abilities.

The results of multiple regression analyses of the data from Kistner and associates' (1988) Study 1 revealed that the tendency to attribute failure to lack of effort was associated with greater academic progress in the LD children, whereas the tendency to attribute failure to lack of ability was negatively correlated with academic progress. The tendency to blame external sources for failures, however, did not correlate with school progress at all.

In Study 2, Kistner and colleagues (1988) investigated developmental changes in the LD children's attributions. The subjects were the 34 LD children from Study along with a matched group of 40 normally achieving (NA) children. A main finding was that the LD children were less likely than the NA children to attribute failure to insufficient effort and more likely to attribute failure to insufficient ability. At the same time, over the 2-year span, a significant increase in the emphasis on the attribution of lack of effort to academic difficulties was observed in both groups. The authors concluded that a self-perpetuating cycle of failure was not present in these LD children over the two years.

There is some evidence to suggest that children with learning disabilities demonstrate lower academic self-concept.
The issue of whether and to what extent they may demonstrate lower self-concept in the social domain or lower global self-concept is less clear. The evidence for the enhancement of self-esteem through placement in fully integrated classes is also equivocal.

There is some evidence suggesting that LD children may be more likely to attribute academic failures to insufficient ability than do their normally achieving peers. At the same time, there is evidence for a diversity of attributional patterns among children with learning disabilities. Reduced self-concept in the learning disabled does not seem to be related to a particular attributional pattern or locus of control orientation. Finally, there is no convincing evidence to suggest that learning disabled children manifest an attributional pattern consistent with learned helplessness.

Social Competence

Unlike the constructs of self-concept and attributional style, social competence is a domain not easily operationalized. Asher (1983) generated a model of social competence based on his review of early literature in this area emphasizing three dimensions: relevance (the ability to "read" a given social situation), responsiveness (the ability to be positively responsive to the social initiatives of others), and a process
view of life (an understanding that relationships develop and 
change over time, and that the timing and quality of one's 
behavior needs to accommodate these dynamics). Asher's (1983) 
model, while somewhat descriptive, did not appear to be 
operationalized in this literature.

Rourke and Fuerst (1991), upon their review of this 
literature, suggested a componential analysis of social 
competence skills into four aspects: (1) perceptual abilities 
(such as the perception of facial expressions), (2) cognitive 
abilities (such as those underlying the discernment of cause-
effect relationships in social situations), (3) motor and 
language skills (those used to execute social behaviors), and (4) 
attitudinal components (such as self-concept, locus of control 
orientation, and self-understanding). A componential analysis 
would seem to offer heuristic value for research in this domain. 
However, such a systematic approach does not seem to be in 
evidence in this literature. Instead, single aspects of this 
multi-faceted construct have been examined in fragmented 
approaches and measures, including laboratory tasks, role-playing 
assessments, standardized tests, and rating scales.

**Teacher-Rated Social Competence**

Merrill (1991) used a rating scale to examine the social 
competence of three matched groups of 40 elementary school age 
children: learning disabled (identified by multidisciplinary 
team), low-achieving, and regular classroom students from grades
3 to 6. They were rated by their teachers using the Walker-McConnell Scale of Social Competence and School Adjustment (Walker & McConnell, 1988), on teacher-preferred behavior, peer-preferred behavior, and school adjustment.

The groups of learning disabled children and low-achieving students were both rated as having significantly lower levels of academic adjustment than the regular students. There were no significant differences in the social competence ratings between the low-achieving and the learning disabled students, however.

**Nonverbal Social Perception**

Axelrod (1982) defined social perception as the ability to perceive nonverbal social cues that contribute to social responses, and examined this nonverbal perceptual aspect of social competence in LD adolescents. There were 54 LD students (identified by school psychological evaluation) and 93 nonLD students in grades 8 and 9. They were administered the Profile of Nonverbal Sensitivity Test (PONS; Rosenthal, Hall, Archer, DiMatteo, & Rogers, 1979) and three subtests of the Four Factors Tests of Social Intelligence (O’Sullivan & Guilford, 1976). The PONS is a standardized measure of accuracy in decoding nonverbal cues (facial and body movements, and tone of voice) based on 220 two-second test items -- film clips of a woman portraying an emotional response. There are three visual presentations (face, upper torso, and figure) and two auditory presentations (scrambled speech and electronically filtered speech). The three
subtests of the Four Factors Tests involve the following tasks: choosing the drawing that shows the same feeling as a given group of expressions, selecting the cartoon that best fills a blank in a cartoon sequence, and choosing the cartoon that best predicts what will follow a cartoon sequence.

The LD adolescents were found to be significantly lower in nonverbal social perception in the visual modality compared to their normally achieving peers. They were also significantly deficient on the Four Factors tasks. It is unclear, however, how representative these laboratory tasks and standardized tests may be in accurately assessing social perception in these adolescents' natural environments.

Another aspect of nonverbal social perception, the ability to interpret facial expressions, was explored by Holder and Kirkpatrick (1991) in 48 learning disabled (LD) children and 48 normally achieving (NA) children aged 8 to 14 years. Each group was subdivided into two age groups (ages 8 to 10 and ages 11 to 15 years). The task was a modified version of Pictures of Facial Affect developed by Ekman and Friesen (1976) consisting of 36 slides of adult male and female faces expressing emotions of happiness, sadness, fear, anger, surprise, and disgust.

The progression for all groups of most accurate to least accurate interpretation was happiness, anger, surprise, sadness, fear, and disgust. There were no interpretive differences between younger and older children, or between males and females. The nondisabled children were found to be more accurate
interpreters of emotion from facial expressions than the children with learning disabilities.

Communicative Competence

In addition to the nonverbal aspects of social competence, investigations of the verbal aspects of social skills have been undertaken. Studies by Bryan, Donahue, Pearl and colleagues (Bryan, Donahue, & Pearl, 1981; Bryan, Donahue, Pearl, & Sturm, 1981; Donahue, Pearl, & Bryan, 1980) have focused on the communicative competence observed during conversation within the context of role playing. These investigators found that LD children appear be adequate communicators generally, but less adequate conversational partners in situations which demand the repair of breakdowns in communication. As speakers they less frequently formulated useful messages which took into account information that was not available to their listeners. They were less proficient as listeners when input was not sufficiently informative; in this context they were less likely to ask questions to gain needed information, and more likely to adopt a nondominant role in comparison to normally achieving peers. These results are similar to Mathinos' (1991) findings that children with learning disabilities seem to be generally less responsive in terms of conversational engagement.
Social Problem Solving

A study by Toro, Weissberg, Guane, and Liebenstein (1990) compared the social problem solving skills of 86 LD children (from self-contained classrooms) with that of 86 nonLD children between the ages of 7 and 11 years. The ability to generate alternative solutions was assessed by the Open Middle Interview (OMI; Polifka, Weissberg, Gesten, Flores de Apodaca, & Picolli, 1981). This instrument requires the child to generate as many solutions as possible to each of four different social problem situations. School behavior was assessed with the Child Behavior Rating Scale (CBRS; Weissberg, Gesten, Carnrike, Toro, Rapkin, Davidson, & Cowen, 1981).

There were significant differences between the groups in the following ways. The children with learning disabilities generated fewer alternatives for solving social problems, showed less tolerance for frustration, less adaptive assertiveness, and less personal and social competence than their nondisabled peers. They also showed more behavior problems in the classroom and incurred more family difficulties at home. These findings need to be interpreted with caution, however. A major methodological limitation of this study is that the LD children had significantly lower IQs than the nonhandicapped children (LD mean IQ = 85, nonLD mean IQ = 102.02), and so some of these differences might be accounted for by differences in IQ.
Social Perception and Self-Concept/Self-Esteem

An early comparison of the social perception of LD and nonLD children was undertaken by Goldman and Hardin (1982). The subjects were 23 LD and 34 nonLD children aged 9 to 11 years old. Administered were the following measures: Piers-Harris Self Concept Scale for Children (Piers, 1969), the Nowicki-Strickland Internal-External Control Scale (NSIECS; Nowicki & Strickland, 1972), the Socialization scale of the California Psychological Inventory (CPI; Gough, 1975), and the Children's Embedded Figures Test (CEFT; Karp & Konstadt, 1971). The learning disabled children differed significantly from their nondisabled peers on each of the four measures. Gender was not shown to be a significant factor. The LD children were less accurate in their perception of social interactions and also showed lower self-esteem than the nonhandicapped children.

Hall and Richmond (1985) also examined social perception in relation to self-esteem. They used the PONS (Rosenthal et al., 1979) to assess social perception in a small sample of LD students (identified by school procedures) and nonLD students. They also administered the Coopersmith Self-Esteem Inventory (CSEI), and Fundamental Interpersonal Relations Orientation - Behavioral Children (FIRO-BC). Significantly lower scores on the PONS and the CSEI, compared to their nonhandicapped peers, suggested that the students with learning disabilities had more difficulty in comprehending nonverbal cues and had lower self-esteem, respectively. At the same time, their endorsements on
the FIRO-BC questionnaire suggested that the two groups did not
differ significantly on their stated needs for affection,
 inclusion, and control. Caution was advised by Hall and Richmond
(1985) in interpreting the latter finding, since the FIRO-BC, a
measure of hypothetical social role playing (for which they did
not provide a reference), has limited known validity.

Social Perception and Behavior Problems

Stone and La Greca (1984) used an active role-play
assessment procedure described by Gottman, Gonso, and Rasmussen
(1975) to assess social and friendship-making skills in their
study of social perception in 30 LD (identified by brief
psychological evaluation) and 30 nonLD boys between 8 and 12
years of age. They also used a short form of the PONS – the Face
and Body PONS (Rosenthal, Hall, DiMatteo, Rogers, & Archer,
1979). This measure was employed along with a token economy
procedure in order to control for possible attentional
differences between the LD and nonLD children. As well, scores
on the Conduct-Problem and Personality Problem scales of the
Behavior Problem Checklist (BPC; Quay, 1977) were used to measure
acting out behavior and anxious, withdrawn behavior,
respectively.

It was revealed that the LD children were distinguished from
the nondisabled children in their overall deficiencies in social
skills role-playing. They were also rated by their teachers as
more anxious and withdrawn on the BPC. On the other hand, the LD
children performed comparably with the nonLD children on the PONS under attention-incentive conditions. As Stone and La Greca (1984) noted, however, correlational analyses showed no relationship with the other social competence measures -- which were correlated with each other -- raising the question of the validity of the PONS - Short Form.

Social Perception and Peer Status

The social perceptual skills of 30 children with learning disabilities (identified by a school board) and a matched group of 30 normally achieving children were assessed by Stiliadis and Weiner (1989) using the Test of Social Inference (TSI; Edmundson, DeJung, Leland, & Leach, 1974) and the Social Perception Behavior Rating Scale (SPBRS; Maheady, Maitland, & Sainato, 1984). The Peer Acceptance Scale (Bruininks et al., 1974) was used as a measure of social status. The TSI requires that the child make inferences about problem situations presented in 30 pictures. On the SPBRS the teacher uses a 5-point Likert scale to rate the frequency of behaviors associated with deficiencies in social perception in the classroom.

Stiliadis and Weiner's (1989) findings suggested that the group of learning disabled children had significantly poorer social perceptual ability as measured by either the TSI or the SPBRS. The SPBRS was significantly related to peer status, whereas the TSI was not. Possible reasons cited by the authors
were that the tests might not be measuring the same construct, or they might be measuring different aspects of the same construct.

Social Perception: Developmental Considerations

Jackson, Enright, and Murdock (1987) addressed the issue of development in the domain of social perception, employing a cross-sectional design with 11-, 14-, and 17-year-old boys. There were 10 LD (identified by multidisciplinary team) and 10 nonLD boys in each age group. The measures employed were the PONS (Rosenthal et al., 1979) and the Four Factors Tests (O'Sullivan & Guilford, 1975). The results showed that all three age groups of LD boys were deficient in social perception compared to their same-age peers, as measured by both instruments used in this study. The findings suggested that both learning disabled and nondisabled children improve with age, but that the gap between the groups did not close through age 17.

The studies of social competence that were reviewed provide some evidence suggesting that children with learning disabilities, as a group, may be deficient relative to peers in various aspects of social competence. It is true that some studies have been shown them to be less accurate in interpreting emotion from facial expressions and body language, and in comprehending social interactions. Some studies have shown that they may be less skilled conversationally than their peers,
particularly in rectifying situations in which there is inadequate information. There is some evidence that deficient social competence in these children may be related to lower self-esteem. And there is the suggestion that LD children improve in social skills as they grow older, whereas the disparity between them and their peers may not attenuate, at least through age 17, or so.

These findings in the domain of social competence, however, must remain tentative, since there is little systematic replication of these studies, and more basically, a less than methodical approach to this complex area of investigation.

**Methodological Limitations**

In fact, our review of investigations related to the general psychosocial functioning, social status, self-concept/self-esteem, and social competence of the learning disabled has generated a modest contribution to our understanding of these children. Much of this literature is fragmented with studies that are not easily comparable or logically contiguous. The major methodological limitations encompass a number of issues. Fundamentally, there is no consistent definition of learning disability that has been applied throughout these studies, and similarly, the measures employed often lacked operational definitions and adequate reliability and validity. "Self-concept," "self-perceptions," "internal attributions," "external attributions," and "social competence," for example, have been
interpreted and measured in various ways. Indeed, studies in the domain of social competence did not seem to be based on a testable conceptual model, such as the componental model suggested by Rourke and Fuerst (1991).

With few exceptions, developmental issues were not adequately tested, nor was the relationship of gender, SES, and placement to development sufficiently explored. Cross-sectional studies and more comprehensive longitudinal studies, such as that of Spreen (1988), are needed to investigate aspects of psychosocial functioning of LD children that likely have a developmental component, as has been demonstrated in the perceptual and cognitive abilities of these children (e.g., Esser, Schmidt, & Woerner, 1990; Morris, Blashfield, & Satz, 1986). Furthermore, a basic methodological inadequacy present throughout these studies involves the application of an undifferentiated contrasting-groups design to the investigation of children with LD who have been presumed to be homogeneous with respect to socioemotional functioning.

The use of the contrasting-groups approach requires considerable skill on the part of the researcher, since many potential confounds can obscure the findings (Beck, Andrasik, & Arena, 1984). When groups are relatively homogeneous, this methodology may be an appropriate means of investigation. The researcher's knowledge of particular, fairly circumscribed confounds can be used, and individual experimental and control subjects can be matched on these dimensions (e.g., on age or IQ).
When heterogeneity or potential heterogeneity exists, however, an approach that employs the subtyping concept may be more viable.

A Question of Heterogeneity

While some investigators were still relying on the contrasting-groups approach to study learning disabled children, treating them as homogeneous in terms of their psychosocial functioning, many researchers examining their neuropsychological performance had already been validating the heterogeneity that existed in terms of the patterning of their abilities (e.g., Doehring, Hoshko, & Bryans, 1979; Fisk & Rourke, 1979; Fletcher & Satz, 1985; Lyon & Watson, 1981; Morris, Blashfield, & Satz, 1986; Petrauskas & Rourke; Strang & Rourke, 1985; Watson & Goldgar, 1983).

Learning Disability Subtypes and Psychosocial Functioning

As early as the 1970's there were a few investigators who had begun to hypothesize associations between particular subtypes of learning disabilities and particular patterns of behavior. While many of such studies during the 1970's and 1980's are characterized by hypotheses that posed such associations without the framework and articulation of a larger conceptual model, they
do represent a qualitative step away from the contrasting-groups approach to research in this domain.

**Reading Disabilities and Problem Behavior**

Some investigators began to examine the relationship between particular subtypes of learning disabilities and particular forms of behavioral disturbance. Berger, Yule, and Rutter (1975) for example, reported prevalence data that involved the co-occurrence of reading disabilities and teacher-rated behavior problems in 10-year-old children who were from an inner London borough and the Isle of Wight. There were 44 reading disabled and 72 control children in the Isle of Wight group, and 73 reading disabled and 105 control children in the inner London borough group. These children had been screened and randomly selected from larger samples (the Isle of Wight n = 1142, the inner London borough n = 1689). The reading disabled children had been classified as such if their reading scores were at least 2 standard deviations below their expected scores on the basis of age and IQ. Both the Isle of Wight and inner London borough children with reading disabilities exhibited Verbal-Performance IQ discrepancies, with Verbal significantly lower than Performance IQ.

The Neale Analysis of Reading Ability (Neale, 1958) is a standardized British test that was used to measure reading accuracy and comprehension. The Wechsler Intelligence Scale for Children (Wechsler, 1949) was used to measure IQ. A teacher rating scale, the Children's Behaviour Questionnaire (also
designated as Rutter's B Scale [Rutter, 1967] -- the complement to Rutter's A Scale, a parent rating scale), was employed to measure behavior problems. Antisocial behavior was defined as a score of 9 or above on this instrument.

The results obtained from the Isle of Wight indicated that 35% of the boys and 14.3% of the girls with reading disability had high scores, compared to 7.9% of the boys and 5.4% of the girls in the general population. In the inner London borough, 49.1% of the boys and 31.2% of the girls with reading disability obtained high scores on the Children's Behaviour Questionnaire (Rutter, 1967), compared to 24.5% of the boys and 13.2% of the girls from the total inner borough population. Thus, in both populations teacher-rated externalized behavior problems were more prevalent among the children with reading disabilities than among children without reading problems.

Sturge (1982) noted Rutter and colleagues' (Rutter, Tizard, & Whitmore, 1970) earlier research in this area, and wanted to further explore the nature of this suggested linkage between reading disabilities and antisocial behavior problems. Like Berger, Yule, and Rutter (1975), Sturge (1982) assessed 10-year-old children who had been screened and randomly selected from a sample that was part of larger epidemiological and longitudinal studies of Inner London children. Her investigation, however, was designed so that four groups of boys with or without reading and/or antisocial problems could be compared. There were 26
reading disabled boys, 31 antisocial boys, 39 boys who were
reading disabled and antisocial, and 33 controls.

In Sturge's (1982) study, reading disability was defined as
reading performance at least 2 years behind expectation on the
basis of age and IQ. Antisocial behavior was defined as a score
of 9 or more on the Children's Behaviour Questionnaire (Rutter,
1967) with an antisocial or mixed pattern. A structured family
interview (previously described by Brown and Rutter, 1966) was
administered in order to obtain a wide range of information about
the boy's behavior and about the family background and attitudes.

