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Darren R. Fuerst

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Psychosocial Functioning of Children with Learning Disabilities: The Relations Between Psychosocial Subtypes and Neuropsychological Functioning at Three Age Levels

by

Darren R. Fuerst
B.A. York University, 1983
M.A. University of Windsor, 1985

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

Windsor, Ontario, Canada
1991
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ABSTRACT

The aims of this study were threefold: 1. develop a psychosocial typology of children with LD; 2. assess the external validity of the resulting typology; 3. explore the relations between age and psychosocial functioning. To this end, a sample of 728 children with LD between the ages of 7 and 13 years was constructed. All children met a commonly used set of criteria for LD (including normal intelligence, evidence of underachievement on a standardized test of academic skills, and no evidence of primary psychopathology) that has demonstrated good performance in previous research. For some analyses, children were subdivided into three age levels: Young (7-8 years old; 201 subjects), Middle (9-10 years; 258 subjects), and Old (11-13 years; 269 subjects).

Psychosocial functioning was defined by scores on the Personality Inventory for Children (PIC). Measures used for determining the external validity of the subtypes included all subtests of the WISC plus FSIQ, VIQ and PIQ, WRAT Reading, Spelling and Arithmetic, a variety of neuropsychological tests selected on the basis of recent research into the neurocognitive ability structure of children with LD, and factor scales summarizing performance on the major dimensions of that structure.

Two methods were used for derivation of psychosocial subtypes. The first method employed k-means cluster analysis, applied separately to each of the Young, Middle and Old
samples, using Euclidean distance as the dissimilarity measure calculated on 10 PIC scales transformed in such a manner as to emphasize profile shape over the elements of elevation and dispersion. The resulting k-means partitions were validated by replication using a variety of hierarchical-agglomerative clustering techniques. The subtypes found at each of the three age levels were similar, and were strongly related to clusters found in a psychosocial typology developed in previous research. Overall, within each of the three age levels there were no differences between subtypes on WISC, neuropsychological, or factor scale measures. There was some evidence that, in the Middle and Old typologies, children in severely disturbed subtypes tended to show higher WRAT Reading scores, and the largest differences between WRAT Reading and Arithmetic.

The second method of classification involved assigning subjects to the subtypes of a prototypical typology derived in previous research on the basis of similarity of PIC profile shape. Overall, there were no substantial differences between the resulting subtypes on WISC, neuropsychological, or factor scale measures. However, as with the cluster analysis derived subtypes, there was a tendency for severely disturbed subtypes to show higher WRAT Reading scores, and the largest WRAT Reading versus Arithmetic discrepancies. When the subtypes were further broken down at Young, Middle, and Old age levels, there were no substantial differences between the resulting
mean PIC profiles, in terms of either profile shape or elevation, within each subtype. There was an extremely slight tendency for Cld subjects to be found in subtypes characterized as Conduct Disorder and Internalized Psychopathology, although the validity of this finding was questionable.

Overall, the results suggested that the patterns and level of psychosocial adaptation of children with LD are remarkably stable across the age range addressed in this study. It appears that as children with LD grow older they show no greater incidence of pathological patterns of psychosocial functioning. Although some children in this study showed evidence of relatively severe psychopathology, there was no evidence that, with increased age, level of psychosocial adaptation deteriorates. These results contradict the commonly held notion that children with LD are likely to develop psychopathology from the cumulative effects of negative academic and interpersonal experiences. Rather, they suggest that, when significant changes in the psychosocial functioning of children with LD are observed, other factors must be considered.
ACKNOWLEDGEMENTS

I would like to thank each of my committee members for their unique and valuable contributions to this project. Dr. Ferguson is a "survivor", having served on both my Master's and Doctoral committees. In both instances his ability to discern and concisely summarize critical methodological and conceptual issues has considerably strengthened the final result. Dr. Shore, as both teacher and committee member, has always impressed me with his aptitude for keeping perspective and asking the "big" questions when I was caught up with minutia. Dr. Fisk deserves special thanks, for it was he who provided me with a start in this area of research some seven years ago. Many of the questions that are addressed in this study were originally posed by Dr. Fisk; I trust that we have been able to answer some of them along the way. I am very grateful to Dr. Morris for his work as the external examiner of the committee. His positive remarks regarding the research and his final approval of the dissertation are particularly meaningful to me given his stature in this area.

Finally, my warmest thanks are reserved for Dr. Rourke. Dr. Rourke has had primary responsibility for my graduate education, and his influence on my development as both a researcher and a clinician cannot be overstated. He is one of the very few teachers who always leads from the front, challenging his students to keep up. While few of us manage to do so, we are better for trying.
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CHAPTER I: INTRODUCTION AND LITERATURE REVIEW

In this review, contemporary evidence that addresses two major hypotheses (Hypothesis 2 and Hypothesis 3 below) regarding the relationships between socioemotional function/dysfunction and learning disabilities in children is reviewed. Where possible, remarks are confined to relatively recent research (1980 or later) and older studies are included only where they are of some historical significance or are especially germane to the immediate issues. In view of the large quantity of material to be reviewed, the potentially related topics of hyperactivity and attentional deficit disorders, and treatment considerations are not addressed in the current review. Before dealing with the two hypotheses that are of particular concern to this paper, another, widely held position (Hypothesis 1) should be outlined and discussed: specifically, the notion that socioemotional disturbance causes learning disabilities.

Hypothesis 1:
Socioemotional Disturbance Causes Learning Disabilities

In this view, learning problems that children face in school and elsewhere are thought to constitute one reflection of systematic disturbances in socioemotional functioning (e.g., unresolved psychic conflicts). The evidence for this assertion comes from a variety of sources: some are empirical (e.g., Colbert, Newman, Ney, & Young, 1982), but most are "clinical" in nature (e.g., Brumback & Staton, 1983; Ehrlich,
1983). For example, it has been observed by many whose professional work brings them into contact with youngsters who are experiencing problems in academic achievement that a significant proportion of these children suffer from one or more difficulties of a socioemotional sort: e.g., personality conflicts with their teachers that render learning in the classroom difficult, if not impossible; strain associated with difficulties in meeting the (exaggerated) perceived demands of their parents and teachers; extreme psychic conflicts that render them almost incapable of benefitting from ordinary scholastic instruction; "inappropriate" motivation for academic success and social expectancies at variance with those of the school; major psychiatric disorders, such as depression, that remain undiagnosed and/or untreated (Rourke, Bakker, Fisk, & Strang, 1983; Rourke, Fisk, & Strang, 1986). These examples illustrate the following: that social conflict between teacher and student should be kept to a minimum if academic learning is to proceed apace; that unrealistic ego-ideals can, and usually do, have a profound negative impact on performance; that significant intrapsychic conflicts or psychiatric disorders, no matter how generated and maintained, can impact significantly on academic performance; and that the school is largely a middle-class institution that requires at least the temporary adoption of its standards (in North America, largely those of the Protestant Ethic) for success in its programs.
These few examples should serve to illustrate the enormous number of complex sets of interactions that can serve to limit significantly the academic progress of untold numbers of students. In all of these instances, the socioemotional "problem" antedates the difficulty in learning; this is so even in the first example cited above. Furthermore, it is assumed that, were the socioemotional problem to be resolved, satisfactory academic performance would ensue. Thus, solving the student-teacher personality conflict, bringing ego-ideals more closely in tune with reality, rectifying the intrapsychic conflict or psychiatric disorder, and leading the student to adopt a motivational posture and social-expectancy set that are more in line with those of the school would be expected to lead eventually to satisfactory academic progress.

This having been said, it is also necessary to point out that these matters really have to do with academic and other learning difficulties that are not usually included under the rubric of "learning disability." The latter term is commonly reserved for persons whose significant problems in learning are not a result of primary emotional disturbance (or mental retardation, primary sensory handicap, inadequate instruction, inappropriate motivation, or cultural/linguistic deprivation—the "exclusionary" criteria embodied in most definitions of learning disabilities). Thus, although interesting in and of themselves, and of obvious importance for the total understanding and treatment of children's problems in
learning, these factors are not properly considered within the context of socioemotional correlates of learning disability. Hence, the remainder of this review will be devoted to those considerations that fall quite precisely within the latter domain.

Hypothesis 2:

Learning Disabilities Cause Socioemotional Disturbance

The first major hypothesis of interest within the present context is one that, as in the aforementioned view, proposes a causal link between learning difficulties and socioemotional disturbance (Rourke & Fisk, 1981). The differences in this instance are that (a) "learning disability," as commonly defined (Rourke, 1975), is the focus of interest, and (b) the causal relationship is reversed: That is, it is proposed that learning disabilities lead to disrupted or aberrant psychosocial functioning. This general proposition has a very compelling, tacit appeal for most clinicians; it concretizes a view that is widely held and which has become almost a cornerstone of clinical lore in this area. The reasons for the *prima facie* appeal of this view are numerous. For example, it appears to make good clinical sense to maintain that a learning-disabled youngster who persists in his/her learning problems throughout the elementary school years will be the unwilling (and, perhaps, unwitting) butt of criticism and negative evaluations by parents, teachers, and age-mates; that these criticisms will serve to render the learning-
disabled child more anxious and less self-assured in learning situations; that a vicious circle will develop which increasingly hampers academic success and encourages progressively more debilitating degrees of anxiety (i.e., learning failure results in increased anxiety, which results in feelings of inferiority, which results in additional learning failure, and so on); that this sort of undesirable situation is virtually inevitable and would be expected to increase in severity as the child fails to make advances in learning.

Research in support of this position has focused on the emotional, social, and behavioural functioning of children with LD, with particular regard to their interpersonal environment. In this division of the review, current research relevant to, or advanced in support of, variants of this general hypothesis are examined. Four specific areas of investigation are scrutinized: (1) patterns of general psychosocial functioning and pathology; (2) social status with respect to peers and teachers; (3) self-concept/self-esteem and attributions; (4) social competence.

**Psychosocial Functioning and Pathology**

The various techniques that have been used to assess general aspects of psychosocial functioning and psychopathology in children with LD are as diverse as those applied to any other subgroup of children. Many classification schemes have been used to categorize and
summarize the results of studies in this area and, as in other areas of LD literature, there is no consensus regarding the "best" scheme. In this exposition, studies utilizing observation of classroom behaviour, checklists/rating scales, personality inventories, and longitudinal outcomes are examined. Note that the specific methodological pros and cons of these various approaches are (see, for example, Schumaker & Hazel, 1984, for this information), and it is also assumed that readers are familiar with the measurement methods and instruments used in the studies reviewed below (see, for example, Barkley, 1988, for detailed descriptions).

Observation of Classroom Behaviour

While some investigators have relied on psychometric instruments to assess psychosocial functioning of children with LD (see below), others have adapted behaviour analysis procedures, and have introduced direct observation methods into the classroom. The utilization of this group of techniques seems to have become somewhat less popular in recent years, despite evidence suggesting that measures of classroom behaviour may be useful for predicting academic achievement in normal children (McKinney, Mason, Perkerson, & Clifford, 1975). For a detailed review of such studies prior to 1978, see Hoge and Luce (1979). Note that most direct observation studies included in this review (such as those of Bryan or McKinney and colleagues) are reviewed in other sections where they have particular relevance to the topic.
under consideration. Only two representative studies will be examined in this section.

In an early study, Richey and McKinney (1978) contrasted the behaviour of 15 third and fourth grade male LD students (identified in a previous study) with a matched sample of normally achieving students from the same classrooms. Richey and McKinney used two observers per matched subject pair (with data collected across a 3-day period) on 12 general categories of behaviour (covering task-oriented, social, and affective dimensions), at 10-second intervals over a 10-minute period (i.e., 180 instances of observation per subject). Overall, the children with LD differed from normal children on only one dimension, viz., distractibility. The children with LD showed no evidence of the negative behaviours often ascribed to them, such as conduct problems, hyperactivity, or passivity and dependency. Similar results regarding task-oriented behaviour/distractibility have been reported in subsequent studies (e.g., Feagans & McKinney, 1981; McKinney & Specce, 1983; Tarver & Hallahan, 1974).

More recently, Sprafkin and Gadow (1987) compared the observed behaviours of 26 male LD students (identified by the school system) and 27 male emotionally disturbed (ED) students between the ages of 5 and 9 years. Two observers collected data on each subject across a 3-day period, on 5 general categories of behaviour (physical and nonphysical aggression, noncompliance, immature and socially inappropriate
behaviours), at 30-second intervals over a 6-minute period, in 3 different settings (classroom, lunch, and recess). Overall, the results were thought to demonstrate that the ED children demonstrated much more noncompliant and aggressive behaviour than did the children with LD. Sprafkin and Gadow (1987) concluded that, contrary to some opinions, LD and ED children differ significantly on important, intervention-relevant, behaviours.

Checklists/Rating Scales

In a seminal investigation in this area, McCarthy and Paraskevopoulos (1969) compared the Behavior Problem Checklist (BPC; Quay & Peterson, 1975) scores of 36 LD (unspecified selection criteria), 100 emotionally disturbed (ED), and 41 normal students, as rated by their teachers. The raw scores were transformed to scores on three factors identified in previous research, viz., unsocialized aggression, immaturity-inadequacy, and personality problem. In general: The ED children were rated worst; normal children, best; and LD children at levels intermediate to the other two groups. The main behaviour problem of ED and LD children was conduct problem behaviour (disruptiveness, problems with attention, fighting, etc.). In the LD group, problems of immaturity-inadequacy and neurotic behaviour were of about equal importance; however, in the ED group, the latter behaviours were of less importance. McCarthy and Paraskevopoulos (1969) concluded that, while ED and LD
children share some behavioural characteristics that
distinguish them from normal children, these two groups also
demonstrate some unique features.

Gajar (1979) reported somewhat different results when she
compared the BPC ratings of 135 LD (identified by unspecified
means), 122 ED, and 121 educable mentally retarded (EMR)
children. In this study, instead of calculating factor
scores, the investigator summed ratings on the items for each
factor and transformed them into a percentage of total items
for that factor (a somewhat unusual procedure). Gajar found
that the ED group scored significantly worse than the LD or
EMR children on the conduct disorder and personality problem
factors, and worse than the EMR group on the
immaturity-inadequacy dimension. This would suggest that, as
in the previous study, there are some similarities, but also
some differences, between children with ED and children with
LD.