In the total sample of 1689 boys, the prevalence of reading
disabilities was 11%, and the prevalence of antisocial behavior
was 17%. Sturge (1982) noted that 2.25% of this sample was
expected to be both reading disabled and antisocial by chance,
but the actual percentage was slightly higher, i.e., 3.8%. These
findings modestly support the hypothesis that there may be some
less than direct association between reading disabilities and
antisocial behavior. Indeed, given the high incidence of
disadvantageous factors in the families and schools for children
living in Inner London that was revealed in the structured
interview, there is no simple explanation for this association in
this context.

Jorm, Share, and Matthews (1986) employed a longitudinal
approach to investigate the relationship between reading
disabilities and behavior problems in Australian children. They
used the teacher-rated Children's Behaviour Questionnaire
(Rutter, 1967), as had Sturge (1982) and Berger and associates (1975). The questionnaire was administered at the beginning of kindergarten and again at the end of grades 1 and 2. At the end of grade 2, the children were given the Neale Analysis of Reading Ability (Neale, 1966) and an individually administered nonverbal intelligence test, the Columbia Mental Maturity Scale (Burgemeister, Blum, & Lorge, 1972).

Reading disability was defined by using a regression equation in relation to age and IQ. Twenty-five children were classified as reading disabled, 14 as reading backward, and 414 as controls. The actual categorizations of the children, however, were not very stable from grade 1 to grade 2. However, Jorm, Share, and colleagues (1986) compared the frequencies of behavioral classifications (Neurotic, Antisocial, Undifferentiated, and Normal) for the 3 groups of readers based on their original reading-based classifications, and found no association between reading disabilities and psychosocial problems. More meaningful results may have been obtained with older children and more reliable measures.

Maughan, Gray, and Rutter (1985) did assess older reading disabled children and adolescents, as they followed up the same male subjects in Inner London who were first studied at the age of 10 years by Sturge (1982). They were reassessed at age 14 and also 1 year after leaving school -- at age 17, 18, or 19.

At age 14, just under one-third of the reading disabled (with and without antisocial behavior) were reading within the
normal range, whereas two-thirds were below the mean. Only 2
(4.3%) reading disabled boys (who also had antisocial behavior)
were performing in the normal range on group reading tests.
Eight reading disabled boys (17.4%) performed at 1.7 standard
deviations below the mean or lower. Seven of these 8 boys had
exhibited both reading and behavior problems at the age 10.
There was a nonsignificant trend for boys with persistent
behavior problems at both age 10 and 14 to be less likely to
perform in the higher range. There was a similar nonsignificant
trend associating reading level at age 14 with SES.

In relation to behavioral adjustment, Maughan and colleagues
(1985) reported that the boys with few behavior problems at age
10, whether reading disabled or not, continued to be well
adjusted at age 14, as rated by teachers on the Children's
Behaviour Questionnaire (Rutter, 1967). Official records of
delinquent activities showed a nonsignificant trend for levels of
delinquency to be higher in all three problem groups. Dropping
out of school was no more frequent among the reading disabled
without behavior problems than for the comparison group; however,
the rate was almost doubled in the group with reading and
antisocial behavior problems.

Both reading disabled groups had higher rates of
unemployment than the other groups. Young men with both reading
disability and behavior problems fared the worst: Almost one-
third (7/22) were unemployed one year after leaving school.
Those with reading difficulties alone did better (4/17 or 25%),
but not when compared with the other groups.

McGee and colleagues (McGee, Williams, Share, Anderson, & Silva, 1988) conducted a longitudinal study in a large sample of boys in New Zealand. There were 21 boys with reading disabilities (RD), 31 boys with reading backwardness (RR), and 436 normally achieving (NA) boys. Behavior was assessed at 5, 7, 9, and 11 years using Rutter’s Scales A and B for parents and teachers, respectively. The major dimensions measured by Rutter’s instrument were Hyperactivity, Aggressiveness, and Worry. The Diagnostic Interview Schedule for children (Costello, Edelbrock, Kales, Kessler, & Klaric, 1982) was used to assess DSM III disorders (American Psychiatric Association, 1980).

Both groups of boys with reading difficulties had more teacher-reported behavior problems -- particularly aggressiveness and hyperactivity -- during their first year of school and showed a relative increase in such problems, with different relative changes at each age. The RR boys incurred the greatest increase in behavior problems from age 5 to 7, whereas the RD boys showed the greatest increase from age 7 to 9. Both groups continued to show serious levels of behavior problems through age 11. Parents perceived aggressiveness as being most problematic for the RD and RR children. Whereas there was a significant association between family adversity (e.g., parental separation, low SES) and reading backwardness, further analyses suggested that family difficulties per se did not underlie the relationship between reading and behavior problems.
On the Diagnostic Interview Schedule for Children, there were overall differences among any of the groups in the measures of Attention, Hyperactivity, and Antisocial Behavior. At age 11, of the 17 boys with reading problems, there were 6 with attention deficit disorder, 4 with conduct/oppositional disorder, 1 anxious/phobic, and 2 with multiple disorders. McGee and associates (1986) reported that the RD and RR groups did not differ significantly in the prevalence of DSM III disorders in their study, although the overall rate of disorder in these two groups of children with reading problems (51%) was significantly higher than in the comparison group (18%).

We have reviewed studies that have focused on a possible relationship between reading problems and behavioral difficulties. While the results of these investigations have not been entirely consistent, there is limited evidence suggesting that there may be some association between reading disorders and psychosocial problems, particularly of the externalized variety. The results of these studies suggest that the association is less than direct, and that reading disabilities do not constitute a sufficient condition for externalized problems. Further research is needed that involves more precise specification of particular learning disorders and standardized measurement of psychosocial functioning. Finally, although these studies reflect an acknowledgement of the heterogeneity of children with learning
disabilities, they still fall short with respect to a well-articulated conceptual framework and commensurate methodology.

Typologies Based on Classroom Behavior

The time was ripe for methodology that more systematically addressed the potential for heterogeneity in the psychosocial functioning of learning disabled children. A more sophisticated methodology was employed by McKinney, Speece, and colleagues (McKinney, 1989; McKinney & Speece, 1986; Speece, McKinney, & Appelbaum, 1985). They conducted a number of investigations through the Carolina Learning Disabilities Project using cluster analytic techniques and the Classroom Behavior Inventory (CBI: Schaefer, Edgerton, & Aronson, 1977) to identify behavioral subtypes of learning disabled children.

In a study by Speece, McKinney, and Appelbaum (1985), there were 63 learning disabled (identified by multidisciplinary team) children in grades 1 and 2 and a matched group of 66 normally achieving children. Seven cluster-analytic behavioral subtypes were generated, and validated by cluster analyses of the CBI data from special education teachers.

Subtype 1 (28% of the sample) appeared to be a well-adjusted group except for mild attention deficits and problems with independent classroom work. Subtypes 2 an 5 showed variations of normal behavior. Subtype 2 (25%) had slightly elevated ratings
on considerateness and introversion, whereas Subtype 5 (10%) was slightly less considerate and more aggressive. Subtypes 2 and 5 also contained a disproportionate number of girls and boys, respectively. Subtype 3 (14%), exclusively male, was prone to conduct problems. Subtype 4 (14%) was described as introverted, withdrawn and dependent, and was overrepresented by girls. Subtype 7 (3 boys) had serious behavior problems, and Subtype 6 seemed to be a milder version of this global behavior disorder. Speece and colleagues (1985) noted that more than one-third of their LD sample did not exhibit a maladaptive behavior pattern. Another manner of summarizing these data, however, is that almost two-thirds did exhibit problems.

McKinney and Speece (1986) followed longitudinally for 3 years, 47 of the LD students from the Speece et al. (1985) study. The seven original behavioral subgroups were combined into four composite subgroups. Subtypes 2 and 5 were designated as the Normal subgroup. Subtypes 1 and 4 remained as separate subgroups, Attention Deficit and Withdrawn Behavior, respectively. Subtypes 3 (Conduct Problems), 6 (Low Positive Behavior), and 7 (Global Behavior Problems) were combined to form one group with classroom management problems (Problem Behavior). Each year teachers rated the students on the CBI, and measures of reading and mathematics achievement from the PIAT (Dunn & Markwardt, 1970) were obtained.

Children with attentional problems and children with problem classroom behavior during grades 1 and 2 demonstrated poor
achievement outcomes in later grades compared to those who presented with social withdrawal. Results from a forecasting procedure revealed that subtype membership for the major behavioral groups was only moderately stable over time, however. McKinney and colleagues (1986) reported that 45% of the children changed subtype membership in the second year, and 50% changed in the third year of the study. Children with attention deficits and problem behavior manifested the most variable subtype membership (tending to switch from one maladaptive subtype to another rather than to a normal one) and the least favorable academic achievement. LD children who were free of behavior problems and LD children showing withdrawal exhibited a linear pattern of progress similar to that of normal achievers but at a below-average level. The children with attentional or classroom management problems, however, showed a declining pattern of progress relative to the other groups.

Williams, Gridley, and Fitzhugh-Bell (1992) also used cluster analysis in order to develop an empirical typology. These investigators based their typology not only on behavioral variables as did McKinney, Speece and colleagues, but also included neuropsychological and academic variables. The subjects were 42 brain damaged and 53 learning disabled children selected from a larger sample referred for neuropsychological assessment at a large medical center. They ranged in age from 5 to 18 years (mean = 10 years for each group). All the children obtained a
Wechsler Full Scale, Verbal, or Performance IQ greater than or equal to 85.

The neuropsychological measures included the Wechsler Intelligence Scale for Children (Wechsler, 1949), Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974), Wechsler Adult Intelligence Scale (Wechsler, 1955), Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981), Finger Tapping, Finger Agnosia, Tactile Form Perception, the Category Test, and the cross drawing from the Aphasia Screening Test of the Halstead-Reitan Neuropsychological Battery (Reitan & Davison, 1974). The achievement variables were the Reading, Spelling, and Arithmetic subtests of the Wide Range Achievement Test-Revised (WRAT-R; Jastak & Wilkinson, 1984). The Conners Behavioral Rating Scale (CBRS; Conners, 1973) was employed to assess behavior problems.

Two hierarchical cluster analyses were performed on the data. One cluster analysis involved the neuropsychological variables and the academic variables. This cluster analysis revealed three subtypes, two of which were interpretable. Subtype 1 evidenced higher VIQ, Reading, and Spelling. Subtype 2 demonstrated higher PIQ along with higher sensorimotor and constructional skills. Hyperactivity and conduct problems were more pronounced for Subtype 2 than for Subtype 1.

The cluster analysis that involved the behavioral variables in addition to the neuropsychological and achievement measures generated four interpretable clusters. Group 1 (51% of the
sample) performed within normal limits on all the measures with strong nonverbal and spatial skills. Group 2 (20%) had higher verbal skills, poor Arithmetic, finger agnosia, and sensorimotor performance, and behavior within normal limits. Group 3 (9%) was characterized by inattentiveness and clinically significant internalized problems, and a higher percentage of documented brain damage. Group 4 (20%) had the poorest VIQ and achievement performance and clinically significant externalized (i.e., hyperactivity, inattentiveness, and conduct problems) behavior difficulties. This group evidenced a PIQ 4.5 points higher than their VIQ.

Williams, Gridley, and Fitzhugh-Bell (1992) interpreted their findings as supportive of a model of learning disabilities based on the postulation of a continuum of brain dysfunction.

In summary, McKinney, Speece and colleagues (McKinney, 1989; McKinney & Speece, 1986; McKinney, Speece, & Appelbaum, 1985) attempted to develop a behavioral typology of learning disabled children using cluster analytic techniques. Whereas the unstable subtype membership makes the interpretation of McKinney, Speece, et al. studies' longitudinal findings difficult, as McKinney (1989) has summarized, they do present evidence suggesting that the presence of attentional or conduct disorders, in addition to learning disabilities, in the early grades elevates the risk for poorer achievement as well as poorer adjustment.
Williams, Gridley, and Fitzhugh-Bell (1982) employed a comprehensive set of neuropsychological and achievement variables along with classroom behavior variables as a basis for their more informative cluster-analytically derived subtypes. It is notable that their subtype with higher Performance than Verbal IQ showed externalized socioemotional difficulties, which is consistent with a number of the studies that found a relationship between reading disabilities and externalized behavior problems.

It is also noteworthy that Williams and associates (1992) suggested that the Personality Inventory for Children (PIC) would be helpful in providing more extensive information to clarify the relationship between their findings and those of the Windsor Laboratory.

The Turning Point

And it is the findings of the Windsor Laboratory which we now examine. Indeed, a study by Ozols and Rourke (1985) represents a turning point in this learning disabilities research. For here were initiated some tests of proposed linkages between patterns of central processing abilities and deficits thought to predispose particular youngsters to different patterns of socioemotional as well as learning disabilities — a salient aspect of Rourke's (1978, 1982, 1983, 1987, 1988b, 1989) conceptualization of brain and behavior that also addressed developmental issues and social competence and responsiveness.
An understanding of the Ozols and Rourke (1985) investigation will be made clearer by a perusal into the subtyping research that had been and continues to accrue in epigenetic fashion since 1971 in the University of Windsor Laboratory. First of all, learning disabilities had all too often been stereotypically associated with reading or language problems, and, with few exceptions, there had been a consequent failure to recognize the academic and social needs of individuals with arithmetic and nonverbal deficiencies. Rourke and colleagues were among the few investigators who had been conducting a series of investigations that examined both of these subtypes of LD children, and these subtypes became the focus of the Ozols and Rourke (1985) investigation.

As summarized in Rourke and Fuerst (1991), the LD children in one group (referred to as R-S) are those who exhibit relatively poor psycholinguistic skills in the context of well developed tactile-perceptual, psychomotor, visual-spatial-organizational, and nonverbal problem solving skills. They have poor reading and spelling skills, and better (although still impaired) arithmetic skills. Those in the other group (Group A) show outstanding deficiencies in tactile, psychomotor, visual-spatial, and nonverbal problem solving abilities in conjunction with strengths in rote verbal learning, phoneme-grapheme association, verbal classification, and the amount of verbal output. Whereas Group A children demonstrate high levels of word
output. Whereas Group A children demonstrate high levels of word recognition and spelling, they experience great difficulty in arithmetic.

Ozols and Rourke (1985) examined these two groups of children with LD -- one with a pattern of relatively poor auditory-verbal skills within the context of well developed visual-spatial-organizational skills, and the second showing the opposite pattern of abilities and deficits. Their performance was compared on four exploratory measures of social judgment and responsiveness. As expected, and consistent with the Rourke (1982) model, the children with the language disorder performed better than the other group on the tasks requiring nonverbal responses, whereas the children with visual-spatial deficits performed better on the tasks involving verbal responses. The authors interpreted these differences as the likely interaction between their specific processing patterns and the task demands. It needs to be noted that Loveland, Fletcher, & Bailey (1990) replicated and extended these findings.

The Windsor Laboratory Classification Studies:
Psychosocial Typology

Keeping in mind that some children with LD do not show social competence deficits (Ackerman & Howes, 1988), the latter studies, in which there is an appreciation for LD subgroups, have
generated some meaningful information regarding the subtypes that do. Rather than the contrasting-groups approach, it is the subtyping concept, and its accompanying methodology, that can enhance our understanding of the complex patterns characteristic of a heterogeneity that had become more widely recognized.

Accordingly, the Windsor research program was undertaken with the goal to develop a psychosocial typology of LD children with a comprehensive personality inventory of well documented reliability and validity. Let us examine five of the most recent studies that have applied statistical subtyping techniques to selected scales of the Personality Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977, 1984).

In the first Windsor study of this series, Porter and Rourke (1985) examined the hypothesis that learning disabled children might be heterogeneous with respect to their socioemotional functioning. Until this study, this possibility had not been systematically investigated.

The application of Q factor analysis to the PIC scores of 100 LD children, ranging from 6 to 15 years of age, resulted in four subtypes that included 77 children. A Normal subtype (44% of the subjects) included no elevations on the scales reflecting psychosocial dysfunction. An Internalized Psychopathology subtype (26% of the subjects) displayed a mean profile suggestive of serious internalized disturbance, with symptoms of anxiety, depression, and withdrawal. An Externalized Psychopathology subtype (17% of the subjects) exhibited considerable behavioral
disturbance with symptoms suggestive of hyperactivity. The fourth and smallest group, the Somatic subtype (13% of the subjects), showed normal adjustment with the exception of evidencing a variety of somatic complaints. The Porter and Rourke (1985) study supported the contention that the personality characteristics of learning disabled children are heterogeneous, and that there is no unique LD personality subtype. One methodological limitation of this study, however, was that there was no test of statistical reliability.

In the second study of this series, Fuerst, Fisk, & Rourke (1989) focused on establishing this reliability by replicating the Porter and Rourke (1985) study using a new sample of children and different statistical subtyping techniques. Q factor analysis, four hierarchical agglomerative clustering techniques, and one iterative partitioning cluster technique were employed on the scores on nine PIC scales of 132 children between 6 and 12 years old. Three subtypes were derived. There was a Normal subtype, an Internalized subtype, and an Externalized subtype, all similar in size and profile shape and elevation to those reported by Porter and Rourke (1985). A Somatic Concern subtype was not found in this study. The Externalized subtype was also similar to that described by Breen and Barkley (1983) as having Attention Deficit Disorder with Hyperactivity. Taken together, the results of these two Windsor studies suggest that LD children fall into three basic psychosocial subtypes: Normal, Internalized Psychopathology, and Externalized Psychopathology.
In the next study Fuerst, Fisk, & Rourke (1990) applied more sophisticated clustering techniques to a wider range (16) of PIC scales with the same 132 children in the attempt to develop a more fine-grained psychosocial typology. And indeed, six rather than three, subtypes were identified. The Normal, Internalized, and Externalized subtypes were similar to those isolated by Fuerst et al. (1989). There was also a Somatic Concern subtype similar to one uncovered by Porter and Rourke (1985), and two new subgroups: a Mild Anxiety subtype and a Mild Hyperactive subtype. (Additional results from this study pertaining to Hypothesis 3 are discussed in the next section.)