A study by Richmond and Blagg (1985) found results even
more divergent than those of McCarthy and Paraskevopoulos
(1969). In this investigation, school-identified groups of
LD, behaviour disordered (BD), EMR, and normal children were
compared on four dimensions of the BPC. Overall, the normal,
LD, and EMR groups were indistinguishable; only the BD group
scored significantly worse on BPC dimensions (Abelson &
Mutsch, 1985, have reported similar results using a different
rating scale).
Cullinan, Epstein, and colleagues have published a number of studies comparing the BPC scores of LD and other subgroups of children. For example, Cullinan, Epstein, and Lloyd (1981) compared the BPC teacher ratings of 50 LD (identified by the school system) and 50 normal students, ranging from 6 to 18 years of age, matched for age and sex (25 males and 25 females in each group). Sums of mild and severe ratings on items were used to derive scores on three dimensions of the BPC (conduct disorder, personality problem, and inadequacy-immaturity). Overall, the LD students demonstrated more behaviour problems than did normal students. Further analyses revealed that the children with LD differed from the normal children only on the personality problem dimension. Although, overall, boys tended to show more behaviour problems than did girls, there were no significant sex differences on any of the specific dimensions. Cullinan et al. (1981) concluded that children with LD show socioemotional differences from normal children in areas of anxiety, self-confidence, withdrawal, depression, and similar behaviours measured by the personality problem dimension of the BPC.

Epstein and Cullinan (1984) attempted to extend these findings by comparing the BPC scores of 13 age-matched quartets of normal, LD, EMR, and behaviour disordered (BD) (identification techniques unspecified) junior and senior male high school students. In this study, scores on four dimensions of the BPC (conduct disorder, personality problem,
inadequacy-immaturity, and socialized delinquency) were calculated in the same manner used by Cullinan et al. (1981). The investigators found that the BPC could discriminate the normal children from all other groups on the personality and conduct disorder dimensions. The BD group scored worse than all other groups on all dimensions. The LD group performed much like the EMR group (i.e., midway between the normal and BD groups), with the exception that the EMR group showed greater inadequacy-immaturity scores. Epstein and Cullinan (1984) argued that, considering the results of previous research (Cullinan, Epstein, & Dembinski, 1979; Cullinan et al., 1981), it would appear that, as children with LD become older, teachers tend to see them as becoming somewhat worse in terms of psychosocial functioning. This view was based on the finding that the older children in the present study scored higher relative to normal children on both the conduct disorder and personality problem dimensions, rather than just on the latter dimension as was found in the Cullinan et al. (1981) study.

Noting that most studies of LD and BD students have used a preponderance of male subjects, Cullinan, Schultz, Epstein, and Leubke (1984) formed 45 age matched quartets of normal, LD, EMR, and BD females between the ages of 12 and 16 years, and then compared them on four BPC dimensions, calculated in the same manner used in Epstein and Cullinan (1984). The results were similar to those found by Epstein and Cullinan
(1984). BD subjects scored more highly on the conduct disorder, inadequacy-immaturity, and socialized delinquency dimensions. The EMR children obtained scores equivalent to those of normal subjects on all dimensions. The LD and BD girls scored at comparable levels on the personality problem dimension, with both showing significantly more problems than did the normal subjects. Cullinan et al. (1984) concluded that LD (and BD) girls demonstrate psychosocial problems that are quite similar to those found in LD (and BD) boys.

In a study by Epstein, Cullinan, and Bursuck, a somewhat different procedure was used to analyze BPC scores. In this study, the investigators collected BPC ratings on relatively large samples of younger (6-11 years) and older (12-18 years) male and female LD and normal (school identified) students. Rather than calculating scores on the major BPC dimensions, as was done in previous studies, the investigators determined the prevalence of each BPC item within each of the subgroups (i.e., the percentage of the total subgroup for which an item was checked). Overall, the LD students were rated as being substantially more deviant than the normal subjects. Specifically, LD students showed more attentional problems, social and emotional coping problems (such as anxiety), and, in LD males, aggressive conduct problems. In the latter case, problem behaviours typically involved classroom disruption rather than truly delinquent behaviours (such as stealing). Interestingly (see the Hypothesis 3 section below), LD
students also showed a much higher incidence of mild motor impairments (from 2 to 5 times the incidence in normal children for LD boys and girls, respectively). Within the LD group, the incidence of attention problems tended to decrease with age. The LD girls tended to show more "internalized" problems at later ages, whereas LD boys tended to become more rebellious and "externalized".

Research with other behaviour rating scales and checklists has provided essentially similar results. For example, Cohen and Hynd (1986) and Margalit (1989) have reported findings similar to those of McCarthy and Paraskevopoulos (1969) using the Conners Teacher Rating Scale (Conners, 1969, 1973). Harris, King, Reifler, and Rosenberg (1984) compared 30 male 6-to 12-year-old LD (State identified) and 30 matched ED children on teacher-completed Child Behavior Checklist (CBCL; Achenbach, 1978; Achenbach & Edelbrock, 1979, 1981, 1983) scores. Overall, the ED boys showed much more behaviour disturbance than did the LD boys. However, about 50% of the LD boys had CBCL scales falling within the "clinical" range, and within this subgroup of LD students a wide range of pathology was observed (aggressive behaviour was relatively common). McConaughy and Ritter (1986) collected parent-completed CBCL scores of 123 6-to 11-year-old male children with LD (identified by individual psychoeducational assessment). As compared to CBCL norms, the children with LD exhibited lower social competence and more behaviour problems
at rates of clinical significance for both the internalizing and externalizing variety. McConaughy and Ritter (1986) noted, however, that relatively few of the children showed a delinquent profile.

**Delinquent Behaviour**

This may be an opportune point to examine briefly the potential link between learning disabilities and delinquent/antisocial behaviour. The reader is referred to a recent review by Larson (1988), for a more detailed examination of this issue. A number of studies have indicated that there is a marked coincidence of learning problems and delinquent/antisocial behaviour. For example, Sturge (1982) found that in a sample of 1689 10-year-old children, 11% exhibited evidence of reading retardation, and 17% exhibited antisocial behaviour. There was an overlap of 3.6% between these two categories (i.e., children exhibiting both reading retardation and antisocial behaviour), which may appear small, but is somewhat greater than would be expected by chance alone (2.2%). Within delinquent populations, the prevalence of learning disabilities is estimated to be anywhere from 26% to 73% (Larson, 1988).

Unfortunately, methodological problems are rampant in, if not virtually endemic to, this area of research. A study by Wilgosh and Paitich (1982) is an excellent example of this point. They examined 99 adjudicated delinquents, and found that more than 60% of the subjects were "learning disabled".
However, they failed to assess level of psychometric intelligence adequately (using only Raven's Progressive Matrices [Raven, 1960] and the Wechsler Intelligence Scale for Children [WISC; Wechsler, 1949, 1974] Vocabulary subtest) and they also failed to screen for educational and cultural deprivation, perceptual and speech anomalies, primary psychopathology, and a number of other very important "developmental" dimensions. Furthermore, their "diagnosis" of "learning disabilities" was essentially made solely on the basis of discrepancies between Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965) subtest scores and grade placement. All that these investigators demonstrated was that a high proportion of adjudicated delinquents show evidence of academic underachievement.