The fourth study of this series (Fuerst & Rourke, 1993) was an attempt to replicate the subtypes derived in the Fuerst et al. (1990) study using the same 16 PIC scales with a larger, more representative sample (500 referred children between the ages of 6 and 12). The result of the cluster solution using the k-means technique was six subtypes, five of which were very similar to those found in the latter study. The sixth subgroup was a Conduct Disorder subtype. The Mild Hyperactive subtype from the latter study was not found in this investigation.

The fifth and final study of this series in the Windsor program (Fuerst & Rourke, in press) examined the relationship between age and socioemotional patterns. The PIC scores of 728 children between the ages of 7 and 13 years who met the usual exclusionary definition of LD were cluster analyzed by two methods. First, the k-means method was applied separately to
each of the young (7-8 years), middle (9-10 years), and old (11-13 years) subsamples, with a similarity measure that emphasized profile shape over elevation and dispersion. The cluster-analysis derived (CAD) subtypes were validated using a number of hierarchical agglomerative techniques. The subtypes were similar to those found in Studies 1 through 4. Normal, Internalized Psychopathology, and Externalized Psychopathology subtypes were identified, at all three age ranges, which suggested that the major patterns of socioemotional functioning as well as levels of psychopathology were consistent across ages 7 through 13 years. There was no evidence of greater maladjustment in the pathological subtypes at older ages. Four subtypes were found in the young sample, six subtypes were identified in the middle sample, and four subtypes were derived in the older sample, showing that there was virtually no greater diversity of subtypes at older ages. As measured by the PIC, psychosocial patterns seemed quite stable in LD children across ages 7 to 13 years.

In Study 5 subjects were also classified on the basis of similarity of PIC profile shape. "Prototypical" PIC profiles were created by calculating the mean PIC scores on all 16 scales for the seven previously derived subtypes from Studies 1 through 4. Then the subjects were assigned ("matched") to the profiles to which they correlated most strongly. When these profile-matching-derived (PMD) subtypes were further analyzed at the young, middle, and old age ranges, their profiles were similar in shape and elevation.
In the overall typology that was generated across Studies 1 through 5, four of the subtypes were consistently replicable with different samples, PIC scales, and clustering techniques. This replication provides support for the reliability and internal validity of these subtypes (Everitt, 1980). Rourke and Fuerst (1991) concluded that the most reliable subtype, identified in all five studies (six samples), is the Externalized Psychopathology subtype, accounting for 15% to 25% of the subjects. The second most consistent subtype in these studies was the Internalized Psychopathology subtype, also found in all five studies (six samples) with a coverage of 20% to 25%. The third most reliable subtype is the Normal subtype, also identified in all six samples, with some variance across studies, accounting for approximately 33% of the subjects. The Somatic Concern subtype, observed in 14% of the subjects across five samples, was the fourth most reliable subtype.

Rourke and Fuerst (1991) also noted that when (finer-grained) cluster analysis was applied more psychosocial subtypes proliferated, with patterns that suggested that some of those that might have been classified as Normal appeared as Mild Hyperactive, Mild Anxiety, or Conduct Disorder. Further research is needed, according to Rourke and Fuerst (1991), to determine the validity of these subtypes, which are very similar to the Normal subtype.
The Windsor Laboratory Studies:
Focus on Rourke and Fuerst's Hypothesis 3

We have introduced the typology that has been generated in the Windsor Laboratory. Now let us focus on the findings of the Windsor studies that relate to Hypothesis 3 (Rourke & Fuerst, 1983), viz., that particular patterns of central processing abilities can eventuate in (1) particular LD subtypes and (2) particular levels and patterns of psychosocial functioning.

In the Fuerst et al. (1990) study, for example, the subjects were selected so that they comprised three (equal-sized) groups: one with VIQ greater than PIQ by at least 10 points, another with the opposite pattern, and a third with VIQ and PIQ scores within 9 points of each other. Cluster analysis yielded six personality subtypes: Normal, Mild Anxiety, Mild Hyperactivity, Somatic Concern, Internalized, and Externalized.

The results showed that within the normal and mildly disturbed subtypes with LD, there was a tendency for the children with the VIQ > PIQ pattern to be represented at lower frequencies than VIQ = PIQ children or VIQ < PIQ children. In the Internalized Psychopathology subtype, on the other hand, VIQ > PIQ children occurred at a higher frequency than expected: 46%, and VIQ < PIQ children were found at a frequency of 39%. In the Externalized Psychopathology subtype, subjects with VIQ > PIQ occurred at a much higher frequency (63%) than did children with VIQ = PIQ or children with VIQ < PIQ. In general, there was a
tendency for children with VIQ = PIQ to be normal or mildly disturbed, whereas children with VIQ > PIQ tended to be the most disturbed, and VIQ < PIQ children exhibited an intermediate level of psychosocial disturbance.

Instead of IQ patterns, the WRAT patterns of learning disabled children were examined in the Fuerst and Rourke (1993) study. As before, six personality subtypes were identified. These were the same subtypes as in the Fuerst et al. (1990) study except that a Conduct Disorder subtype was revealed instead of a Mild Hyperactivity subtype. Whereas the WRAT Arithmetic scores did not discriminate between any of the subgroups, the WRAT Reading and Spelling scores were more informative. Fuerst and Rourke (1993) reported that the Internalized and Externalized Psychopathology subtypes had mean WRAT Reading and Spelling scores that were significantly higher than those of the Somatic Concern and Normal subtypes, and that the Internalized Psychopathology subtypes scored higher in Spelling than did the Somatic Concern subtype.

These findings were reiterated and clarified by the simultaneous consideration of the WRAT Reading, Spelling, and Arithmetic scores in a canonical discriminant analysis. Again WRAT Reading and Spelling were most discriminating. The Normal, Somatic Concern, and Conduct Disorder subtypes were similar on this variable and clearly separated from the Internalized and Externalized Psychopathology groups. The Mild Anxiety subtype fell halfway between these subtypes. Fuerst and Rourke (1993)
also compared the subtypes on discrepancies between WRAT Reading and Arithmetic and between Spelling and Arithmetic. The Internalized Psychopathology group was significantly different from the Somatic Concern subtype on the Reading minus Arithmetic measure and was significantly different from the Normal subtype on the Spelling minus Arithmetic measure.

As summarized by Rourke and Fuerst (1991), the learning disabled children with well developed reading recognition and spelling skills are more likely to be represented among the PIC profiles characterized by severe psychopathology, be it internalizing or externalizing. This finding is also consistent with Strang and Rourke (1985). The LD children with mild somatization or conduct problems seem to be performing the same in reading and spelling as LD children who are well adjusted. Those children with mild anxiety fall somewhere between those two groups.

White, Moffitt, and Silva (1992) arrived at a similar finding in their application of a principal components analysis to the scores of LD children in Dunedin, New Zealand on measures other than the PIC. The subjects were four groups of 13-year-olds: a specific arithmetic disabled group, a specific reading disabled group, a group of generally disabled children, and a nondisabled group. The dependent measures comprised the following: the Revised Behavior Problem Checklist (RBPC; Quay & Peterson, 1983), Rutter's B Scale (Rutter, Tizard, & Whitmore, 1970), the Rosenberg Self-Esteem Scale (Rosenberg, 1965), the
Inventory of Parent and Peer Attachment (Greenberg, Siegel, & Leitch, 1983), and the Child Version of the Diagnostic Interview Schedule for Children (Costello, Edelbrock, Kalas, Kessler, Klaric, 1982).

White, Moffitt, and Silva (1992) found that with the exception of anxiety, the specific arithmetic disabled group showed a higher proportion of children with internalized problems across all of their scales when compared to the specific reading disabled group.

As in Strang and Rourke (1985) and Fuerst and Rourke (1993), it was revealed that children with the Group A pattern of academic performance are more likely to demonstrate evidence of a particular type of psychopathology (internalized more so than externalized). This particular subtype exemplifies a clear relationship between academic patterns and psychosocial patterns in learning disabled children.

Some General Conclusions

Research investigating the relationship between socioemotional difficulties and learning disabilities has demonstrated evidence to suggest that more than one third of the children with LD are similar to their non-LD peers, in that they do not exhibit problems in psychosocial functioning (e.g., Fuerst, Fisk, & Rourke, 1989, 1990; Fuerst & Rourke, 1991, 1993;

Among the studies surveyed, it has also been shown that there is a subgroup of LD children who appear to experience socioemotional difficulties of the internalized variety. These children have been variously characterized as withdrawn and introverted (Mckinney & Speece, 1986), anxious (Paraskevopoulos & McCarthy, 1970), and socially isolated, anxious and depressed (Fuerst, Fisk, & Rourke, 1989, 1990; Fuerst & Rourke, 1991, 1993; Porter & Rourke, 1985).

A third LD subgroup consistently observed in the literature has been described as exhibiting behavioral problems, including attential difficulties, aggression and antisocial tendencies (Fuerst, Fisk, & Rourke, 1989, 1990; Fuerst & Rourke, 1991, 1993; Grieger & Richards, 1976; Mckinney & Speece, 1986; Paraskevopoulos & McCarthy, 1970; Porter & Rourke, 1985). This subgroup demonstrates externalized socioemotional difficulties. Some of these children are hyperactive, and their difficulty in concentrating, their impulsivity and lack of self-control may create numerous behavior problems, particularly at school (Henker & Whalen, 1989). Some of these children display a lack of control that becomes manifest as conduct disorders characterized as disobedience, destructiveness, and other antisocial behavior (Rutter & Giller, 1984).

Thus, although it appears that more than one third of the learning disabled children that have been studied do not
experience serious socioemotional problems, as measured by the PIC (Fuerst, Fisk, & Rourke, 1989; Porter & Rourke, 1985; Rourke & Fuerst, 1993), two broad categories seem to encompass the majority of the difficulties of those LD children who do: internalized and externalized disorders. Of all the psychosocial subtypes that have been identified, these two groups appear to be the most reliable and relevant, and have been selected as the focus for the proposed study.

Summary and Statement of the Problem

Our review of the literature has concentrated on two basic groups of studies that were each associated with a different hypothesis regarding the relationship between learning disabilities and psychosocial functioning. One was the hypothesis that learning disabilities cause socioemotional disturbance. It was concluded that the results of the studies related to this hypothesis have not contributed substantially to understanding the nature of this relationship, not only because of the lack of a conceptual model, but also because of a lack of appreciation for the likelihood that subtypes of children with learning disabilities may not all exhibit the same degree or pattern of abilities or deficiencies with respect to cognitive or psychosocial domains. Just as there is no unified pattern of learning disability, there is no one form of psychosocial disturbance exhibited by these children.
The second group of studies reviewed were associated with the hypothesis that specific central processing patterns cause specific subtypes of learning problems and specific levels and forms of psychosocial disturbance. The componential analysis of social competence, as formulated and tested by Ozols and Rourke (1985), easily illustrated the possibility that some subgroups of LD children may experience sociocemotional difficulties because of deficiencies in particular perceptual, cognitive or behavioral skills. Investigations such as Ozols and Rourke (1985) and Loveland, Fletcher, and Bailey (1990) assisted us in the realization that a conceptualization and methodology that account for the heterogeneity of children with LD -- both neuropsychologically and psychosocially -- offer the opportunity for substantial and meaningful insights in this realm. A methodology that employs the subtyping concept is one that is inherently more useful than the contrasting-groups/unitary-deficit approach in this context.

Accordingly, a primary purpose of the present investigation concerns an extension of the ongoing research in the Windsor Laboratory in the exploration of hypotheses associated with the second postulation (originally posited by Rourke [1987] and later designated as Hypothesis 3 [Rourke & Fuerst, 1983]), i.e., that specific patterns of central processing abilities and deficits cause specific subtypes of learning disabilities and specific forms of psychopathology, in addition to specific levels of psychopathology.
Support for this hypothesis has been cogently argued by Rourke and Fuerst (1991). They begin with the consideration of the finding (Fuerst & Rourke, 1993; Strang & Rourke, 1985) that Group A subtype, exhibiting a particular form of learning disability (nonverbal), tends to be associated with a particular form of psychopathology (internalized). (Whereas Group A children demonstrate clinically significant levels of psychopathology generally, across internalized and externalized forms, they show a propensity toward internalized problems.) This subtype also tends to show particular patterns of academic performance (large discrepancies between reading and arithmetic, and between spelling and arithmetic, in favor of reading and spelling, as measured by the WRAT). Furthermore, higher levels of internalized psychopathology in these children are associated with higher levels of Reading and Spelling.

Rourke and Fuerst (1991) assert that it is difficult to argue that patterns of academic performance influence socioemotional functioning in a specific fashion. They note that it is similarly difficult to maintain that specific patterns of psychosocial functioning generate specific patterns of scholastic achievement, the exception being the case of primary emotional disturbance, which lies outside the scope of LD. The logical choice of intervening variable, then, is cognitive functioning. Group A children demonstrate outstanding deficiencies in visual-spatial-organizational, tactile-perceptual, psychomotor, and nonverbal problem solving abilities, in the context of
outstanding strengths in rote verbal and psycholinguistic skills. This particular configuration of cognitive-neuropsychological functioning seems to lead to significant difficulties with mechanical arithmetic in the context of well-developed word recognition and spelling, as well a tendency for internalized psychosocial problems.

The logical proposition (Rourke & Fuerst, 1993), then, is that patterns of cognitive-neuropsychological functioning influence both academic and psychosocial functioning. With this theoretical position as a basis for the present investigation, two of the most reliable psychosocial subgroups observed in the learning disabilities literature have been selected as its focus: those presenting with Internalized Psychopathology, and those presenting with Externalized Psychopathology, as measured by the Personality Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977).

Neuropsychological subtypes of these two representative groups of LD children will be derived through separate cluster analyses. The basic justification for the a priori selection of the Internalized vs. Externalized groups for investigation concerns their reliability and clinical relevance. Another reason for their juxtaposition concerns the fairly oppositional contrast of their psychosocial patterns, with a presentation at a high clinical level of severity — a methodological design that may systematically illuminate potential relationships with neuropsychological-cognitive patterns. A number of studies have
selected learning disabled children on the basis of their neuropsychological or achievement patterns and then examined the psychosocial functioning of these neuropsychologically-based or achievement-based subtypes. Few studies, however, have used the reverse methodological approach. We have reviewed much evidence suggesting that internalized and externalized socioemotional problems are prevalent and reliable. Thus, if we select learning disabled children on this basis, we may determine the potential neurocognitive underpinnings of such psychosocial problems.

Thus, the primary concern in this investigation is whether reliable neuropsychological subtypes, derived through cluster analysis, can be identified for each of these Internalized and Externalized Psychopathology groups of LD children -- children who were originally selected on the basis of their learning difficulties (and lack of primary emotional disturbance, sensory handicap, educational or cultural deprivation). That is, learning difficulties was the presenting problem. The lack of primary emotional disturbance implies that there is no previous history of psychopathology and no indication of family psychopathology. In the case of learning disabilities so exclusively defined, the appearance of any subtypes exhibiting specific neuropsychological patterns associated with specific levels and forms of socioemotional disturbance would imply some contribution of those processing patterns toward the generation of their particular psychosocial problems.
Whereas the nature of this investigation is somewhat exploratory, the results of particular studies, in and outside the Windsor Laboratory, have been instrumental in generating hypotheses. Some fundamental expectations for the present study were formulated on the basis of the observation by Fuerst, Fisk, and Rourke (1990): that of higher than expected frequencies of WISC VIQ > PIQ discrepancies among both Internalized and Externalized Psychopathology groups of children with LD, relative to the sizes of the subtypes in that study. Another finding relevant for hypothesis formulation was that of Fuerst and Rourke (1993): the observation that both Internalized and Externalized Psychopathology LD groups of children achieved mean WRAT Reading scores that were significantly higher than those of the Somatic Concern and Normal psychosocial subtypes. These findings from the Windsor Laboratory provide the expectation that we will see subtypes exhibiting WRAT Reading (R) > Arithmetic (A) performance and WISC VIQ > PIQ among both psychosocial groups. In addition, that Fuerst and Rourke (1993) found the largest mean R - A values in the Internalized Psychopathology group provides a basis for a similar expectation in the present study, along with the suggestion that patterns of cognitive assets and deficits may be associated with a type of psychopathology, in addition to level of psychopathology in some children referred for neuropsychological assessment.

The expectation that we will see a subtype presenting a somewhat opposite pattern, a WISC PIQ > VIQ discrepancy among the
Externalized Psychopathology group in this investigation, was guided by the results of a study by Williams, Gridley, and Fitzhugh-Bell (1992). When a cluster analysis was conducted on the neuropsychological, academic and behavioral performances of a mixed LD and BD group of children, one of the four subgroups identified was distinguished by externalized behavioral disturbance (as measured by the Conners Behavioral Rating Scale), a mean WISC PIQ 4.5 points higher than the mean VIQ, and evenly deficient performance across WRAT Reading, Spelling, and Arithmetic subtests. Indeed, clinical experience suggests that some children with reading or language deficiencies (with or without concurrent deficiencies in arithmetic) exhibit socioemotional problems (e.g., Rourke, Fisk, & Strang, 1986).

The finding that children with outstanding nonverbal disabilities have a tendency to display internalized psychosocial problems, at the very least, raises the question that some children with verbal disabilities might have a tendency to exhibit externalized psychosocial problems. Studies by Berger, Yule, and Rutter (1975) and by McGee, Share, Anderson, and Silva (1986) produced evidence suggesting that teacher-rated externalized behavior problems were more prevalent among children with reading problems in comparison to nondisabled children. In contrast to those who exhibit outstanding nonverbal learning disabilities, however, the relationship between their pattern of outstanding psycholinguistic deficiencies does not appear to constitute a
sufficient condition for the development of psychosocial problems as does the NLD pattern (Rourke & Fuerst, 1993).