The results of most studies reviewed in this and other sections of this paper indicate that the great majority of children with LD do not demonstrate truly antisocial or delinquent behaviour. As Sturge (1982) has pointed out, there is no simple association between LD and antisocial/delinquent behaviour (i.e., the apparent relationship may be an artifact), and associated factors, such as culture, SES, family environment, peers, and other disadvantageous influences, must be properly assessed before valid conclusions can be drawn. See Bryan, Werner and Pearl (1982), and Schumaker, Hazel, Sherman and Sheldon (1984), for interesting studies of conformity and peer influence in this context.
Personality Inventories

As Goh, Cody, and Dollinger (1984) have pointed out, assessment of personality of children with LD using "objective" inventories has been relatively rare, perhaps due to the paucity of suitable instruments. One personality inventory that has been employed rather extensively in empirical studies in this area is the Personality Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977, 1984). The PIC is an interesting research tool in that it is relatively convenient to administer and score, provides good coverage of various behavioural domains, has acceptable norms, and has actuarial interpretive guidelines (see Wirt et al., 1977, 1984, for details).

Harrington and Marks (1984) noted that commonly used procedures for assessing psychosocial adaptation in diagnostic contexts may require substantial professional resources. They noted the convenience, and other laudable aspects, of the PIC, and wondered if the Adjustment scale (a measure of general psychosocial functioning) could serve as a screening instrument in psychoeducational assessment. To this end, they compared the Adjustment scale scores of 11 normal, 14 LD, and 10 behaviour disordered (BD) children in grades 1 to 6. The results showed that the Adjustment scores of the BD children were significantly higher (i.e., suggesting greater pathology) than were those of both the normal and LD subjects. Although the LD subjects showed a mean Adjustment score within the
clinical range (72 T), this was not significantly higher than that of the normal children (60 T). Although Harrington and Marks (1984) were suitably cautious in interpreting their results, they failed to note that the Adjustment scores of the LD subjects also showed a substantial degree of variability (about 23 T), suggesting that some of their LD subjects had distinctly pathological elevations on this scale. A study carried out by Forbes (1987) confirms this impression. When the Adjustment scores of 100 children (6-to 12-years of age) referred to a private clinic were examined, 46% of children with scores greater than 84 T had a diagnosis of LD (made by the school system), versus 12% of children with scores below 84 T. This was thought to suggest some association between LD and disordered psychosocial functioning.

Other researchers have examined the full complement of PIC scores in an attempt to determine if PIC profiles can discriminate LD from other diagnostic categories. For example, Goh et al. (1984) contrasted the PIC profiles of 30 LD (diagnosed by an "interdisciplinary team") and 30 BD children with a mean age of about 9 years. The results showed that, overall, the PIC profiles of the children with LD were within roughly normal limits, whereas the profiles of BD children showed significant elevations on a number of scales. Using a profile classification system developed by DeHorn, Lachar, and Gdowski (1979), Goh et al. (1984) found that about 27% of LD subjects had normal PIC profiles, 37% had profiles
indicative of respondent concerns over cognitive development, and about 20% had profiles characterized by concern with both cognitive development and internalized psychopathology. Overall, only 36% of LD subjects had PIC profiles indicative of psychopathology versus 87% for the BD subjects. Results roughly consistent with those of Goh et al. (1984) have also been reported by Forbes (1987).

**Longitudinal Studies**

Common to Hypothesis 2 approaches is the notion that the negative consequences of LD, in some manner, distort the development of psychosocial adaptation over time. It is often argued that, as children with LD grow older, their socioemotional difficulties should worsen. Even if academically related frustration and failure become less important as children move towards adulthood, the adaptive demands that are commensurate with advancing age do not lessen. Indeed, one would expect that they probably become more complex, with consequent negative impact in psychosocial functioning for those who do not achieve at developmentally appropriate levels. For example, Capute and Accardo (1980) have maintained that the typical outcome for an adolescent with LD is "an illiterate, unemployable teenage dropout, addict, and potential suicide" (Capute & Accardo, 1980, p. 298).

Some researchers have followed children with LD for extended periods of time to determine if, indeed, the long-
term prospects for these children are poor. With respect to psychosocial functioning, early studies produced equivocal results (see Horn, O'Donnell, & Vitulano, 1983, for a review of research prior to 1980, and a discussion of methodological issues): Specifically, there is evidence for both poor (Cerny, 1976; Werner & Smith, 1979) and adequate (Abott & Frank, 1975; Edginton, 1975) psychosocial outcomes for persons with LD. A representative sample of the results of studies in this area follows.

Fafard and Haubrich (1981) conducted a follow-up study of 21 young adults, ages 16 to 23 years, with LD (diagnosis based on standardized testing) at anywhere from 10 to 19 years after initial contact with the investigators' institution. An interview, consisting of 20 questions covering academic, vocational, and social adjustment, was administered to subjects and their parents. In general, the majority of subjects had finished high school, found employment, and had adequate psychosocial adaptation. A small number of parents did express concern about their child's ability to make friends, and some subjects did appear to be dependent on family for social activities (more so, perhaps, for females). The greatest difficulties for these children (now adults) appeared to be in the area of career/vocational counselling and assistance. Psychosocial outcomes seemed to be relatively benign (i.e., there was no significant degree of psychopathology reported).
Levin, Zigmond, and Birch (1985) carried out a four-year follow-up study of 34 children with LD, identified as such by the school system when in ninth grade (most had already been recognized or diagnosed as LD by age 9). Four years later, about 30% of the participating students (i.e., 11 subjects) had left school, and most of those remaining in school were still receiving special education. Of those drop-outs who participated in the study, about 60% (7 of 11 students) had been asked to leave school because of behaviour problems. While only 2 of 11 (18%) drop-outs were employed, 8 of 11 (73%) were enrolled in alternative (GED) or vocational programs. Self-concept scores (discussed in detail below), as measured by a standard instrument, were within normal limits initially (in the ninth grade) and showed positive increases at follow-up. Considering that this was a clearly handicapped population four years before follow-up, and that at follow-up most had either dropped out of school or were still receiving special education, the psychosocial outcome, to the limited extent that it was addressed in this study, would appear, once again, to be relatively good.

Jorm, Share, Matthews, and Maclean (1986) assessed 543 children entering kindergarten on psychosocial measures, and again at two and three years after entering school. At the end of the study, children were administered various cognitive and reading tests, and classified as either normal, "specific retarded readers" (reading achievement below predictions based
on age and cognitive measures), or "backward readers" (underachieving readers not making criterion for retarded readers). The results were thought to demonstrate that backward (underachieving) readers had behavioural problems, primarily in the domain of attention deficit and hyperactivity, at the time they entered school; normal and specific retarded readers did not differ on these measures. Jorm et al. (1986) speculated that, for the backward readers, behavioural problems either caused the reading problems or that some common factor was causing both the reading and emotional problems. However, the specific retarded readers showed no psychosocial disturbance either at school entry or after their reading problems had become manifest.

McGee, Williams, Share, Anderson, and Silva (1986) performed a similar study, taking psychosocial ratings from teachers and parents for children at 5, 7, 9, and 11 years of age. The children selected for investigation were 18 boys with specific reading retardation (reading substantially below prediction based on WISC Performance IQ score; i.e., reading disabled), 22 boys with general reading backwardness (reading lower than age expectations, but not substantially below predicted level based on Performance IQ), and a comparison group of 436 other boys meeting neither of these criteria. The results were thought to demonstrate that both groups of children with reading difficulties manifested problem behaviours at school entry (mainly of aggressive and
hyperactive types) and that these problems tended to become somewhat worse over time - peaking at about age 9, but continuing at relatively high levels at age 11 - especially for the reading disabled boys. At age 11, 57% of the reading disabled boys met DSM III diagnostic criteria for psychiatric disorder (mainly attention deficit, conduct disorder, and/or oppositional behaviour), as did 47% of the general reading backward children, versus 18% of the comparison group. In contrast to Jorm et al. (1986), McGee et al. (1986) concluded that reading disabled children are about three times as likely to evidence psychopathology as are normal children, and that the problem behaviours of these children worsen with age. However, nondisabled children with reading problems showed similar socioemotional disturbance and, as problem behaviours were already present on entry to school, reading disability per se could not be directly causing problems in psychosocial functioning (similar results with non-LD children have been reported by Kohn & Rosman, 1974).

Finally, Spreen and colleagues have carried out longitudinal studies of children with LD over a time span of more than 15 years. The results of this project are summarized in Spreen (1988). Given the wealth of published material that has been generated from this research, the following synopsis has been derived from that source. (Interested readers should refer to Spreen (1988) for detailed information and relevant citations.)
In the first phase of the research documented in Spreen (1988), 203 children with LD (identified as such using standardized measures and exclusionary criteria) and their parents were interviewed about 9 years after their first contact with the investigators. A matched sample of 52 children was selected as a control group. In addition to a structured interview, behaviour rating scales and a personality inventory were administered. The results were not encouraging. The LD subjects at the first follow-up showed evidence of greater socioemotional disturbance and antisocial behaviour. There was, however, no difference in the number of contacts with the police or offences committed by LD or control subjects, and there were no differences in the use of alcohol or illegal drugs. Thus, overall, there was no evidence of greater delinquency in the LD group.

In the second phase of the research program, subjects were again assessed about six years after phase one. By then, most subjects were in their mid-twenties. The results were comparable to those found in the first phase. There was no evidence of greater delinquency or drug use in the LD group. However, the LD subjects did experience greater psychosocial disturbance. On the MMPI, the LD females tended to have profiles suggestive of low self-confidence, brooding, social alienation, and depression; males tended to show evidence of autistic behaviour and disruptive thought. Spreen (1988) concluded that, overall, the long-term psychosocial outcome
for children with LD is relatively poor. However, he cautioned that variability in outcomes was substantial. Some of the LD subjects were productive, well adjusted members of the community, whereas others were found in group homes, prisons, or institutions.

Summary

While the results of classroom observation, checklist/rating scale, personality inventory, and longitudinal studies are often contradictory, it would appear that, as a group, children with LD are at somewhat greater risk for aberrant psychosocial development or psychopathology. However, it is also clear that not all children with LD fare poorly in these respects: The range of psychosocial outcomes is probably as great as that seen in normal children (i.e., some do very well, some do moderately well, some do poorly, etc.). Although, on average, children with LD may fare worse relative to their normal peers, reliable estimates of the incidence of various degrees and types of disordered psychosocial adaptation have not emerged from the literature. Considering the studies reviewed above, a simple and clear causal link between LD and psychopathology has not been demonstrated.

Social Status

The extent to which children with LD are accepted, rejected, or ignored by peers and teachers has been a lively area of investigation for the last 15 years or so. There
appear to be two main reasons for this interest. First, the social status of children with LD may provide a general marker of socioemotional functioning, as it seems logical to assume that children with psychosocial deficits or frank psychopathology will have difficulty interacting with and gaining the acceptance of peers and teachers. Second, social status may interact with psychosocial functioning in a bidirectional manner: That is, low social status may adversely affect psychosocial functioning, which in turn may affect social status, and so on (although some researchers, such as Asher, 1983, have proposed purely unidirectional models). The volume of studies in this area precludes detailed review within the confines of this paper. For studies prior to the mid-1980s the reader is referred to two comprehensive and cogent reviews by Dudley-Marling and Edmiaston (1985) and Wiener (1987). Studies of historical interest and more recent investigations are discussed in this section, which is divided in terms of the techniques typically employed in such studies.

**Nomination Techniques**

Perhaps the most oft-cited study of social status of children with LD is an investigation by Bryan (1974b). In this study, the sociometric status of 84 LD students (identified by school authorities) in grades 3, 4, and 5, was contrasted with the status of normal subjects matched on sex, race, and classroom. A "nomination" technique, in which the
children in a classroom are asked to identify other children with various positive and negative social characteristics (e.g., best friend, most attractive, most anxious), was employed. Bryan examined the intercorrelations of the nomination items, and identified two major independent dimensions of status: social acceptance and social rejection. Overall, the LD students received fewer acceptance nominations and more rejection nominations than did control students. On the dimension of rejection nominations there was also a sex by group (LD or control) interaction. Bryan (1974b) attributed this to a much greater rejection of female LD students relative to other subgroups (see, however, Dudley-Marling & Edmiaston, 1985, in which the authors point out that this conclusion is, in fact, a misinterpretation of the interaction effect). These findings were replicated in subsequent studies by the same author (Bryan, 1976; Bryan & Bryan, 1978).

Other researchers using similar techniques have found essentially the same results as did Bryan (1974b). For example, Scranton and Ryckman (1979) compared peer nominations of 42 primary LD students (identified using exclusionary criteria) with control subjects matched by home room. In this study, the school used an "open concept" system in which students moved about frequently; the investigators maintained that this would control for the potential stigma of attending special education classes, although they did not empirically test this assertion. (Recent research by Stephens, Wiener,
and Harris (1988) has in fact shown that degree of integration into the regular classroom is positively related to social status. The investigators found that, as in the Bryan (1974b, 1976) studies, LD students received fewer positive nominations and more negative nominations relative to control subjects. LD female students also appeared to be more rejected relative to other subgroups, and there were, in fact, no significant differences between normal and LD males on either positive or negative items. It should be pointed out, however, that subsequent studies have either not reported or have not found gender differences in social status (Wiener, 1987; see, for example, Shirer, Wiener, and Harris, 1988).

Siperstein, Bopp, and Bak (1978) compared peer nominations of LD students (identified by the school system) with those of 155 normal classmates. The authors elicited nominations in three major domains (academic ability, athletic ability, and physical attractiveness) plus general acceptance ("Who do you like the best?"). The results showed that, overall, LD students were significantly less popular than were their normal peers. However, there were no differences in the domains of athletic ability or physical attractiveness. Also, LD students were no more likely to be "isolates" (i.e., not nominated as a friend) than were normal students. LD students were, however, under-represented in the "star" category (defined as nomination by a high proportion of peers). Siperstein et al. (1978) argued that children with LD
may be socially hampered, but are not necessarily rejected, perhaps because of their strengths in nonacademic areas such as athletics.