Crucial expectations for this study were guided by the observation that the psychosocial profile for Strang and Rourke's (1985) Group A children (those exhibiting nonverbal learning disabilities, or NLD) was similar to that manifested by the Internalized Psychopathology group identified by Porter and Rourke (1985) and Fuerst, Fisk, and Rourke (1989). Case studies (Rourke, 1989; Rourke, Bakker, Fisk, & Strang, 1983; Rourke, Fisk, & Strang, 1986) have been consistent with this observation. Also, a recent study by White, Moffitt, and Silva (1992), using personality measures other than the PIC (viz., the Revised Behavior Problem Checklist [RBPC; Quay & Peterson, 1983], Rutter's B Scale [Rutter, Tizard, & Whitmore, 1970], the Rosenberg Self-Esteem Scale [Rosenberg, 1969], The Inventory of Parent and Peer Attachment [Greenberg, Siegel, & Leitch, 1983], and the Diagnostic Interview Schedule for Children - Child Version [Costello, Edelbrock, Kalas, Kessler, & Klaric, 1982]) has provided some external validation for the association of internalized socioemotional problems with children who exhibit specific arithmetic disability. Taken together, these findings suggest that there will be an NLD subtype among the Internalized Psychopathology group in this study, and that a higher proportion of these children will be represented among the Internalized group as compared to the Externalized group.
Rourke's (1982, 1987, 1988b, 1989) NLD Model has provided an explication of the social and emotional concomitants of the NLD child's learning disability. First, in accordance with Rourke's Model, the NLD child's deficits in social competence appear to result, in great part, from basic difficulties in reasoning and novel problem solving as well as deficits in integrating information from a variety of sources. The difficulties in multimodal processing, as well as those in visual-spatial organization, are also reflected in problems recognizing cause-effect relationships during social intercourse, identifying expressions of emotion and "body language," and in the failure to appreciate the subtleties of personal space, tone of voice, and other nonverbal aspects of communication. In addition to their inappropriate judgments regarding nonverbal cues, smooth expressions of affection are hampered by tactile insensitivity and psychomotor clumsiness, rendering close relationships difficult. In social situations, a high volume of aprosodic, stereotypic verbal output, without the appropriate "give and take," tends to encourage negative feedback and alienation from others. Over years, this interaction between the NLD child's nonverbal deficiencies and the negative responses of peers and other individuals significant in their lives would appear to contribute to the social withdrawal that we see in these children and adolescents. The social withdrawal and social isolation, in turn, encourage the likelihood of depression and anxiety (Rourke, 1982, 1987, 1988b, 1989; Rourke, Young, & Leenaars, 1989).
Here let us pose an extension of this explanation. consistent with the cognitive model of depression. (Beck, 1976; Beck, 1987; Beck, Rush, Shaw, & Emery, 1979; Clark & Beck, 1990) that might also help to explain the NLD child or adolescent's particular penchant toward the internalized variety of psychosocial problems. In line with this model, a person's internal thoughts play a significant role in the development of emotional problems. Thoughts verbalized to oneself often precede an external event and a particular emotional response. Continual thoughts of a negative nature encourage persistent unpleasant emotions and may lead to depression.

Recall that in the case of the NLD child, the lack of social skills over time tends to lead to social ostracism and the negative feelings that accompany the ostracization. The routinized, unimodal processing style of the NLD child would be expected to further, in repetitive fashion, a rehearsal of this negative ideation with less attention to environmental inputs. In other words, the stereotypic application of language and overreliance on language that we see in these youngsters when they attempt to cope with anxiety, especially in the context of the social ostracism and isolation, would likely foster the rumination of negative thoughts verbalized to themselves. Such a pattern of processing information would be expected to encourage a habitual "grinding out" of internal dialogue. If negative self-talk is fuel for depression, as the cognitive model of depression would predict (Beck, Rush, Shaw, & Emery, 1979), then
the NLD child's unimodal verbal style would unfortunately accommodate this pattern all too well. This unimodal pattern of negative "self-talk" would exacerbate the tendency toward an enclosed circle of depression, continued social withdrawal, and increased depression -- as would be consistent with Beck's model (Beck, Rush, Shaw, & Emery, 1979).

Conversely, complementary logical criteria, compatible with findings by Williams et al. (1992) and Meichenbaum's model of self-control (Meichenbaum, 1977; Meichenbaum, 1992; Meichenbaum, Butler, Grunson, 1981; Meichenbaum & Goodman, 1971), are posited as a possible basis for the expectation that at least some children with outstanding psycholinguistic deficiencies will exhibit externalized psychosocial disturbance. First of all, it is expected that their intact reasoning and problem solving abilities would be available to help them generate or seek out useful coping strategies. Thus, in agreement with Rourke and Fuerst (1991), the central processing pattern of these children (i.e., psycholinguistic deficits in the context of age-appropriate abilities in visual-perceptual-organization, psychomotor coordination, tactile perception, concept formation and novel problem solving) would not entail a sufficient condition for socioemotional disturbance.

If, however, psychosocial problems develop, with the influence of contributing factors (e.g., unrealistic expectations, decreased peer affiliation, motivational, attributional, self-concept or self-esteem issues) it is
reasonable to expect that with their relatively contrasting information processing style, the psychosocial problems of these children would tend to contrast with those of the NLD child, as well: viz., as an externalized, rather than internalized form. In the NLD child we see a neuropsychological-cognitive processing pattern that, in a pervasive sense, involves an example of verbal mediation rigidly applied. In the child with linguistic deficiencies, verbal mediation, as at least one means of self-control (Meichenbaum, Butler, & Grunson, 1981), is deficient. The relative difficulty that linguistically deficient children have in verbalizing problems to themselves and to others, in the context of well developed psychomotor skills, would appear to engender frustration and anger that would more readily lead to acting out in terms of hyperactivity and behavior problems, rather than negative self-talk, social withdrawal, and depression.

In summary, the following expectations were generated through extensions of the aforementioned findings in the context of Rourke's (1982, 1987, 1988b, 1989) NLD Model and the proposition (Rourke & Fuerst, 1993) that patterns of neuropsychological-cognitive processing influence both academic and psychosocial functioning.

**Hypotheses**

Hypothesis 1. It is hypothesized that the Internalized Psychopathology group is a heterogeneous group, and that when
cluster analysis is applied to their neuropsychological performances, reliable subtypes will emerge.

Hypothesis 2. It is expected that the Externalized Psychopathology group is a heterogeneous group, and that when cluster analysis is applied to their neuropsychological performances, reliable subtypes will emerge.

Hypothesis 3a. There will be a neuropsychological subtype displaying a mean WISC VIQ > PIQ discrepancy represented among the Internalized Psychopathology group. It is also expected that a statistically significant proportion of its members will exhibit a WISC VIQ > PIQ discrepancy of at least 5 standard score points.

Hypothesis 3b. It is expected that a subtype will emerge from the Internalized Psychopathology group displaying a mean WRAT Reading > Arithmetic subtest discrepancy (i.e., that this subtype will be an Arithmetic Disability subtype). Further, it is expected that a statistically significant proportion of its members will exhibit a WRAT Reading > Arithmetic discrepancy of at least 5 standard score points.

Hypothesis 3c. It is anticipated that the subtypes described in 3a and 3b will be the same subtype, i.e., it is expected that a subtype will emerge from the IP group that
demonstrates a mean WISC VIQ > PIQ discrepancy along with a WRAT Reading > Arithmetic discrepancy.

Hypothesis 4a. A neuropsychological subtype displaying a mean WISC VIQ > PIQ discrepancy will be found among the Externalized Psychopathology group. A statistically significant proportion of its members are expected to exhibit a WISC VIQ > PIQ discrepancy of at least 5 standard score points.

Hypothesis 4b. It is also expected that a subtype emerging from the Externalized Psychopathology group will display a mean WRAT Reading > Arithmetic subtest discrepancy. Further, a statistically significant proportion of its members are expected to exhibit a WRAT Reading > Arithmetic discrepancy of at least 5 standard score points.

Hypothesis 4c. It is anticipated that the subtypes described in 4a and 4b will be the same subtype, i.e., it is expected that a subtype will emerge from the EP group that demonstrates a mean WISC VIQ > PIQ discrepancy along with a WRAT Reading > Arithmetic discrepancy.

Hypothesis 5a. There will be a neuropsychological subtype exhibiting a mean WISC PIQ > VIQ discrepancy represented among the Externalized Psychopathology group. It is also expected that a statistically significant proportion of its members will
exhibit a WISC PIQ > VIQ discrepancy of at least 5 standard score points.

Hypothesis 5b. If the neuropsychological subtype described in Hypothesis 5a emerges in the Externalized Psychopathology group, then it is expected to exhibit outstanding psycholinguistic deficiencies. That is, it is expected that the members of this subtype will demonstrate impaired performance in Language 2 abilities, as designated in Table 3. Further, they are also expected to show average or near-average performance in Simple Motor, Complex Motor, Visual-Spatial 1, Visual-Spatial 2 abilities, as designated in Table 3.

Hypothesis 6. A higher proportion of children with R > A discrepancies of 5 standard score points or greater will be found among the Internalized Psychopathology group as compared to those of the Externalized Psychopathology group.

Hypothesis 7a. Children who exhibit the Group A (nonverbal learning disabilities, or NLD) pattern of neuropsychological assets and deficits will be found among both Internalized and Externalized Psychopathology groups.

Hypothesis 7b. A significantly higher proportion of NLD children will be represented among the IP group than among the EP group.
Subjects

The 338 subjects examined in this study were selected from a clinical database of over 5200 children who were referred for neuropsychological assessment because of suspected learning difficulties. The subjects were selected a priori (using Fuerst’s [1991] profile matching program) to comprise two groups based on profiles on the Personality Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977). The Internalized Psychopathology group consisted of 174 subjects and there were 164 subjects in the Externalized Psychopathology group. They met the following criteria: (1) chronological age between 7 and 14 years inclusive, (2) at least one IQ score of 80 or above (i.e., FSIQ, PIQ, and/or VIQ) on the Wechsler Intelligence Scale for Children (WISC; Wechsler, 1949), (3) centile score of 35 or below on at least one subtest of the Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965), no primary sensory deficit (i.e., no greater than 25 decibel hearing loss with either ear for the frequency range of 500 to 4000 Hz), (4) English as a primary language, (5) no evidence of educational or cultural deprivation, (6) no primary emotional disturbance, (7) complete PIC profiles, (8) complete neuropsychological profiles, and (9) complete WRAT Reading, Spelling, and Arithmetic scores. Detailed information
regarding the socioeconomic status of the selected children was not available, although the subjects were generally drawn from a homogeneous lower to middle class urban/suburban area.

Tables 1 and 2 contain descriptive statistics for the sample before and after outlier deletion, respectively.

Table 1

**Characteristics of the Initial Sample: Mean Age, Mean Scores on WISC Full Scale IQ (FSIQ), Verbal IQ (VIQ), Performance IQ (PIQ), and Mean WRAT Reading (RSS), Spelling (SSS), and Arithmetic (ASS) Standard Scores**

Internalized Psychopathology Group \( (n = 174) \)

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<td>ASS</td>
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Externalized Psychopathology Group \( (n = 164) \)

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Table 2

Characteristics of the Sample After Outlier Deletion: Mean Age, Mean Scores on WISC Full Scale IQ (FSIQ), Verbal IQ (VIQ), Performance IQ (PIQ), and Mean WRAT Reading (RSS), Spelling (SSS), and Arithmetic (ASS) Standard Scores

<table>
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<tr>
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Measures

The Personality Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977), a rationally and empirically constructed measure of psychosocial functioning, designed for children and adolescents between the ages of 6 and 16 years, was administered to each subject’s primary caretaker, usually the biological mother. It consists of 600 true-false items that are completed by the respondent based on the observation of the child’s behavior, attitudes and family relationship. There are 33 scales, 15 supplementary scales and 16 which are typically used: 3 validity scales (Lie, F, and Defensiveness), 1 screening scale of psychological adjustment (Adjustment), and 12 clinical scales that describe a variety of dimensions in children (Achievement, Intellectual Screening, Development, Somatic Concern, Depression, Family Relations, Delinquency, Withdrawal, Anxiety, Psychosis, Hyperactivity, and Social Skills [refer to Appendix A for a more detailed description of these scales]). A child’s profile may be expressed in standard T-scores, with positive elevations above the mean suggesting the greater likelihood of pathology.

The subjects were also administered a comprehensive battery of neuropsychological tests by highly trained psychometric technicians in a standardized fashion. The assessment comprised neuropsychological measures that had been chosen so as to reflect a broad range of abilities in which learning disabled children
have been shown to be deficient. This selection of measures conforms with Rourke and Adams' (1984) criteria for the essential aspects of a neuropsychological test battery, viz., adequate reliability (Brown, Rourke, & Cicchetti, 1989), validity, and coverage, and includes measures delineated by Reitan (1974) as representative of adaptive skill areas. Thirteen of these measures were selected for the present study. Table 3 provides a list of these measures (see Appendix B for a more detailed description). Additional variables that were analyzed in this investigation comprise WISC FSIQ, VIQ, and PIQ scores.

Procedures

A profile matching program designed by Fuerst (1991) for the PIC was employed, which assigned 174 subjects to a group demonstrating internalized psychosocial problems, and 164 subjects to a group demonstrating externalized psychosocial difficulties. This involved the calculation of correlations between each subject's PIC profile and two prototypical PIC profiles -- Internalized Psychopathology (IP) and Externalized Psychopathology (EP) -- and the assignment (matching) of the subtypes to one of these prototypes, or elimination from further analysis. Subjects showing no positive correlations or only weak correlations (i.e., < .40) with the prototypical profiles were dropped from subsequent analyses.
Table 3

List of Variables According to Categories

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Finger Tapping Test [FTT]</td>
<td>SIMPLE MOTOR</td>
</tr>
<tr>
<td>2. Dynamometer [DYN]</td>
<td></td>
</tr>
<tr>
<td>3. Maze Test - Contact Time [MAZES]</td>
<td>COMPLEX MOTOR</td>
</tr>
<tr>
<td>4. Target Test [TARGET]</td>
<td>VISUAL-SPATIAL 1</td>
</tr>
<tr>
<td>5. WISC Object Assembly subtest [OBJASS]</td>
<td>VISUAL-SPATIAL 2</td>
</tr>
<tr>
<td>6. WISC Block Design subtest [BLKDES]</td>
<td></td>
</tr>
<tr>
<td>7. WISC Vocabulary subtest [VOCAB]</td>
<td>LANGUAGE 1</td>
</tr>
<tr>
<td>8. WISC Comprehension subtest [COMP]</td>
<td></td>
</tr>
<tr>
<td>10. Sentence Memory Test [SENMEM]</td>
<td></td>
</tr>
<tr>
<td>11. WRAT Reading subtest [READ]</td>
<td>ACADEMIC 1</td>
</tr>
<tr>
<td>12. WRAT Spelling subtest [SPELL]</td>
<td></td>
</tr>
<tr>
<td>13. WRAT Arithmetic subtest [ARITH]</td>
<td>ACADEMIC 2</td>
</tr>
</tbody>
</table>
The neuropsychological measures were categorized, using a rational sorting procedure, into 8 domains: (1) SIMPLE MOTOR, (2) COMPLEX MOTOR, (3) VISUAL-SPATIAL 1, (4) VISUAL-SPATIAL 2, (5) LANGUAGE 1, (6) LANGUAGE 2, (7) ACADEMIC 1, and (8) ACADEMIC 2. The selection of tests and their designated categories were determined on the basis of considerations outlined by Fisk and Rourke (1979) and findings related to discriminant validity and factor models (Davidson, 1992; Francis, Fletcher, & Rourke, 1988; Francis, Fletcher, Rourke, & York, 1992; Hamilton, 1994; Harnadek & Rourke, 1993). The variables in each domain were chosen to reflect the highest possible correlations with one another and the lowest possible correlations with variables in the other domains (as suggested by Lawlis and Chatfield, 1974), and similar numbers of variables were included in each domain. The variables as a group were selected so as to reduce redundancy and increase discriminant validity, clinical meaningfulness, and interpretation.

Standardization of most of the neuropsychological measures was achieved by converting them into I-scores ($M = 50, SD = 10$) based on normative data (Knights & Norwood, 1980). WISC and WRAT subtest scores was standardized on the basis of their own respective normative data. Right- and left-hand I-scores for each of the motor and tactile measures were averaged to yield a composite score, since there has been little support for the discriminant validity of right-hand versus left-hand performance.
in children with learning disabilities (Francis, Fletcher, & Rourke, 1988).

The I scores were calculated such that high scores reflected good performance, and low scores, poor performance. The PIC scores are the exception to this rule, in which profile elevations (i.e., high scores) represents poor psychosocial adjustment and vice versa.

Detection and Deletion of Outliers

Before conducting any further analyses a procedure was be employed to identify and eliminate outliers from the data, since all of the cluster techniques that were used in this study are sensitive to outliers. This procedure entails a three-step process similar to the one applied in Fuerst (1991). A similarity measure was selected to be used in the first step of this process. Of the two most commonly used types of similarity measures, the correlation coefficient emphasizes profile shape, whereas distance emphasizes elevation. Since pattern of performance was our primary concern, correlation would have been the optimal choice (Aldenderfer & Blashfield, 1984); however, SAS software (Version 5.18) was selected to implement the cluster algorithms (Fuerst & Rourke, 1993), which limits similarity measures to Euclidean distance. Therefore, a transformation was performed by standardizing each subject's scores on the neuropsychological and academic measures in such a way that the elements of profile elevation and dispersion were eliminated from
the data (Fuerst, 1991; Fuerst, Fisk, and Rourke, 1989). The
transformation used the equation \( z = \frac{(X - M)}{SD} \), where \( X \) is the
subject's raw score, \( M \) and \( SD \) are the mean and standard
deviation, respectively, of that subject's neuropsychological
profile, and \( z \) is the resulting standard score (Fuerst, Fisk, &
Rourke, 1989; Lorr, 1983).

Next, the Euclidean distance between each subject and all
the other subjects was calculated. As each distance was
calculated, it was compared to a pre-selected constant (or
radius). A running frequency count of all distances less than or
equal to this constant was made for each subject. Finally, a
certain percentage of the subjects with the lowest frequency
counts was detected. The exact percentage of the subjects was
contingent upon the performance of the hierarchical agglomerative
clustering techniques used in the attempts at replication.