A more recent study using the nomination technique has been reported by Landau, Milich, and McFarland (1987). This investigation is of interest because of the relative sophistication of its design: 65 male third to sixth grade LD students (identified by the school system plus exclusionary criteria) were compared to normal male classmates, and the LD students were additionally subdivided by WISC-R Verbal IQ (VIQ)-Performance IQ (PIQ) discrepancy (viz., VIQ=PIQ within 8 points, VIQ>PIQ by at least 15 points, or VIQ<PIQ by at least 15 points). (The general rationale for such an approach is discussed in detail in the Heterogeneity and Hypothesis 3 sections of this review.) Briefly, Landau et al. (1987) wondered if the social status difficulties of children with LD found in previous studies were due to difficulties of but a subgroup of these children, rather than being characteristic of all children with LD. The results confirmed that not all male LD children experience problems in social status. In general, the VIQ>PIQ children showed no significant differences in positive or negative peer evaluations relative to normally achieving classmates. In contrast, the VIQ=PIQ children were less popular and more likely to be rejected than normal children. The VIQ<PIQ subjects were less popular than normal children, and were also nominated as being more
socially withdrawn.

**Rating Scales**

The second method used to assess social status is by means of rating scales. In this technique, subjects are presented with a list of peers and are asked to rate them on various attributes (such as attraction, aggression, like-dislike, and so on). Theoretically, rating scales may provide more detailed information about social status than do nomination measures, as each child is rated by all classmates and, as names of all classmates are provided, children cannot inadvertently overlook certain peers (Sainato, Zigmond, & Strain, 1983). Also, there is clearly a difference between not being nominated as "best friend" or "best athlete" and not being accepted by peers.

In two of the earliest peer-rating studies, Erwininks (1978a, 1978b) contrasted the peer-rated social status of elementary school students with LD (identified by the school system) with normally achieving peers. In the first study, Bruininks (1978a) found that, overall, LD students received lower ratings relative to total class ratings, but only LD males were rated significantly lower than a comparison group. The comparison group was also more accurate in assessing their own social status, as LD subjects tended to overestimate their own popularity. In a second study, with a somewhat larger LD sample, Bruininks (1978b) found essentially the same results, in that LD students were once again rated lower than
comparison students, and tended to rate their own status more highly than did other students. Bruininks (1978b) determined that the LD students could accurately estimate the status of students in the comparison group, thus ruling out response bias (i.e., to always rate more positively) as a factor in misperception of their own status.

Studies using the peer rating technique have provided results which suggest that not all children with LD have lower than normal social status. Perlmutter, Crocker, Cordray, and Garstecki (1983) compared the social status and perceived social status ratings of 55 grade 10 LD students (identified by the school system) with 107 classmates. Overall, the classmates of LD students tended to rate them lower than they rated normally achieving peers. Classmates also tended to describe LD students as more aggressive and disruptive. Unlike Bruininks' (1978a, 1978b) findings, the LD students were no worse at predicting their social status than were normal students. In addition, Perlmutter et al. (1983) found that about 45% of the LD students received neutral ratings (not popular, but not disliked); indeed, one subgroup of LD students (about 20%) was rated quite highly (i.e., within the upper quartile of ratings of normal children) by their peers. In other words, this subgroup of LD children was as popular as the most popular normal children. Similar results have been reported by Siperstein and Goding (1983) using the nomination method.
Some researchers have found that, as a group, children with LD receive social status ratings that are comparable to normal children. For example, Sainato, Zigmond, and Strain (1983) administered the same rating scale used by Bruininks (1978a, 1978b) to LD pupils (presumably identified by the school system) and randomly selected normally achieving classmates. Overall, the range of ratings for the LD students was comparable to that of the ratings of their classmates. There was also no significant difference in mean ratings for the two groups. Bursuck (1983) has reported comparable results using a nomination technique.

A study by Sabornie and Kauffman (1986) is interesting not only for the results obtained, but also for a methodological variation that was employed. In their investigation, Sabornie and Kauffman selected 46 LD (identified by an interdisciplinary team within the school system) and matched control secondary school students from coed physical education classes. Peer social status ratings were obtained employing methods similar to those used in other studies, with the exception that "don't know them" responses, which, when provided for, are typically considered neutral responses, were treated separately as a measure of familiarity and did not contribute to social status scores. These investigators found that the social status of LD students was not significantly different from that of their normal peers. Although the difference in familiarity scores of LD and normal
subjects was not statistically significant, Sabornie and Kauffman (1986) argued that familiarity can impinge on measures of social status, and should be taken into account when assessing social acceptance. The authors also noted that the outlook for social acceptance of children with LD may not be as bleak as the results of some early studies would seem to suggest.

Finally, Hoyle and Serafica (1988) have reported the results of an investigation using both peer nomination and peer rating methods. In this study, 23 male LD students (identified by the school's diagnostic team) and matched control subjects were compared on peer nominations and on ratings of "like", "dislike", "neutral", and "unfamiliar" status. A questionnaire examining the child's social network (e.g., number and characteristics of relationships, frequency and type of interaction, etc.) was also administered. Overall, LD students differed from normal students on the status measures only in terms of the number of peer nominations received. Thus, they were less often named as a best friend, but they were not less liked, more disliked, or more unfamiliar than were normally achieving students. Interestingly, LD subjects less often named as friends those classmates who expressed liking for them, which suggests that LD students are less accurate in assessing their own social status, and perhaps have more general problems with social perception. (Note, however, that social perception and status
have been found to be only weakly related by Stiliadis and Wiener [in press], and unrelated by Bruck and Herbert [1982] and Martin [1985].) With respect to social networks, there was no difference in the size or composition of networks between LD and normal children. However, LD students were less likely to associate with classmates and engage in extracurricular activities. The children with LD also spent more time alone or with family and friends not connected to school, and they also studied more with members of their network (perhaps reflecting a need to work harder at academic subjects).

**Teacher Ratings and Interactions**

Relatively few studies have examined the social status of LD students as perceived by their teachers. Clearly, teachers' perceptions of LD students may influence their behaviour towards these children. That teachers do behave differently towards children with LD has been documented in studies using direct observation. For example, when attempting to initiate interaction with a teacher, children with LD are more likely to be ignored than are normal children (Bryan, 1974a; Bryan & Wheeler, 1972); however, teachers also tend to interact more frequently with LD students (Dorval, McKinney, & Peagans, 1982) and, when they do, they tend to make more negative evaluative statements than they direct to normal children (Bryan, 1974a). Dorval, McKinney, and Peagans (1982) found that more than half of teacher-initiated contacts
with LD students involved management of behaviour (usually due to inattention or rule breaking), and that these contacts were five times as frequent as compared to normal students. These investigators also found that, while LD students initiated interactions as often as did normal classmates, these contacts were much more likely to be contextually inappropriate (irrelevant and/or disruptive).