Fuerst (1991) has provided a rationale for this method of
outlier detection, as follows. With the transformation discussed
above, Euclidean distance acts as a measure of similarity of
profile shape, with larger values indicating less similarity.
The number of subjects which fall within a hypersphere of a given
radius centered on a case provides a measure of the density of
subjects in the space around that case. Since the radius is
constant for all cases, the frequency is proportionate to the
density by a multiplicative constant (in this case, the inverse
of the volume of the hypersphere). Cases found in higher density
regions of the space defined by the variables were used in the
clustering. Cases found in low density regions were relatively dissimilar to other cases in the sample, and these cases were defined as outliers. Fuerst (1991) suggested that this method of outlier detection works best in comparison to other approaches in the case of the presence of clusters that are not so compact, or in the case where outliers are distanced from compact clusters but close to the centroid of the whole sample.

**Cluster Analyses**

In order to test Hypotheses 1 and 2, separate cluster analyses were conducted on the neuropsychological and academic performance of the Internalized Psychopathology group (IP) and the Externalized Psychopathology (EP) group.

Most investigators would agree that there is no one best clustering method for all situations. Everitt (1980) suggested the application of several techniques in order to identify reliable and valid solutions. The iterative partitioning method, or k-means analysis (MacQueen, 1967), was selected as the initial clustering technique. This nonhierarchical technique has demonstrated good performance with large data sets (Fuerst, 1991). The SAS Version 5.18 implementation of the k-means technique (PROCedure FASTCLUS) was used (Sarle, 1985).

In the k-means method the variance within each cluster is implicitly minimized by a reassignment process. This method begins with the partition of observations into a specified number of clusters. A given subject is reassigned by moving her or him
to the cluster whose centroid is closest to that subject.
Reassignment continues until every subject is assigned in this
way to the cluster with the nearest centroid (Hair, Anderson, &
Tatham. 1987).

**Determination of the Number of Clusters**

The number of clusters present in the data was determined by
the internal reliability of the solution (see below) and by the
clinical interpretability of the resulting neuropsychological
profiles at various partition levels (from 2 to 10 clusters), as
described in Fuerst and Rourke (in press). None of the
quantitative data suggested for determining the true number of
clusters has proved effective across all techniques and samples
(e.g., Everitt. 1980). Previous experience with data similar to
that of this study (Fuerst, 1991; Fuerst, Fisk, & Rourke. 1989.
1990; Fuerst & Rourke. 1993; Fuerst & Rourke, in press) has
strongly suggested that replicability (reliability) and clinical
interpretability are generally superior to quantitative methods
for this purpose.

**Subtype Replication by Hierarchical Cluster Analysis**

To assess the internal validity (reliability) of the k-means
derived subtypes, five additional clustering techniques were
applied to the same subjects and neuropsychological measures used
in the k-means analysis. Reliability is a concern when using
multivariate subtyping techniques in exploratory investigations.
Cluster analysis can produce clusters of random data, and different clustering techniques can produce incompatible solutions with the same data (Fletcher, 1985). Thus, the following hierarchical agglomerative clustering methods were used to assess reliability: the average linkage method (Cunningham & Ogilvie, 1972), McQuitty's similarity analysis (McQuitty, 1966; Sokal & Michener, 1958), the complete linkage method (Johnson, 1967; Lance & Williams, 1967), Ward's minimum-variance method (Milligan, 1980; Ward, 1963), and the equal variance-maximum likelihood method (EML; Sarle, 1985) -- all applied with good results by Fuerst and colleagues (Fuerst, 1991; Fuerst, Fisk, & Rourke, 1989; Fuerst, Fisk, & Rourke, 1990). SAS Version 5.18 was used to implement these algorithms (Fuerst & Rourke, 1993).

In the average linkage method, originated by Sokal and Michener (1958), the distance between two clusters is the average distance between pairs of observations, one in each cluster (Hair, Anderson, & Tatham, 1987). It has a bias toward producing clusters with equal variances. McQuitty's (1966) similarity analysis is a weighted average linkage method. The complete linkage method, developed by Sorensen (1948), is also similar to the average linkage algorithm, except that the clustering criterion is based on the maximum distance (or minimum similarity) rather than the average distance (Hair, Anderson, & Tatham, 1987). Its bias is to produce clusters with equal diameters.
In Ward's method the distance between two clusters is based on the sum of squares between the clusters summed over all the variables. It has a tendency to produce clusters with similar numbers of observations (Hair, Anderson, & Tatham, 1987). The equal variance-maximum likelihood method (EML; Sarle, 1985) is similar to Ward's method but it removes the bias toward equal-sized clusters and has a slight bias toward generating unequal-sized clusters.

One idiosyncracy of the hierarchical agglomerative techniques is that once a subject is assigned to a cluster, that subject remains there. Accordingly, the following procedure as described by Fuest and Rourke (in press) was employed to minimize fusion errors.

First, a k-means solution for a large number of clusters (between 50 and 80) was derived using the SAS FASTCLUS algorithm (Sarle, 1985). Next, these initial clusters were used as input for the five hierarchical clustering techniques. The preliminary results of the hierarchical clustering were examined, and the optimal number was selected. This optimal number (the level at which the hierarchy is "cut") was set at the number of clusters identified in the original k-means analysis.

Finally, a k-means relocation pass was performed using the BMDP (Dixon, 1985) algorithm, with seeds determined by cluster membership at the same hierarchical level that was chosen for the original k-means solution. Thus, the k-means algorithm was used as a reassignment method in which each hierarchical agglomerative
cluster solution was examined to see if any of the cases needed to be reassigned by moving them to the cluster with the nearest centroid. This method was implemented because of its ability to provide good recovery of cluster structure with high levels of coverage (Bayne, Beauchamp, Begovich, & Kane, 1980; Fuerst, 1991; Fuerst, Fisk, & Rourke, 1989; Fuerst, Fisk, & Rourke, 1990; Fuerst & Rourke, 1993; Fuerst & Rourke, in press; Milligan, 1980).

The method employed to evaluate the reliability of the initial k-means solution was replication by at least three of the five hierarchical techniques. The degree to which these hierarchical clustering methods replicated the initial k-means solution was assessed quantitatively, using three different techniques, similar to that employed by Fuerst & Rourke (in press).

The principal technique encompassed three external criteria statistics: Rand's statistic (Rand, 1971), an adjusted Rand statistic described by Morey and Agresti (1984), and another adjusted Rand statistic suggested by Hubert and Arabie (1985). Rand's statistic is a measure of the agreement between two cluster solutions by assessing the extent to which pairs of subjects are clustered together or apart (i.e., the extent to which the pairs of subjects clustered together in one solution are clustered together in the second solution). The adjusted Rand statistics correct for chance agreement between solutions. The "pure" Rand's statistic is difficult to interpret;
theoretically, an adjusted value of 0.0 indicates pure chance agreement, whereas 1.0 indicates complete agreement (Fuerst & Rourke, in press). Empirical investigations have shown that adjusted values above 0.2 indicate better-than-chance agreement (Milligan & Cooper, 1986).

As another means of assessing agreement, the percentage of subjects misclassified by the hierarchical cluster analyses was determined, using the groups derived by the k-means analysis as a reference. This method provides information about the agreement of the solutions that is readily comprehensible.

Third, correlations were calculated between the mean neuropsychological profiles of the k-means-derived subtypes and each of the subtypes of the five hierarchical agglomerative cluster solutions. Whereas visual matching of mean profiles was also employed, the correlation coefficient was considered to be a quantitative measure with more objectivity.

Testing the Remaining Hypotheses

To test Hypotheses 3a and 4a, mean WISC VIQs and PIQs were calculated for the subtypes in the Internalized Psychopathology group (IP) and Externalized Psychopathology (EP) group to see if there were a subtype with a mean VIQ > PIQ discrepancy of at least 5 standard score points among each of these groups. Next, if the latter condition were met, a univariate analysis of variance (ANOVA) was to be performed to determine if the mean VIQ > PIQ discrepancy of at least 5 standard score points were
significantly different from that of the other subtypes. In addition, the number and percentage of individual subjects with VIQ > PIQ discrepancies of 5 points or greater was obtained for each subtype, in order to determine if there were consistency between the subtype mean discrepancies and the individuals' discrepancies.

To test Hypotheses 3b and 4b, mean WRAT Reading - Arithmetic subtest discrepancies were calculated for the subtypes in the Internalized Psychopathology group and the subtypes in the Externalized Psychopathology group to see if a subtype with a mean Reading > Arithmetic discrepancy of at least 5 standard score points were present in each of these groups. If this condition were met, an ANOVA was to be performed to see if the discrepancy were significantly different. Also, the number and percentage of individual subjects with Reading > Arithmetic discrepancies of 5 points or greater was computed for each subtype to see if there were comparability between subtype and individual discrepancies.

Hypothesis 3c was tested by inspecting the subtypes that emerged from the Internalized Psychopathology group to see if one presented with a concurrent mean VIQ > PIQ discrepancy and mean Reading > Arithmetic discrepancy, each of 5 standard score points or greater. Similarly, Hypothesis 4c was examined by inspecting the subtypes emerging from the Externalized Psychopathology group to see if there were a subtype that presented with both a mean
VIQ > PIQ discrepancy and a mean Reading > Arithmetic discrepancy, each of 5 standard score points or greater.

To test Hypothesis 5a, mean WISC VIQs and PIQs were calculated for the subtypes of the Externalized Psychopathology group to determine if there were a subtype with a WISC PIQ > VIQ discrepancy of at least 5 standard score points. If the latter condition were met, an ANOVA was to be performed to see if the discrepancy were significantly different from that of the other subtypes. Also, the number and percentage of subjects with PIQ > VIQ discrepancies of 5 points or greater was computed for each subtype to determine the comparability between subtype- and individual-level discrepancies.

Hypothesis 5b was tested by examining the mean neuropsychological profiles for each of the subtypes from the Externalized Psychopathology group to determine if there were a subtype that had outstanding psycholinguistic deficiencies (i.e., impaired performances on the Auditory Closure Test, Speech Sounds Perception Test, and the Sentence Memory Test, and average or near-average performances on the Finger Tapping Test, Dynamometer, Mazes Test, Target Test, WISC Object Assembly and Block Design subtests).

To test Hypothesis 6, the number and percentage of subjects in each of the Internalized and the Externalized Psychopathology groups who exhibited WRAT Reading > Arithmetic discrepancies of 5 standard points or greater were calculated to determine if the larger proportion of children exhibiting such discrepancies were
to be found in the Internalized group. If this condition were met, a chi-square analysis was to be performed in order to identify a significant difference between the IP and EP groups on the basis of these discrepancies.

To test Hypotheses 7a and 7b, the neuropsychological profiles of the children in the Internalized and Externalized Psychopathology groups were visually inspected to identify NLD children by using the criteria outlined in Casey, Rourke, and Picard (1991). (Refer to Appendix C.) If any NLD children were identified, then the percentage of NLD children within each of the Psychopathology groups was to be calculated and compared to see if there were a higher proportion in the Internalized Psychopathology group. If there were a sufficient number of subjects, a chi-square analysis was to be conducted to determine if any difference observed in the proportions of NLD children for each of the Psychopathology groups were significant.
CHAPTER III
RESULTS

Assessing Replicability

As outlined in the last section, after the subjects were assigned to either the Internalized Psychopathology (IP) or Externalized Psychopathology (EP) groups, outlier detection and deletion was conducted separately for each of these psychosocial groups. Five percent of the subjects in the IP group and 10% in the EP group were deemed to be outliers. Examination of the k-means cluster solutions for each of the IP and EP groups, in which 2 to 10 clusters had been obtained, suggested that 3 subtypes were present in the IP group and that 4 subtypes were present in the EP group. For each of these subtypes, mean I-scores on all 13 neuropsychological and academic variables were calculated and graphed in Figures 1 through 7.

The three k-means-derived neuropsychological subtypes from the IP group were replicated with excellent accuracy by three hierarchical agglomerative techniques: Ward's minimum variance method, the complete linkage method, and the EML technique. The first of three criteria used to evaluate replicability across solutions was Rand's statistic and its modified versions. As shown in Table 4, all versions of Rand's were greater than 0.9 -- evident of excellent cluster recovery.
Figure 1. Subtype 1, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Internalized Psychopathology group.
Figure 2. Subtype 2, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Internalized Psychopathology group.
Figure 3. Subtype 3, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Internalized Psychopathology group.
Figure 4. Subtype 1, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Externalized Psychopathology group.
Figure 5. Subtype 2, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Externalized Psychopathology group.
Figure 6. Subtype 3, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Externalized Psychopathology group.
Figure 7. Subtype 4, derived from the k-means cluster analysis of the neuropsychological and academic performance of the Externalized Psychopathology group.
The replication achieved by the three hierarchical agglomerative techniques for the four k-means-derived subtypes from the EP group (viz., Ward's, average linkage, and EML) was not as striking as that of the subtypes of the IP group (see Table 5). The "pure" Rand statistics were all above 0.7. The adjusted Rand statistics ranging from 0.34 to 0.86 are indicative of better-than-chance agreement, since they were above values of 0.2 (Milligan & Cooper, 1986).

The second criterion employed to assess agreement between solutions was the calculation of the number and percentage of subjects misclassified by the hierarchical agglomerative methods, by using the k-means solution as the standard solution. With respect to the IP group, all three of the hierarchical methods performed similarly, as is shown in Table 6. Ward's minimum variance method generated 1 misclassification (0.6%), the complete linkage method produced 4 misclassifications (2.4%), and the EML technique produced 6 misclassifications (3.6%). The misclassifications were related to Subtypes 1 and 3, as is apparent in Table 6. All three hierarchical methods recovered k-means Subtype 2 with 100% accuracy.

As can be seen in Table 7, with respect to the EP group, the average linkage technique replicated the four k-means subtypes most accurately, with 7 misclassifications (4.7%). Ward's method and the EML method produced 32 (21.6%) and 58 (39.2%) misclassifications, respectively.
Table 4

Rand's Statistic, plus the Morey & Agresti (1984) and Hubert & Arabie (1985) Adjustments to Rand's Statistic for Ward's, Complete Linkage, and EML Solutions Using the K-means Solution as a Reference (Internalized Psychopathology group)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rand</td>
</tr>
<tr>
<td>Ward's</td>
<td>.99</td>
</tr>
<tr>
<td>Complete Linkage</td>
<td>.97</td>
</tr>
<tr>
<td>EML</td>
<td>.96</td>
</tr>
</tbody>
</table>
Table 5

Rand's Statistic, plus the Morey & Agresti (1984) and Hubert & Arabie (1985) Adjustments to Rand's Statistic for Ward's, Average Linkage, and EML Solutions Using the K-means Solution as a Reference (Externalized Psychopathology group)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rand</td>
</tr>
<tr>
<td>Ward's</td>
<td>.78</td>
</tr>
<tr>
<td>Average Linkage</td>
<td>.93</td>
</tr>
<tr>
<td>EML</td>
<td>.72</td>
</tr>
</tbody>
</table>
Table 6

**Number of Subjects from each K-means Subtype Misclassified by Ward's, Complete Linkage, and EML Methods (Internalized Psychopathology group)**

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>K-means Subtype</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>n = 57</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>n = 32</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>n = 76</td>
</tr>
</tbody>
</table>

Ward's

<table>
<thead>
<tr>
<th>Complete Linkage</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EML</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 7

**Number of Subjects from each K-means Subtype Misclassified by Ward's, Average Linkage, and EML Methods (Externalized Psychopathology group)**

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>1 (n = 6)</th>
<th>2 (n = 64)</th>
<th>3 (n = 31)</th>
<th>4 (n = 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward's</td>
<td>0</td>
<td>21</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Average Linkage</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>EML</td>
<td>3</td>
<td>21</td>
<td>13</td>
<td>21</td>
</tr>
</tbody>
</table>
The mean I-score neuropsychological and academic profiles of the subgroups derived from the Ward's, complete linkage, and EML cluster analyses were calculated and depicted in Figures 8 through 10 for the IP group. The profiles derived from the Ward's, average linkage, and EML cluster analyses are displayed in Figures 11 through 14 for the EP group. The correlations between the mean profiles of the k-means subtypes and each of the hierarchical subtypes were also calculated as the third criterion for assessing replication of the subtypes. It is apparent in Table 8 that with respect to the IP group there were very strong relationships between the k-means and hierarchical solutions. All of these subtypes correlated at .99 or greater, implying that the shapes of the profiles of the Ward's, complete linkage, and EML subtypes were virtually identical to their corresponding k-means-derived subtypes.

For the EP group the relationships between the k-means and hierarchical solutions were also quite strong, as is presented in Table 9. Here the correlations ranged from .85 to .99, with the majority of the hierarchical subtypes correlated at .99 or above.

In light of the three criteria used to assess replicability (viz., Rand and adjusted Rand statistics, misclassifications, and intercorrelations), the k-means solution for the IP children demonstrated excellent replicability and that for the EP children demonstrated fair replicability. Hypothesis 1 has received a fair amount of support: the k-means cluster solution for the
Figure 8. K-means Subtype 1 (Internalized Psychopathology group) and its replication by Ward's, complete linkage, and EML solutions.
Figure 9. K-means Subtype 2 (Internalized Psychopathology group) and its replication by Ward’s, complete linkage, and EML solutions.
Figure 10. K-means Subtype 3 (Internalized Psychopathology group) and its replication by Ward's, complete linkage, and EML solutions.
Figure 11. K-means Subtype 1 (Externalized Psychopathology group) and its replication by Ward's, average linkage, and EML solutions.
Figure 12. K-means Subtype 2 (Externalized Psychopathology group) and its replication by Ward’s, average linkage, and EML solutions.
Figure 13. K-means Subtype 3 (Externalized Psychopathology group) and its replication by Ward's, average linkage, and EML solutions.
Figure 14. K-means Subtype 4 (Externalized Psychopathology group) and its replication by Ward’s, average linkage, and EML solutions.
Table 8

Mean Profile Intercorrelations between K-means Subtypes and corresponding Ward's, Complete Linkage, and EML EML Subtypes (Internalized Psychopathology group)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward's</td>
<td>.99</td>
<td>1.00</td>
<td>.99</td>
</tr>
<tr>
<td>Complete Linkage</td>
<td>.99</td>
<td>.99</td>
<td>.99</td>
</tr>
<tr>
<td>EML</td>
<td>.99</td>
<td>.99</td>
<td>.99</td>
</tr>
</tbody>
</table>
Table 9

Mean Profile Intercorrelations between K-means Subtypes and corresponding Ward’s, Average Linkage, and EML Subtypes (Externalized Psychopathology group)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward's</td>
<td>.83</td>
<td>.98</td>
<td>.98</td>
<td>.98</td>
</tr>
<tr>
<td>Average Linkage</td>
<td>.85</td>
<td>.99</td>
<td>.98</td>
<td>.99</td>
</tr>
<tr>
<td>EML</td>
<td>.90</td>
<td>.99</td>
<td>.98</td>
<td>.99</td>
</tr>
</tbody>
</table>
Internalized (IP) group has replicated well across three of the five hierarchical methods. Given the misclassifications of the EP subtypes, and the small N (6) of Subtype 1 and its questionable reliability, Hypothesis 2 is modestly supported, and the internal validity of the EP subtypes equivocal. Guardedly, we proceed with the description of the nature of the IP and EP subtypes.

Cluster Interpretation

The I-score means for the neuropsychological performance of the k-means-derived subtypes are presented in Tables 10 and 11. In order to facilitate interpretation, these I-score means for the three k-means-derived subtypes from the IP group (Figures 1 to 3) and for the four k-means-derived subtypes from the EP group (Figures 4 to 7) were plotted and visually inspected.

The Internalized Psychopathology Group

Subtype 1 was the second largest subgroup to have emerged from the IP group, containing 57 subjects -- 34.5% of this subsample. This subtype was composed of 49 boys (86.0%) and 8 girls (14.0%) and evidenced a mean age of 10.5 years. These children were characterized by above average kinetic steadiness, and average simple motor speed, motor strength, visual-spatial-organizational abilities, and expressive vocabulary. They demonstrated low average verbal comprehension, short-term visual memory, sound-symbol matching, and word reading. Their abilities
in sound-symbol matching, sentence memory, spelling, and mechanical arithmetic were mildly impaired.

There were 32 children comprising Subtype 2 -- 19.4% of the IP subsample. This subtype contained the fewest number of children overall, including 27 boys (84.4%) and 5 girls (15.6%). They evidenced the oldest mean age (viz., 10.7 years). These children exhibited above average performance in simple motor speed, and average performance in motor strength, kinetic steadiness, visual-spatial-organizational skills, and expressive vocabulary. Short-term visual memory, verbal comprehension, word reading, and mechanical arithmetic were low average. Sentence memory, sound-symbol matching, and spelling were mildly impaired.

Subtype 3 contained the largest number of subjects: comprising 76 children and 46.1% of the IP group. Subtype 3 also contained the largest proportion of boys: 67 boys (88.2%) and 9 girls (11.8%). The mean age of these children was the same as that of Subtype 1: 10.5 years. Their simple motor speed, motor strength, kinetic steadiness, visual-spatial-organizational skills, and vocabulary were in the average range. Short-term visual memory, verbal comprehension, and word reading were in the low average range. Their sentence memory, sound-symbol matching, spelling, and mechanical arithmetic were mildly impaired.

As shown in Table 12, all three of these subtypes from the IP group demonstrated mean IQ discrepancies in the opposite direction from that which was expected: Their Performance IQs were higher than their Verbal IQs. These PIQ > VIQ discrepancies
Table 10

T-Score Means (Standard Deviations) from the Neuropsychological and Academic Measures for each K-means Subtype (Internalized Psychopathology group)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subtype 1 (n=57)</th>
<th>Subtype 2 (n=32)</th>
<th>Subtype 3 (n=76)</th>
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<tbody>
<tr>
<td></td>
<td>T-Score (SD)</td>
<td>T-Score (SD)</td>
<td>T-Score (SD)</td>
</tr>
<tr>
<td>FTT</td>
<td>53.5 (11.9)</td>
<td>55.1 (11.7)</td>
<td>53.5 (11.8)</td>
</tr>
<tr>
<td>DYN</td>
<td>50.2 (5.8)</td>
<td>50.8 (5.0)</td>
<td>51.1 (5.5)</td>
</tr>
<tr>
<td>MAZES</td>
<td>55.0 (9.0)</td>
<td>53.1 (11.2)</td>
<td>51.9 (13.9)</td>
</tr>
<tr>
<td>TARGET</td>
<td>42.4 (15.0)</td>
<td>44.7 (14.0)</td>
<td>41.7 (13.0)</td>
</tr>
<tr>
<td>OBJASS</td>
<td>54.9 (9.2)</td>
<td>53.0 (11.0)</td>
<td>53.6 (10.2)</td>
</tr>
<tr>
<td>BLKDES</td>
<td>51.9 (9.4)</td>
<td>49.7 (6.5)</td>
<td>52.6 (10.4)</td>
</tr>
<tr>
<td>SSPER</td>
<td>42.3 (31.8)</td>
<td>33.5 (19.0)</td>
<td>37.5 (17.1)</td>
</tr>
<tr>
<td>SENMEM</td>
<td>35.6 (10.4)</td>
<td>36.1 (11.5)</td>
<td>35.5 (12.6)</td>
</tr>
<tr>
<td>VOCAB</td>
<td>51.3 (6.5)</td>
<td>52.1 (8.7)</td>
<td>50.0 (8.3)</td>
</tr>
<tr>
<td>COMP</td>
<td>47.7 (9.7)</td>
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<td>47.8 (8.7)</td>
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<tr>
<td>READ</td>
<td>43.8 (8.8)</td>
<td>42.2 (6.6)</td>
<td>44.1 (7.8)</td>
</tr>
<tr>
<td>SPELL</td>
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<td>40.1 (8.4)</td>
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<tr>
<td>ARITH</td>
<td>39.8 (5.4)</td>
<td>41.1 (5.8)</td>
<td>40.5 (5.5)</td>
</tr>
</tbody>
</table>
Table 11

**T-Score Means (Standard Deviations) from the Neuropsychological and Academic Measures for each K-means Subtype (Externalized Psychopathology group)**

<table>
<thead>
<tr>
<th>Variable</th>
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<td>FTT</td>
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<td>(11.4)</td>
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<tr>
<td>DYN</td>
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<td>51.2</td>
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<td>50.9</td>
</tr>
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<td></td>
<td>(3.3)</td>
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<td>(4.3)</td>
<td>(6.5)</td>
</tr>
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<td>MAZES</td>
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<td>54.5</td>
</tr>
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<td>(12.5)</td>
<td>(10.0)</td>
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<tr>
<td>TARGET</td>
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<td>(9.6)</td>
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<td>(8.9)</td>
</tr>
<tr>
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<td>40.2</td>
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<td>37.6</td>
</tr>
<tr>
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<td>(13.9)</td>
<td>(30.8)</td>
<td>(18.7)</td>
<td>(18.2)</td>
</tr>
<tr>
<td>SENMEM</td>
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<td>38.2</td>
<td>35.3</td>
</tr>
<tr>
<td></td>
<td>(9.5)</td>
<td>(9.9)</td>
<td>(15.4)</td>
<td>(12.2)</td>
</tr>
<tr>
<td>VOCAB</td>
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<td>54.5</td>
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</tr>
<tr>
<td></td>
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<td>COMP</td>
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<td>(3.4)</td>
<td>(8.8)</td>
<td>(8.8)</td>
<td>(7.9)</td>
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<tr>
<td>SPELL</td>
<td>41.0</td>
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<td>39.9</td>
<td>40.4</td>
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<td>(4.8)</td>
<td>(7.3)</td>
<td>(6.0)</td>
<td>(6.8)</td>
</tr>
<tr>
<td>ARITH</td>
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<td>40.1</td>
<td>40.3</td>
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<tr>
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<td>(5.1)</td>
<td>(5.9)</td>
<td>(8.2)</td>
<td>(5.2)</td>
</tr>
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were 7.8, 5.8, and 7.8 standard score points for Subtypes 1, 2, and 3, respectively. Thus, Hypothesis 3a, the expectation that there would be at least one subtype in the Internalized Psychopathology group that showed a mean VIQ > PIQ discrepancy of at least 5 points, was not supported.

The discrepancies between WRAT Reading and Arithmetic, however, were in the direction predicted for all three subtypes, i.e., Reading > Arithmetic discrepancies of 3.4 for Subtype 1, 5.9, for Subtype 2, and 7.2 standard score points for Subtype 3 (as is evident in Table 14). The latter provides support for Hypothesis 3b, which stated that at least one subtype from the Internalized Psychopathology group would emerge demonstrating a mean Reading > Arithmetic discrepancy. In fact, not just one, but all three subtypes presented with this pattern.

Hypothesis 3c, the expectation that a subtype would emerge from the Internalized Psychopathology group with both a Reading > Arithmetic discrepancy and a VIQ > PIQ discrepancy, however, was not supported.

The Externalized Psychopathology Group

When we examine the k-means subtypes that emerged from the Externalized Psychopathology group (refer to Table 11), we see that Subtype 1, smallest of the EP subtypes, contained 6 subjects—4.1% of this subsample. This subtype was composed of 5 boys (83.3%) and 1 girl (16.7%) and was the youngest of the EP
subtypes, with a mean age of 9.8 years. The highest performances of these children were evidenced in visual-spatial organization and verbal comprehension, in the average range. They exhibited low average performance in motor speed, motor strength, kinetic steadiness, short-term visual memory, expressive vocabulary, sound-symbol matching, word reading, spelling, and mechanical arithmetic. Their sentence memory was mildly impaired.

Subtype 2, composed of 64 subjects (43.2% of the EP group), was the largest EP subgroup, with 53 boys (82.8%) and 11 girls (17.2%). This subtype was the next-to-the-oldest EP subtype, with a mean age of 10.6 years. These children demonstrated average motor speed, motor strength, kinetic steadiness, visual-spatial abilities, and expressive vocabulary. Performance was low average for these children in verbal comprehension, word reading, and mechanical arithmetic. They performed in the mildly impaired range in short-term visual memory, sentence memory, sound-symbol matching, spelling, and mechanical arithmetic. Their impaired performance on the Target Test and Sentence Memory Test suggested that they had some difficulties in attentional deployment across visual and verbal modalities, respectively.

There were 31 subjects (20.9% of the EP group) comprising Subtype 3: 24 boys (77.4%) and 7 girls (22.6%). Subtype 3 evidenced a mean age was 10.5 years. Of all of the EP and IP subtypes, this subtype exhibited the highest performance in visual-spatial abilities, ranging from average to high average. Their performance in simple motor speed, kinetic steadiness, and
expressive vocabulary were in the average range. Motor strength, verbal comprehension, and word reading were in the low average range. They performed in the mildly impaired range in short-term visual memory, sentence memory, sound-symbol matching, spelling, and mechanical arithmetic.

The performance of Subtype 3 is consistent with Subtype 2 in that both are characterized by impaired performance on the Target Test and Sentence Memory Test, with the suggestion of attentional deficiencies across visual and verbal modalities. It is also notable that Subtype 3 demonstrated the lowest reading performance of all the EP and IP subtypes, as well as the most even performance in reading and arithmetic (i.e., a mean Reading Arithmetic discrepancy of only 1.7 standard score points).

Subtype 4 comprised 47 subjects: 31.6% of the EP group, including the largest proportion of boys. There were 46 boys (97.9%) and 1 girl (2.1%), and they evidenced the oldest mean age: 10.7 years. These children were characterized by average motor speed, motor strength, kinetic steadiness, and visual-spatial-organization. They were low average in short-term visual memory, vocabulary, verbal comprehension, and word reading. Sentence memory, sound-symbol matching, spelling, and mechanical arithmetic were mildly impaired. This subtype exhibited the largest mean IQ discrepancy favoring Performance IQ, i.e., 8.0 points, of all the subtypes to have emerged from the EP group as well as the IP group (refer to Table 13).
With respect to WISC IQ discrepancies, an inspection of Table 13 shows that Hypothesis 4a, the expectation that at least one of the subtypes from the EP group would present with a mean VIQ > PIQ discrepancy, was not supported. That is, none of the neuropsychological subtypes that emerged from either psychosocial group presented with a VIQ > PIQ discrepancy. They all exhibited mean PIQ > VIQ discrepancies.

As is observed in Table 13, all 4 of the subtypes from the EP group exhibited mean PIQ > VIQ discrepancies, ranging from 5.7 to 9.0 standard score points. Thus, Hypothesis 5a, the expectation that at least one subtype would emerge from the Externalized Psychopathology group showing a mean PIQ > VIQ discrepancy of at least 5 standard score points was supported. In fact, all 4 of the EP subtypes demonstrated such discrepancies of 5 points or greater.

In addition to the fact that all of 4 EP subtypes showed PIQ > VIQ discrepancies, all of them demonstrated psycholinguistic deficiencies in the manner delineated with respect to Hypothesis 5b. That their Language 2 abilities (viz., Speech Sounds Perception and Sentence Memory) appear to be less developed relative to Simple Motor, Complex Motor, Visual-Spatial 1 and Visual-Spatial 2 abilities provides support for Hypothesis 5b.

With respect to WRAT subtest discrepancies, an inspection of Table 15 provides the mean WRAT standard scores for the four subtypes. Hypothesis 4c was not supported. Whereas all 4 subtypes to have emerged from the EP group show mean Reading >
Arithmetic discrepancies, a subtype did not emerge from the EP group demonstrating a mean VIQ > PIQ discrepancy co-occurring with the mean Reading > Arithmetic discrepancy.

That all 4 of the EP subtypes are characterized by mean WRAT Reading > Arithmetic discrepancies (ranging from 1.9 to 9.2), supported Hypothesis 4b: the expectation that a subtype would emerge from the Externalized Psychopathology group displaying a mean Reading > Arithmetic discrepancy of at least 5 standard score points. Indeed, 3 of the 4 subtypes showed this discrepancy of 5 points or greater.

Relationship of the IP and EP Subtypes to Known Subtypes

It is noteworthy that each of the three k-means-derived neuropsychological subtypes from the IP group and each of the four k-means-derived neuropsychological subtypes from the EP group exhibited higher Language 1 abilities relative to Language 2 abilities, as designated in Table 3 (with respect to the discrepancies exhibited between WISC Vocabulary and Comprehension subtests on the one hand, and the Speech Sounds Perception Test and Sentence Memory on the other). In other words, their propensity for rote verbal facility in terms of expressive vocabulary appeared to exceed their ability to grasp more novel linguistic relationships, such as phoneme-grapheme analysis. This pattern is similar to the pattern seen in NLD children.
Table 12

Mean WISC Full Scale IQ (FSIQ), Verbal IQ (VIQ), and Performance IQ (PIQ) Standard Scores and (Standard Deviations) for each Subtype from the Internalized Psychopathology group

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Subtype 2</th>
<th>Subtype 3</th>
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<td>97.9</td>
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<td>(8.8)</td>
</tr>
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<td>94.4</td>
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<td>101.4</td>
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<tr>
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<td>(12.7)</td>
<td>(13.5)</td>
<td>(11.8)</td>
</tr>
<tr>
<td>PIQ - VIQ</td>
<td>7.8</td>
<td>5.9</td>
<td>7.8</td>
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</table>
Table 13

Mean WISC Full Scale IQ (FSIQ), Verbal IQ (VIQ), and Performance IQ (PIQ) Standard Scores and (Standard Deviations) for each Subtype from the Externalized Psychopathology group

<table>
<thead>
<tr>
<th>Subtype</th>
<th>Variable</th>
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<td>(8.6)</td>
<td>(11.0)</td>
<td>(9.9)</td>
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<td>VIQ</td>
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<td>92.7</td>
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<td>(8.1)</td>
<td>(11.4)</td>
<td>(9.6)</td>
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<td></td>
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<td>(11.2)</td>
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</table>
Table 14

Mean WRAT Reading, Spelling, and Arithmetic Standard Scores and (Standard Deviations) for each K-means Subtype from the Internalized Psychopathological group

<table>
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<tr>
<th>Variable</th>
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<th>Subtype 3</th>
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<td>R &gt; A</td>
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<td>7.9</td>
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</table>
Table 15

**Mean WRAT Reading, Spelling, and Arithmetic Standard Scores and (Standard Deviations) for each K-means Subtype from the Externalized Psychopathological group**

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<th>Variable</th>
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<td>R &gt; A</td>
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<td>6.1</td>
<td>1.7</td>
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</table>
At the same time, each of the k-means IP subtypes and each of the k-means EP subtypes demonstrated written spelling performance that was deficient in addition to their deficient arithmetic performance. This pattern is distinctly different from that of NLD children, who typically perform at or above age-expectancy level in written spelling (DeLuca, Rourke, & Del Dotto, 1991). In spelling performance the k-means IP subtypes are similar to children presenting with developmental output failure (DOF; Levine, Oberklaid, & Meltzer, 1981) who experience difficulties in both arithmetic and spelling achievement.

Particular subtypes that exhibit the closest resemblances to known subtypes include Subtypes 1 and 3 from the IP group, and Subtype 3 from the EP group. Subtype 1 from the IP group demonstrates some similarities with DOF children and with the arithmetic-disabled Subtype 4 that has been described by DeLuca, Rourke, and Del Dotto (1991). IP Subtype 1 from this study and DeLuca and colleagues' Subtype 4 both demonstrate higher WISC Performance than Verbal IQs, higher WRAT Reading than Spelling and Arithmetic, age-appropriate motor skills, visual-spatial-organization, and vocabulary relative to less well developed short-term visual memory and sentence memory.

Subtype 3 from the EP group resembles DOF children and also DeLuca and colleagues' (1991) Subtype 2. They are similar in their demonstration of externalized behavioral difficulties, higher WRAT Reading than Arithmetic, higher rote verbal than
sound-symbol matching skills, visual-spatial-organizational skills in the average range, and impaired sentence memory and short-term visual sequential memory.

Subtype 3 from the IP group resembles, in some respects, Subtype A or the NLD children described by Rourke (1987, 1988, 1989). Subtype 3 children differ, however, in that they exhibit a higher Performance IQ rather than Verbal IQ, and they have better psychomotor and visual-spatial skills, and their modestly higher mean Reading than Arithmetic discrepancy (viz., 3.4 standard score points) is not the striking discrepancy seen in NLD children.