Few studies have actually examined teachers' attitudes towards children with LD. In the Perlmutter et al. (1983) study, teachers rated LD students as being less socially competent, and more aggressive and disruptive than their normal classmates (as did the LD student's peers, see above). These relationships obtained regardless of peer-rated social status. Garrett and Crump (1980) asked teachers to sort students into nine categories (from most to least preferred), and found that LD students were significantly less preferred than were their normal classmates. Siperstein and Goding (1983) found similar results when they asked teachers to rank students according to overall social performance and classroom behaviour. The LD students were consistently ranked in the lowest third of the class. Using direct observation techniques, Siperstein and Goding (1983) also found that teachers displayed more corrective and nonsupportive/negative behaviours towards LD students than towards normal classmates.

**Summary**

The available evidence indicates that, as a group,
children with LD may have somewhat lower social status relative to normally achieving peers. This should not be surprising, as research with non-LD children has also shown that, in general, academic achievement and social status are positively (but weakly) correlated (Green, Forehand, Beck, & Vosk, 1980). However, it would appear that only some children with LD have truly low social status, and are actively disliked/rejected by peers. On the other hand, some children with LD are quite popular, perhaps because they exhibit attributes that are important to their peers. As in most respects, children with LD are heterogeneous with regard to social status. (The importance of considerations relating to the issue of heterogeneity are discussed later in this report.) As yet, the nature and extent of relationships between peer status and other aspects of psychosocial adaptation are poorly understood, as are other predictors and correlates of social status (despite the assertions of some authors, such as Feigin and Meisgeier, 1987). Little is known of teacher perceptions and attitudes towards children with LD; however, the available evidence suggests that further investigation of these potentially important issues is warranted.

**Self-esteem/Self-concept**

The notion that children with LD are especially prone to being negatively shaped by academic and interpersonal setbacks and failures has been popular for some time. Unfortunately,
research in this area has tended to be fragmented, with few investigators detailing the precise theoretical framework in which their research hypotheses have been generated (see Pickar, 1986, for an example of exceptions to this assertion). In the interests of clarity, a general model which most investigators in this area appear to espouse is outlined as follows:

(1) Experiences of academic and interpersonal failure result in children with LD developing pathological patterns of attribution and locus of control. For example, such children may come to see their academic and social failure as due to external forces over which they have no control. Alternately, they may see failure as due to their own inadequacies, and their few successes as due to external events (such as luck).

(2) Over time, these children come to have reduced self-esteem and poor self-concept (e.g., feelings of inferiority). They may develop patterns of academic and interpersonal behaviour that are consistent with "learned helplessness."

(3) Poor self-concept, reduced self-esteem, learned helplessness, or other negative effects further interfere with academic and social functioning, possibly by fostering the development of aberrant behaviours, thus exacerbating their psychosocial problems.

There are many variants of this general model, but most
research in this area tends to follow, implicitly or explicitly, some form of the above line of reasoning. At the same time, it should be pointed out that our literature search did not unearth any investigations that examined all aspects of this model. Most studies have concentrated on rather limited portions of such models and present the other aspects as "givens," or logical extensions, without providing supporting empirical evidence for such assumptions.

Pathological Self-Esteem/Self-Concept

Obviously, the simplest investigative approach in research following the lines of this model would be to determine if children with LD do, in fact, evidence reduced self-esteem or pathological self-concepts. In one of the earliest studies addressing this issue, Zimmerman and Allebrand (1965) compared children with roughly normal intellectual abilities who were reading at least two years below grade placement with children reading at or above grade level. They found that, overall, the poor readers demonstrated much lower feelings of self-reliance, personal worth, and personal freedom, and greater feelings of anxiety and isolation. The subjects with reading disability exhibited attitudes towards achievement, as revealed by verbal responses to a projective item, that suggested feelings of discouragement and inadequacy, and a tendency to see learning tasks as imposed by authority and without personal benefit.

Empirical results and clinical observations consistent
with those of Zimmerman and Allebrand have been reported by a number of investigators. For example, Black (1974) compared matched groups of normal and retarded readers (defined as performance at least one-half year below grade level), and found that the retarded readers had lower (more negative) self-concept scores. Black (1974) also found that, in both groups, there were significant negative correlations between self-concept and the variables of age, school grade, and measures of reading achievement. Black argued that older students with learning disabilities view themselves more negatively than do younger LD students, and that children tend to judge their personal worth and adequacy on the basis of school performance.

More recently, Margalit and Zak (1984) compared groups of normal and LD children (identified by teachers and brief psychological assessment) on measures of self-concept and anxiety. They found that LD children showed more "pawning" anxiety (i.e., anxiety regarding events over which they felt they had no control) than did normal children; however, there was no difference between the groups in terms of anxiety over competency issues. Children with LD had lower self-concept scores overall, and they showed a tendency to have greater feelings of self-dissatisfaction.

Winne, Woodlands, and Wong (1982) compared measures of self-concept between groups of normal, gifted, and LD students who were selected on the basis of tests of vocabulary,
reading, and teacher ratings. The self-concept scales covered rather diverse domains, including physical abilities and appearance, intellectual and academic ability, and peer and home relationships. The investigators took some trouble to determine that the inventories were measuring comparable constructs across groups. The results showed that the LD students exhibited lower evaluations of their intellectual and academic abilities than did their normal and gifted peers. However, in the other self-concept domains measured, LD students scored at levels comparable to those of the normal students. Indeed, the LD students scored significantly higher than did the gifted students in domains related to physical ability and interpersonal relations.

Similar results were found by Chovan and Morrison (1984), who compared groups of learning disabled, normal, and high achieving students on six factors of a self-report self-concept inventory. They found that children with LD scored significantly lower (less positive) on two self-concept factors covering behaviour and intellectual/school status. However, on factors relating to physical appearance, anxiety, popularity, and happiness there were no significant differences between the groups.

Academic self-concept and academic expectations of LD students have also been examined by Hiebert, Wong, and Hunter (1982). In this study, the authors selected LD and normally achieving students on the basis of identification by school
counsellors and teachers using IQ, achievement test scores, and grade reports. Overall, LD students, as compared to normal students, reported lower self-concepts relating to academic pursuits, and had lower academic expectations. In addition, both the parents and teachers of LD students had lower academic expectations for these children. The teachers also rated the LD students as behaving in more socially aberrant ways than did normal students.

Unfortunately, many studies, such as Chovan and Morrison (1984), provide virtually no information regarding the criteria used to classify children as learning disabled, and fail to provide detailed characteristics of the samples used. A demonstration of the desirability of accurately specifying the characteristics of the subjects used is provided by DeFrancesco and Taylor (1985). These investigators noted that previous studies of self-concept in learning disabled children had ignored two potentially important factors, namely sex and socioeconomic status (SES): Both of these dimensions have been shown to have some effect on ratings of self-concept. Thus, the investigators selected two groups of normal and LD subjects (judged to be so on the basis of standardized testing), and determined both global self-concept (using a self-report scale) and social class (based on parental education, occupation, and residence) of the children. Overall, the investigators found no relationship between sex and self-concept; however, there was a significant correlation
between self-concept and SES (specifically, the higher the SES, the higher the self-concept). Although they found that LD children scored significantly lower on the self-concept measure, SES was found to be a significant covariate accounting for part of the difference between normal and LD subjects. The authors suggested that differences in socialization practices across social classes may partially mediate differences in self-concept between normal achieving and LD children.