Subtype Differences in WISC IQs

Group comparisons between the subtypes with respect to mean WISC VIQ, PIQ, and FSIQ standard scores were conducted using MANOVA. Comparisons between the IP subtypes using MANOVA showed no significant differences on mean WISC VIQ ($F[2,162] = 0.64, p = .530$), PIQ ($F[2,162] = 0.07, p = .934$), and FSIQ ($F[2,162] = 0.38, p = .683$) standard scores. As well, no significant differences were observed between the EP subtypes on comparisons employing MANOVA on mean WISC VIQ ($F[3,144] = 0.95, p = .418$), PIQ ($F[3,144] = 0.42, p = .738$), and FSIQ ($F[3,144] = 0.64, p = .593$) standard scores.
**Subtype Differences on the WRAT**

Group comparisons between the subtypes' performance on the WRAT were conducted using MANOVA. Comparisons between the IP subtypes using MANOVA on mean WRAT Reading ($F[2,162] = 3.67, p = .028$) showed significant differences, whereas such comparisons using MANOVA on mean Spelling ($F[2,162] = 2.66, p = .073$), and Arithmetic ($F[2,162] = 0.52, p = .596$) standard scores showed no significant differences. Planned comparisons using Tukey's Studentized Range (HSD) Test revealed that IP Subtype 1 performed significantly lower in Reading than IP Subtype 3 at the .05 level of significance. Comparisons between the EP subtypes on the WRAT employing MANOVA did not show significant differences in Reading ($F[3,144] = 1.84, p = .142$), Spelling ($F[3,144] = 1.09, p = .357$), or Arithmetic ($F[3,144] = 0.36, p = .779$).

**Comparisons Between the IP and EP Groups**

Recall that 3 of the 4 IP subtypes and 3 of the 4 EP subtypes exhibited mean WRAT Reading $>$ Arithmetic discrepancies of at least 5 standard score points (see Tables 14 and 15, respectively). In order to determine if this similar characterization of these discrepancies for the IP and EP groups that was observed on a subtype basis was comparable on an individual basis, such discrepancies were also analyzed on the basis of the performance of individual subjects.

The number and percentage of individual subjects, in each of the IP and EP groups, who exhibited WRAT Reading $>$ Arithmetic
discrepancies of 5 standard score points or greater were calculated and compared. As is shown in Table 16, 47.9% of the children in the Internalized Psychopathology group exhibited such discrepancies, as compared to 47.3% of the children in the Externalized Psychopathology group. Thus, Hypothesis 6 was not supported. Rather than finding a higher proportion of children with $R > A$ discrepancies in the Internalized Psychopathology group, a virtually identical proportion of such children were found in the IP and EP groups.

As is evident in Table 16, there was a higher proportion, overall, of children with $PIQ > VIQ$ discrepancies in both IP and EP groups relative to the proportion of children with $VIQ > PIQ$ discrepancies of 5 or more points. With respect to the IP group, 58.4% of the children showed $PIQ > VIQ$ discrepancies of at least 5 standard score points as compared to 16.4% who showed 5-point-or-greater $VIQ > PIQ$ discrepancies, which was statistically significant using single-sample chi-square analysis ($X^2[1, N = 185] = 36.30, p < .001$). Similarly, 55.4% of the children in the EP group showed $PIQ > VIQ$ discrepancies of 5 points of greater, whereas 17.8% of these children presented with $VIQ > PIQ$ discrepancies of this magnitude. Again, these differences were found to be statistically significant using chi-square analysis ($X^2[1, N = 146] = 29.03, p < .001$).
Table 16

Frequencies (Percentages) of IQ and WRAT Discrepancies of 5 Standard Score Points or Greater for the Internalized Psychopathology and Externalized Psychopathology groups

<table>
<thead>
<tr>
<th>Discrepancies</th>
<th>IP (n = 165)</th>
<th>EP (n = 148)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIQ &gt; PIQ</td>
<td>27 (16.4)</td>
<td>26 (17.6)</td>
</tr>
<tr>
<td>PIQ &gt; VIQ</td>
<td>93 (56.4)</td>
<td>82 (55.4)</td>
</tr>
<tr>
<td>Reading &gt; Arithmetic</td>
<td>79 (47.9)</td>
<td>70 (47.3)</td>
</tr>
<tr>
<td>Arithmetic &gt; Reading</td>
<td>37 (22.4)</td>
<td>33 (22.3)</td>
</tr>
</tbody>
</table>
A higher proportion of children with Reading > Arithmetic discrepancies emerged across both IP and EP groups than children with Arithmetic > Reading discrepancies of 5 points or greater. It was 47.8% of the IP children who presented with WRAT Reading > Arithmetic discrepancies of 5 points or greater as compared to 22.4% who showed this magnitude of discrepancies in the opposite direction, and these differences were statistically significant ($X^2 [1, N = 165] = 15.206, p < .001$) using chi-square analysis. For the children in the EP group, as well, such discrepancies (47.3% and 22.3%, respectively) were statistically significant ($X^2 [1, N = 148] = 13.292, p < .001$).

With respect to Hypotheses 7a and 7b, a visual inspection of the neuropsychological profiles of the children in the IP and EP groups yielded 2 children in each group who showed the NLD (nonverbal learning disabilities) pattern, using the criteria (in Appendix C) delineated by Casey, Rourke, and Picard (1991). Hypothesis 7a was supported: Children who exhibited the NLD pattern were found in both the Internalized and Externalized Psychopathology groups. Hypothesis 7b, however, was not supported. Rather than finding a significantly higher proportion of NLD children in the IP group, an equal number of NLD children were found in each psychosocial group.
CHAPTER IV: DISCUSSION

At this point it may be helpful to view the present investigation within the context of classification research in learning disabilities and psychopathology and its basic empirical and conceptual requirements. Empirically, progress in science has traditionally been assisted by valid and useful methods of classifying its subjects into fundamental comprehensible variables. Thus, the attempt to identify reliable and valid subtypes of various learning disorders and psychopathologies constitutes a basic step in the neuropsychology of learning disabilities. Conceptually, the attempt to explain relationships between particular neurocognitive profiles and specific psychopathologies constitutes another step in this research endeavor. From a clinical and developmental point of view, a major challenge is to understand why one LD child will be psychosocially normal, whereas another child with a particular type of learning disability will develop a certain level and/or pattern of psychosocial disturbance, and another child with a different neurocognitive pattern may be at risk for another type of psychosocial problem.

In our review of the literature, it became evident that progress has been made in formulating models that account for the development of psychopathology in learning disabled children. There has been a welcome shift from thinking in terms of a single
personality profile for learning disabled children to recognizing that there is evidence for various subtypes of psychosocial patterns that have multiple causes which interact with one another.

In accordance with this trend, an attempt was made in the present investigation to integrate these variables into a meaningful heuristic framework by employing both conceptual and statistical methods of investigation. Cluster analysis was used to uncover the natural structure in the data under scrutiny, in the attempt to allow relationships and patterns in the data to more clearly emerge.

A primary purpose of the present investigation was to extend the Windsor Laboratory research in the exploration of hypotheses associated with the postulation that specific patterns of central processing abilities and deficits cause specific subtypes of learning disabilities and specific forms and levels of psychopathology (Rourke, 1987; Rourke & Fuerst, 1993). Learning disabled children who demonstrated internalized and externalized psychopathology, respectively, but who had originally been referred for their learning difficulties, were the focus of this study. The neuropsychological performance of these two groups was separately cluster analyzed in an attempt to better understand their potential contribution toward two respective patterns of psychosocial problems: internalized and externalized psychopathology.
Hypotheses Concerning Internal Validity

Cluster analyses yielded some support for Hypothesis 1, based on our initial criteria. That is, there was the suggestion of internal validity for the 3 subtypes that emerged from the Internalized Psychopathology (IP) group, based on three criteria: Rand and modified Rand statistics, misclassifications, and intercorrelations. Further analysis of the nature of the subtypes, however, revealed that although the k-means-derived IP subtypes had been reliably replicated by the hierarchical agglomerative techniques, they were not very distinct from one another, thus making their internal validity tenuous. Indeed, additional analyses showed they were not very distinct from the EP subtypes.

The recovery of the Externalized Psychopathology subtypes was less striking than that of the Internalized Psychopathology subtypes. Whereas the Rand statistics and intercorrelations were adequate, there was a high percentage of misclassifications. The reliability of EP Subtype 1 is particularly questionable because of its small N of 8. Thus, the insufficient reliability of the k-means-derived EP subtypes did not provide support for the internal validity of the 4 EP subtypes, or Hypothesis 2.

With the caveat, then, that the internal validity of all of the subtypes is questionable, any support found for the specific hypotheses related to the subtypes remains questionable, as well.
Hypotheses Concerning the IP Subtypes

Hypothesis 3a was not supported. That is, we did not see even one subtype in the IP group showing a mean VIQ > PIQ discrepancy of at least 5 standard score points.

Hypothesis 3b was supported. It was expected that at least one subtype with a mean Reading > Arithmetic discrepancy of 5 or more points would have emerged. In fact, all 3 IP subtypes presented with this pattern.

Hypothesis 3c, the expectation that a subtype would emerge from the IP group with both a Reading > Arithmetic discrepancy and a VIQ > PIQ discrepancy was not supported.

Hypotheses Concerning the EP Subtypes

The expectation that at least one of the subtypes from the EP group would present with a mean VIQ > PIQ discrepancy -- Hypothesis 4a -- was not supported. All of the IP and EP subtypes exhibited PIQ > VIQ discrepancies.

Hypothesis 4c was not supported. A subtype did not emerge from the EP group demonstrating a VIQ > PIQ discrepancy co-occurring with the Reading > Arithmetic discrepancy.

Support was shown for Hypothesis 4b, the expectation that an EP subtype would display a Reading > Arithmetic discrepancy of at least 5 points. Indeed, 3 of the 4 subtypes showed this pattern.

Hypothesis 5a was supported. Not just one EP subtype, but all 4 EP subtypes presented with a mean PIQ > VIQ discrepancy of at least 5 points.
Support for Hypothesis 5b was seen in that all 4 EP subtypes demonstrated psycholinguistic deficiencies.

Hypotheses Related to Comparisons Between the IP and EP Groups

Hypothesis 6, was not supported. Rather than finding a higher proportion of children with Reading > Arithmetic discrepancies in the Internalized Psychopathology group, a virtually identical proportion of such children were found in the IP and EP groups.

Hypothesis 7a was supported: Children who exhibited the NLD pattern were found in both the Internalized and Externalized Psychopathology groups. Hypothesis 7b, however, was not supported. Rather than finding a significantly higher proportion of NLD children in the IP group, an equal number (N = 2) were found in each psychosocial group.

Resemblances with Known Subtypes

Each of the three k-means-derived IP subtypes and each of the four k-means-derived EP subtypes exhibited higher Language 1 abilities relative to Language 2 abilities (i.e., higher Vocabulary and Comprehension [rote verbal abilities] relative to Speech Sounds Perception and Sentence Memory [novel linguistic skills], a pattern not unlike that seen in NLD children.

In spelling performance, however, the IP subtypes are more similar to DOF (developmental output failure) children, who show problems in both arithmetic and spelling. IP Subtype 1 is
similar to both DOF children and DeLuca and colleagues' (1991) arithmetic disabled Subtype 4. EP Subtype 3 resembles DOF children and DeLuca and colleagues' (1991) Subtype 2. IP Subtype 3 resembles Group A or NLD children except that Subtype 3 exhibits a higher Performance IQ rather than Verbal IQ and the Reading > Arithmetic discrepancy of this subgroup is not the striking discrepancy seen in NLD children.

Similarities Across Both Psychosocial Groups

There was a significantly higher proportion of children (approximately 55% in each psychosocial group) with PIQ > VIQ discrepancies of 5 points or greater in both IP and EP groups relative to the proportion of children with VIQ > PIQ discrepancies. Similarly, a significantly higher proportion of children (approximately 47% in each psychosocial group) with Reading > Arithmetic discrepancies of 5 points or greater emerged from both the IP and EP groups than those with the opposite pattern.

Homogeneity Across the Sample

When it was first hypothesized that we would see patterns or discrepancies consistent with underlying relationships involving language processing or language-mediated self-regulation and psychopathology in these children, such manifestations had been envisioned more specifically in terms of particular subtypes in
the Internalized and Externalized Psychopathology groups that would have been distinguished from the rest.

Instead, the results appear to bear a more subtle, if pervasive, suggestion of such a relationship. In other words, rather than finding particular subtypes that stand out from the rest among the subtypes in each psychosocial group, for example, we see instead more generalized patterns across a number of the subtypes within each of the IP and EP groups and across these groups.

We have noted that the proportionate representation of IQ and academic achievement discrepancies has been generally consistent among individuals across the psychosocial groups. Recall that throughout the subtypes across both the Internalized and Externalized Psychopathology groups we saw a subtle but generalized pattern of higher rote verbal facility relative to the ability to grasp novel linguistic relationships, in addition to a large proportion of children who demonstrate higher mean WISC PIQs than VIQs, and higher WRAT Reading than Arithmetic.

Thus, the validity of the k-means-derived IP subtypes seems as equivocal as that of the EP subtypes. Indeed, there is evidence to suggest that all of the subtypes are quite similar and that the entire sample, in fact, is fairly homogeneous.

Whereas it may be intriguing to postulate that the findings exhibiting a stable neuropsychological pattern across two psychosocial subtypes of similar high severity but contrasting symptomatology may be indicative of a meaningful relationship,
there is evidence to suggest that the generalized pattern apparent across this sample may simply be an artifact of bias within the sample. It may be noted that the pattern of higher performance in Language 1 abilities relative to Language 2 abilities (consistent with deficient in attention/short term memory) is a pattern seen more generally in children who have learning disabilities.

Methodological Shortcomings and Suggestions for Future Research

Sample Bias

The equivocal internal validity of the subtypes that emerged from cluster analyses performed on each psychosocial group raises the question of bias. The present findings demonstrating a lack of distinct subtypes likely have been influenced by sample bias -- bias that is virtually unavoidable in archival research, but that has the potential to be better controlled in future studies. There may have been bias in the present sample that restricted the range of cognitive and academic patterns of performance, so that the potential for differences to emerge between subtypes may have been attenuated.

One source of bias may have been the pattern of referrals, particularly in a clinically-referred sample generated by parents, teachers, and other professionals. Future research may
benefit from the aggregation of assessment data from a number of children's clinics that use the same battery of tests, which could provide a more representative sample. It is not known how the base rate of types of learning disorder referrals in this clinical sample compares with that of other samples, but a larger, more diverse sample would be less subject to bias.

Other sources of bias may have been produced by the general approach used in classifying children as learning disabled (LD), as well as the specific subject selection criteria used in the present investigation. The "cut-off score" method was used to delineate a discrepancy between intelligence and achievement and classify the LD children. A fundamental shortcoming in this regard is that there are no objective criteria for determining where cut-offs should be placed (Francis, Espy, Rourke, & Fletcher, 1991).

Also, the cut-off approach fails to correct for regression artifacts. Regression-based discrepancy definitions (where the discrepancy is between observed and predicted achievement) may address the potential regression toward the mean. A further problem, however, is that there is no simple way to rectify the correlation between IQ and achievement. Reynolds (1984) found that using discrepancy criteria based on comparisons of IQ and reading achievement, for example, leads to an overidentification of children with higher IQs as disabled and underidentification of children with lower IQs. Future research may benefit from the
application of computer programs that employ regression formulas that also correct for correlations between IQ and achievement.

As well, the issue of the lack of comparability of achievement discrepancies across ages remains (Francis, Espy, Rourke, & Fletcher, 1991). Phillips and Clarizio (1988) point out that scaled score differences on the WRAT (Jastak & Jastak, 1985), for example, may not represent equal intervals because standard scores and centiles on this instrument have been derived from grade-equivalents. A major difficulty with grade-equivalents is that achievement discrepancies are not equivalent across grades.

A predominant limitation in the present study was that the original classification criterion for LD (viz., WISC Full Scale IQ of 50-120 standard scores points) had to be broadened in order to collect a sufficient number of subjects. Ultimately, the criteria stated that at least one WISC IQ score needed to be 80 or greater, along with the condition that at least one WRAT centile score had to be 35 or below (the original centile score range had been 30 or below). The resultant more liberal intelligence-achievement disparity caused subjects to be included who were more generally mentally challenged (e.g., those in the borderline range of intelligence), and likely reduced the occurrence of cognitive and academic discrepancies in this clinical sample still further.

Individuals in the mentally challenged range generally present with flatter neuropsychological profiles than those with
more specific learning disabilities (Sternberg, 1987), and the modest achievement discrepancy that was applied apparently reinforced this pattern. Unlike more specifically learning disabled children, this sample of children apparently demonstrated multiple difficulties more generally across intellectual, neuropsychological, and academic measures, manifesting less variation among those domains as a basis for generating more discriminant subtypes. If a more rigorous definition of LD had been applied, it would have increased the likelihood that more definitive differences between subtypes would have emerged.

The age range, as well, had been broadened to include younger children (ranging in age from "9 to 14 years" to "7 to 14 years"), in order to gather as many subjects as possible. Thus, not only were developmental variables not controlled, but also this compromise in age range caused the range of neuropsychological measures to be restricted to those of the younger children's battery.

Coverage

The need to include younger children in order to gain more subjects resulted in a less than representative sample of neuropsychological and academic measures. The original sample of measures that had been proposed included 22 variables across 11 domains. The dependence on the younger children's battery constrained coverage to 13 measures across 8 domains.
Information regarding a comprehensive characterization of what this sample of LD children were truly like cognitively was lost, and more importantly in this context, the discriminant ability to identify distinct subtypes.

The original set of measures had been selected with the basic purpose of providing adequate characterization of overall neuropsychological functioning, as well as the specific purpose of affording the potential for discriminating between Group A (or NLD) children and Group R-S children to allow for these subtypes to be isolated, consistent with the proposed hypotheses. Harnadek and Rourke (1993), using stepwise discriminant function analysis, had found that the best discriminating variables that distinguished NLD children from R-S children and normal controls were the Target Test, Trail Making Test, Part B, the Tactual Performance Test (TPT), and the Grooved Pegboard Test. Of these, all had to be eliminated except for the Target Test, because they were not part of the younger children's battery. Since the former measures were not able to be retained, the opportunity to detect and isolate subtypes resembling Group A and Group R-S was likely compromised.

Subtyping Techniques

In addition to the methodological problems that can stem from the subject sample and the measures used as a basis for typology characterization, the techniques employed to achieve
valid and meaningful typology are subject to problems of their own.

Two basic subtyping techniques were employed in this investigation: cluster analysis and profile matching. Although each method offers major advantages over other methods for the present purpose, each has its own disadvantages. The application of cluster analysis is a useful multivariate subtyping technique, providing a fairly objective method of uncovering the natural structure of the data under scrutiny relative to clinical methods. However, as Fuerst (1991) cautions, cluster analytically-derived subtypes are always constrained by assignment rules, which implies subjectivity.

The profile matching program developed by Fuerst (1991) has some of the same advantages of cluster analysis, including clear specification and efficient algorithm implementation. As applied in the context of the design of this study, however, there were difficulties collecting a sufficient number of subjects from the database to accommodate two separate cluster analyses. It is suggested that future research with a similar design, but involving the aggregation of databases, could generate enough subjects to allow for a more fine-grained typology, i.e., more distinct a priori psychosocial groups that would offer the possibility for more power in discriminating neuropsychological subtypes derived from these groups.

Also, future investigations could explore the utility of selecting neuropsychological subtypes based on well defined
clinical criteria, followed by analyses of their psychosocial functioning. The subtypes cited in the hypotheses in this investigation that were originally derived from achievement-based patterns, are delineated in terms of well-articulated clinical criteria -- the Group A (or NLD) subtype, and the R-S subtype (basic phonological processing disorder) -- and need to be further researched in terms of neurocognitive-psychosocial correlates. It would be interesting, for example, to examine the possibility of isolating some consistent differences (e.g., neuropsychological, demographic, motivational, or environmental) between the particular NLD children who manifest internalized vs. externalized psychopathology, respectively, with a more precise articulation of the developmental findings already observed.

A psycholinguistic subtype similar to the R-S subtype, Petrauskas and Rourke's (1979) Subtype 2 (or phoneme-grapheme matching disorder) is another clinical subtype that is worthy of continued investigation. Whereas there is evidence to suggest that the greater proportion of learning disabled children who manifest either of these patterns of psycholinguistic difficulties appear normal psychosocially, a substantial number of case studies of these children who demonstrate externalized psychopathology have been observed (Rourke, 1989).

Other subgroups appearing in the literature that have evidenced some association with externalized psychosocial problems, such as DeLuca and associates' (1991) arithmetic disability Subtype 2 and Levine and colleagues' (1981)
developmental output disorder (DOF) are worthy of further investigation in this regard.

General Methodological Considerations

The nature of this investigation was fairly exploratory, and the specific findings have been no more than equivocal. A more general discussion of the techniques employed in this study, however, may provide useful methodological insights.

The subtyping concept was applied using the multivariate technique of cluster analysis in the attempt to uncover in learning disabled children relationships between levels and patterns of psychopathology on the one hand, and cognitive and academic patterns on the other. Psychometric research has long focused on individual differences and similarities in the configuration of scores (McQuitty, 1987). Consistent with this tradition, a configural approach to the data was employed on a number of levels of analysis. By focusing on patterns of abilities more precise information about learning disorders is often obtained (Fletcher & Satz, 1980).

A transformation algorithm was employed that de-emphasized levels of performance and dispersion, thus enhancing patterns of performance (Fuerst, 1981; Fuerst, Fisk, & Rourke, 1989). Such a
standardization technique emphasizing pattern assists in the specification of inferential constructs elucidated through the relationships of given scores in the context of other scores.

Similarly, higher-order strata such as IQ discrepancies, academic patterns, and comparisons between rationally-empirically-derived categories of neuropsychological measures (e.g., Language 1 vs. Language 2) were employed as potential representations of meaningful variance in performance and the inferred functions underlying this performance. The employment of such specific patterns relied on the postulation that in particular contexts such patterns may be predictive by integrating the combined meaning of many performances. Whereas the findings in this particular study were not that informative, empirical evidence from numerous studies (e.g., Fuerst, 1991; Fuerst, Fisk, & Rourke, 1990; Fuerst & Rourke, 1993; Loveland, Fletcher, & Bailey, 1990; Ozols & Rourke, 1985; Rourke, 1989; Rourke & Finlayson, 1978; Rourke & Strang, 1978; Strang & Rourke, 1983) maintains that the employment of such higher-order patterns are highly useful tools in investigating relationships between learning disorders and psychosocial functioning.

Methodologically, it is also notable that this investigation attempted to address the need for a balance between statistical and clinical perspectives, as is consistent with the scientist-practitioner model. The multivariate subtyping approach, based on the mean performances of subgroups on various measures, was complemented by tests that examined the number and proportion of
individual subjects who presented with particular cognitive or academic patterns. In other words, the validity of the patterns that emerged through subtypes was re-examined at the individual subject level. Chi-square was employed in order to determine whether and to what extent particular neuropsychological patterns evident at the subtype level were also evident at the individual level. This analysis at both the subtype level and the individual level is unusual in subtyping research and provides comparability between research and clinical perspectives. The extent to which there is comparability between subtype and individual provides support for ecological validity (Fisk, Finnell, & Rourke, 1985; Rourke, 1985, 1989).

It is usually understood that a given classification of children into fairly homogeneous subtypes does not necessarily imply that the children so classified are so similar that the characterization of the subtype is predictive at an individual level. Traditionally, subtyping in psychology serves the purpose of identifying some basic differences between subgroups or identifying more general principles that are shared among subgroups (Paris, Jacobs, & Cross, 1987). The approach employed in this investigation, however, has the potential to yield findings that may be more useful for individual prediction and treatment than the more traditional analyses.

More generally, the present investigation has been unique with respect to the methodological design. Previous investigations have traditionally pursued the present research
problem by isolating cognitively- or academically-derived subtypes and then examining their personality patterns. The utility of this approach, in and outside of the Windsor Laboratory, has been well established. The present investigation has been innovative in that it has employed the opposite approach. Here, a priori psychosocial groups were selected, and then their neuropsychological and academic performances were clustered and examined.

Since internalized and externalized psychopathology had already been observed in association with particular cognitive and academic patterns in the context of studies employing the traditional design, logical criteria suggested that these patterns might be elucidated in the context of a design that approached the same basic research problem from the opposite direction. The focus on severe rather than mild forms of psychopathology was also a methodological strategy designed to maximize the power to obtain conclusive findings and aid in their interpretability.

However, the present methodological design was shown to be less than adequate in its ability to address the multidimensional complexity of motivational and interpersonal factors in addition to the neuropsychological variables that may contribute to personality. The specific results of the analyses in the context of this methodological design are very modestly informative. At the same time, such results have been instrumental in demonstrating to investigators that one may not gain as much
information when the problem is approached from this perspective. That in itself is useful information.

Furthermore, even though the present design was not particularly fruitful, the types of psychosocial disorder that were examined remain relevant and deserve further investigation. Learning disabled children exhibiting internalized psychopathology and those exhibiting externalized psychopathology had been selected as the focus of study because of their established reliability as psychosocial subtypes, and because of the need for the early identification of these groups (Stone & La Greca, 1990). These are the children who are at risk for becoming neglected or rejected by their peers. If more were understood about these two subtypes of LD children in terms of their neuropsychological patterns, their early identification could be facilitated, and appropriate intervention programs could be instituted with better prognoses. Further investigation regarding these psychosocial subtypes is needed.

Final Comments

Some general conclusions with respect to the task of classification studies, such as the present one -- those that address relationships between learning disorders and psychosocial functioning -- may now be formulated.
Many learning disabled children never develop psychosocial difficulties at the clinical level of significance. At the same time, our investigation of the literature suggests that one-third of this population may experience at least mild psychosocial problems. Because children with learning disabilities develop diverse motivational and attributional patterns and live in complex social environments that continually shape and influence their development, multiple and complex variables must be considered when attempting to understand the etiology of such psychosocial problems. Although some of these variables can be manipulated experimentally, many, for practical and ethical reasons, cannot be so easily controlled.

The present investigation has generated evidence to suggest that more information can be obtained when we begin with neuropsychological or achievement-based subtypes, and then examine their psychosocial patterns, rather than using the opposite approach. A combination of empirical and clinical methods of classification and data analysis can assist the neuropsychological investigator in this end. Whatever the methodology, there should be a perspective that views ecological validity as a fundamentally important consideration. More emphasis needs to be placed on data-analytic techniques that examine the validity of findings at subtype and individual levels. For even the most valid subtypes need to be relevant and useful to the children we are studying as well as the scientific community.
The isolation of the NLD subtype (Rourke, 1989) is a seminal example of the comprehensive characterization of a subgroup of learning disabled children with ecological validity and relevance. There remains the need for such continued identification of specific patterns of neuropsychological abilities and deficits that may be related to relevant aspects of personality, that is, to specific levels and forms of psychosocial problems, particularly in learning disabled children in whom the uneven development of complementary neurocognitive systems affords considerable adaptive challenges. Indeed, it has been some time since it was possible to have thought of the development of cognition and personality as separate processes without considering the complex link between them.
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APPENDIX A
Description of the Scales
On the Personality Inventory for Children

Lie
The Lie Scale was designed to identify a defensive response set manifested by a tendency to ascribe virtuous behavior to the child, and to deny common behavior problems in the child.

E
The E Scale was designed to identify deviant response sets, such as exaggeration of symptoms or random responding. In the general clinical population, E appears to reflect intensity or severity of symptoms. High E Scale elevations (i.e., T-scores greater than or equal to 120) may be indicative of atypical response sets.

Defensiveness
This scale was designed to measure the tendency, in the respondent, to be defensive about the child’s behavior. Elevations may be indicative of the tendency to be vigilant and hostile, and to withhold information. The respondent may be resistant to the view that existing problem behaviors may be caused by psychological factors.

Adjustment
This scale is a general measure of maladjustment and a screening device used to identify children in need of psychological evaluation.

Achievement
The Achievement Scale was designed to identify children whose academic achievement is significantly below age expectation. It is strongly related to reading comprehension, but a poor predictor of arithmetic achievement.
**Intellectual Screening**

This scale is a screening device meant to identify children whose difficulties may be attributed to impaired intellectual functioning, and who are in need of an in-depth intellectual assessment.

**Development**

This scale provides a measure of poor intellectual and physical development, including motor coordination, language skills, and cognitive functioning.

**Somatic Concern**

This scale is composed of a number of health related variables (e.g., somatic complaints and illness, adjustment to illness, eating habits, sleep patterns, energy and strength, headaches, stomach aches, and physical basis for symptoms). Careful evaluation is needed in order to determine if somatic complaints are in response to stress, have been employed to avoid responsibility or uncomfortable situations, require medical intervention, or are associated with depression or other emotional states.

**Depression**

The Depression Scale consists of items deemed to reflect childhood depression (e.g., brooding, worry, crying spells, emotional lability, pessimism, anhedonia, self blame or self criticism, poor self concept, uncommunicativeness, withdrawal, social isolation, low energy level, and problems eating and/or sleeping).

**Family Relations**

This scale is a measure of family effectiveness, cohesion, and stability. It is indicative of parental effectiveness, parental emotional adjustment, and the presence of feelings of love, happiness and cooperation in the home.

**Delinquency**

The Delinquency Scale consists of items designed to measure delinquent tendencies (e.g., impulsivity, frustration, hostility, poor judgment, disregard for limits, a lack of sensitivity
regarding the rights and feelings of others, a tendency to blame others, and problematic sexual behavior).

Withdrawal

This scale is a measure of withdrawal from social contact. It reflects shyness and fear of strangers, distrust of others, emotional distance, and isolation from peers and general social intercourse.

Anxiety

This scale is a measure of overt manifestations of anxiety, such as limited frustration tolerance, exaggeration of problems, irrational fears, worries, nightmares, and behavioral and physiological correlates of anxiety.

Psychosis

This scale was designed to identify children with psychotic symptomatology. Elevations may be indicative of anxiety, social withdrawal, poor social skills, emotional lability, inappropriate affect, reality distortion, and cognitive disorganization.

Hyperactivity

This scale was designed to identify children who exhibit characteristics of the "hyperactive syndrome." Elevations may be indicative of impulsivity and restlessness, distractibility, low frustration tolerance, poor attention and concentration, poor peer relationships, and discipline problems.

Social Skills

The Social Skills Scale is a measure of the effectiveness of interpersonal skills in childhood and the reasons for failure in social situations. It is composed of items which reflect level of participation, appropriate role taking, social comprehension, tact, poise, and self confidence in social situations.

*adapted from Porter (1980) and Wirt, Lachar, Klinedinst, and Seat (1977)*
APPENDIX B
Description of the Tests
Included in the Neuropsychological Battery

Finger Tapping Test (Reitan & Wolfson, 1985)

The Finger Tapping Test, a measure of motor speed, requires the child to tap as fast as possible with the index finger of each hand. Four trials of 10 seconds each are given for each hand. The score is the average of the best three out of four trials.

Strength of Grip (Reitan & Davison, 1974)

The subject squeezes a Smedley Hand Dynamometer three times with each hand, alternating hands each trial. The score is the mean pressure exerted (in kgs.) for each hand.

Maze Test (Klove, 1963)

The subject is required to direct a stylus through a maze which contains blind alleys and rests on a 70° angle (on the Tactual Performance Test stand). Three scores are obtained and electrically recorded: the number of contacts with the side of the maze, the total amount of time which the stylus contacts the side of the maze, and the total time from beginning to end (or speed). Two successive trials are performed with each hand, and total scores are obtained for the two trials with the dominant hand and the two trials for the nondominant hand.

Wechsler Intelligence Scale for Children (Wechsler, 1949)

The WISC (Wechsler, 1949), administered to children ages 5 to 15 years old, consists of six Verbal subtests (Information, Comprehension, Arithmetic, Similarities, Vocabulary, and Digit Span) and five Performance subtests (Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding). The test yields scaled subtest scores as well as three composite scores. Verbal IQ is a composite score derived from the six Verbal subtest scores indicative of overall "verbal" functioning. Performance IQ is a composite Score derived from the scaled scores of the five Performance subtests indicative of overall nonverbal "visual perceptual" functioning. Full Scale IQ is a composite score derived from the total scaled subtest scores, and it is indicative of overall "intellectual" functioning.
Target Test (Reitan & Davison, 1974)

The Target Test requires the subject to draw lines connecting dots to reproduce visual-spatial configurations of increasing complexity that have been tapped out by the examiner. The score is the number of items out of 20 correctly reproduced.

Speech Sounds Perception Test (Reitan & Wolfson, 1985)

The Speech Sounds Perception Test requires the child to attend to 30 tape-recorded nonsense syllables and underline the correct answer among a choice of three answers. The score is the number of sounds correctly identified.

Sentence Memory Test (Benton, 1965)

The Sentence Memory Test requires the subject to repeat tape recorded sentences of gradually increasing length (from 1 to 26 syllables). The score is the number of sentences correctly repeated.

Wide Range Achievement Test (Jastak & Jastak, 1965)

The Wide Range Achievement Test is a measure of academic achievement. It consists of three subtests (Reading, Spelling, and Arithmetic) at two age ranges (Level I: 5 to 11 years, Level II: 12 to 45 years and over). The Reading subtest measures oral single-word reading. The Spelling subtest is a measure of written single words to dictation. The Arithmetic subtest is a timed test that consists of mechanical arithmetic operations and mathematical reasoning problems. The scores are the number correct for each subtest. Raw scores on these subtests may be converted into standard scores, centiles, and grade equivalents.

adapted from Rourke, Fisk, & Strang (1986)
APPENDIX C
CRITERIA USED TO IDENTIFY NLD CHILDREN

Step 1
For the purpose of the initial selection from the empirically-derived subtype, each child had to evidence at least the following characteristics (specific variable findings and their relationship to appropriate age-dependent norms are in parentheses):

1. **Bilateral tactile perceptual deficits** (performance on measures of finger agnosia or dysgraphesthesia was 1 SD or more below the norm).

2. **Bilateral psychomotor deficiencies** (performance on the Grooved Pegboard Test was 1 SD or more below the norm).

3. **Visual-Spatial/Organizational deficiencies** (performance on the Target Test was 1 SD or more below the norm, and Verbal IQ > Performance IQ by 10 or more standard score points).

4. **Good verbal capacities** (Verbal IQ > 79 and performance on either the Speech-Sounds Perception Test or the Auditory Closure Test equal to or no greater than 1 SD below the norm).

5. **Mechanical arithmetic deficiencies** (performance on the WRAT Reading and Spelling subtests exceeding that of the WRAT Arithmetic subtest by 10 or more standard score points).

The above liberal criteria were used in order to identify all potential subjects, and are not to be construed as the defining features of the NLD syndrome.

Step 2
Once all the potential subjects were identified, their neuropsychological reports were reviewed independently by the author and another clinical neuropsychology doctoral student. Only those children who were considered to exhibit the neuropsychological and academic features of the NLD syndrome were included. Criteria relating to difficulties in adapting to novel or otherwise complex situations were not employed in the selection process, since it was not always possible to determine precisely that the child was experiencing such difficulties.

Step 3
Inter-rater correlational analyses were undertaken to assess inter-rater reliability.

adapted from Casey, Rourke, & Picard (1981)
VITA AUCTORIS

Loretta Johns was born and grew up in Philadelphia. She accepted University and State Scholarships at the University of Pennsylvania where she earned a Bachelor of Science in Education with a Fine Arts minor in 1977. She interned and taught at the Marianne Frostig Center for Educational Therapy in Los Angeles, and then accepted a Teaching Fellowship in Special Education and a Charlotte Newcombe Scholarship in Fine Arts at Glassboro State College in New Jersey where she earned a Master of Arts Degree in Learning Disabilities in 1985. While conducting a private practice as a Learning Disabilities Specialist, she began graduate coursework at Drexel University in Philadelphia, involving a clinical practicum at the Brain-Behavior Laboratory of the Hospital of the University of Pennsylvania. In 1988 she began her doctoral studies in Clinical Neuropsychology on a Visa Scholarship at the University of Windsor, encompassing a clinical practicum at Columbia-Presbyterian Neurological Institute in New York City in 1990.