Not all investigators have found that children with LD have reduced self-concept/self-esteem relative to normally achieving peers. For example, Silverman and Zigmond (1983) measured the self-concept of a large sample of middle and high school students classified as LD on the basis of psychological evaluation. Using a standardized measure of self-concept, they found that their sample of LD students did not score lower than did the normative sample. They also found no relationship between self-concept and age, IQ, or academic achievement. These findings were confirmed in a second (replication) study. The investigators noted that, within the LD samples, some individual children did show rather low self-concept scores. However, the authors concluded that, in general, LD students do not show reduced self-concept, and that previous findings to the contrary may reflect investigators' prejudices that academic achievement is important in defining self-worth.
Pickar and Tori (1986) have presented findings similar to those of Silverman and Zigmond (1983). In their study, Pickar and Tori examined the issue of self-concept from within an Eriksonian framework: They examined the first six of Erikson's psychosocial stages (trust, autonomy, initiative, industry, identity, and intimacy). They compared normal and LD secondary school students (diagnosed using exclusionary criteria) on a self-concept scale oriented towards the domains of the six Eriksonian psychosocial stages, plus a second commonly used self-concept inventory covering global self-concept and a number of specific domains. Overall, there were few differences between the normal and LD groups. On the Eriksonian scale, the only difference between groups was in the Industry domain. On the second scale, LD students did show lower self-concept scores in the domains of popularity and intellectual/school status; however, the latter was only found in LD males. Overall, the authors concluded that the evidence for lower self-concept in children with LD is equivocal.

**Attributions/Locus of Control**

Patterns of attributions and locus of control of children with LD have also received some attention from researchers. One contention in such research is that normally achieving students tend to internalize success and externalize failure (e.g., "I succeed because I am competent; I fail because a task is hard."), whereas children with LD are thought to
externalize success and internalize failure (e.g. "I succeed because a task is simple; I fail because I am incompetent."). For example, in an early study of this issue, Hallahan, Gajar, Cohen, and Tarver (1978) found that a group of LD students demonstrated a significantly greater imputation of degree of external control relative to a matched group of normal students. These results contrast with those of Hisama (1976), who compared a group of normal children at the third or fourth grade level with a group of children identified by teachers, counsellors, and principals as either LD and/or behaviour disturbed. This investigator found that there were no differences in locus of control between the normal and special education students. The results of this study suggest that, as a group, children in special education classes (and perhaps children with LD) are no more likely to ascribe failure to internal factors versus external factors than are normal children.

When the special education group in the Hisama (1976) investigation was further subdivided into high external and low external subgroups, and the performance of these subjects on symbolic transcription tasks was compared, the low external locus of control subgroup was found to perform more poorly than did the high external subgroup. Furthermore, when "low external" children were given negative feedback about their performance on these tests, their performance deteriorated significantly, whereas the performance of the "high external"
subgroup did not change. Thus, it would appear that some special education (and, perhaps, LD) children tend to have a more internal locus of control, and that the performance of these children can be adversely affected by negative feedback (Hisama, 1976).

Other researchers have taken a more comprehensive view of attributions in children with LD. For example, Jacobsen, Lowery, and DuCette (1986) noted that some researchers have proposed multidimensional patterns of attributions and behaviours indicative of "helplessness" in children with LD as an explanation of academic underachievement (see, for example, the review papers of Sabatino, 1982, and Thomas, 1979). These hypothesized patterns of attributions have met with inconsistent, and in some cases contradictory, results on empirical testing. In their own study, Jacobsen et al. (1986) compared patterns of attributions of normal and LD students under different situations (academic vs. social) and outcomes (success vs. failure). Overall, the results indicated that the LD children were no more "helpless" than were normal children, as both groups tended to ascribe success to internal factors. However, the LD children, as compared to the normal children, also tended to invoke the external factors of luck and task ease as explanations for their accomplishments, which might limit feelings of self-worth arising from successful performance. On the other hand, children with LD tended to assume more personal responsibility (i.e., attribute to
themselves lack of effort and ability) in failure situations. Such a pattern of results is inconsistent with a "helplessness" model, and the investigators cautioned against attribution remediation efforts based on such an approach (e.g., training children to attribute failure to lack of effort rather than to external, uncontrollable factors).

Other researchers have tried to establish a link between patterns of attribution and self-concept in LD students. For example, Cooley and Ayres (1988) attempted to relate both self-concept scores and attribution patterns (on internal vs. external, and stable vs. unstable dimensions) in groups of normal and LD students (diagnosed on the basis of intelligence and achievement test scores, and actively receiving special education services). The results showed that the LD students had lower global self-concept scores relative to normal students. However, more detailed analyses indicated that this difference was largely due to differences in self-concept in the academic domain, as had been found in previous studies (see above). Overall, there were no significant differences in attribution patterns between the two groups. However, there was a relationship between attributions and self-concept: Specifically, students with lower self-concept, particularly in the academic domain, tended to attribute success to external factors, and failure to ability, which is a stable internal cause. Cooley and Ayres (1988) argued that such a pattern of attributions and self-concept would produce
reduced motivation and effort, leading to feelings of helplessness (although not in the "classic" sense).

**Developmental Considerations**

Implicit in the model outlined at the beginning of this section is a developmental dimension: That is, negative academic and interpersonal experiences presumably take time to operate, and may have a cumulative effect on a child (i.e., negative effects become worse with time). This being the case, it is surprising that very few investigators have examined the developmental aspects of this model. One exception to this is the study of Chapman and Boersma (1980). These investigators found in a cross-sectional study that achievement expectations, academic self-concept, and locus of control did not differ in LD students at different grade levels. This would suggest that the negative cognitive/motivational features of children with LD may be stable over time. In a more recent study, Chapman (1988) followed matched groups of sixth grade normal and LD students (selected on the basis of standardized tests and exclusionary criteria) over a two-year period. At the beginning and end of the study, students were administered an academically oriented locus of control scale, a multidimensional academic self-concept scale, and a multidimensional scale of academic expectations. Overall, the LD students showed lower self-concept, had lower academic expectations, and demonstrated attribution patterns that suggested a tendency towards learned
helplessness (i.e., they were more "externally orientated" with respect to academic achievement). However, these negative cognitive/motivational features of the LD students did not become worse over time. This finding was particularly interesting as the children in this study were not receiving any special remedial help, and they received significantly lower grades over the period of the study as compared to the normal children. Thus, despite experiencing continued failure, the children with LD did not show the deterioration in cognitive and motivational features that many investigators might predict.

Thus far, only studies that have concentrated on the effects of academic experience on attribution, locus of control, and self-esteem/self-concept have been examined. Relatively few studies have attempted to demonstrate the effect of experiences outside the academic domain on these latter variables. One exception to this generalization is a study conducted by Hall and Richmond (1985). They noted that some previous research had suggested that children with LD have difficulty with nonverbal communication in interpersonal relations. They proposed that such difficulties might be related to reduced self-esteem. Thus, they administered a self-esteem inventory, an interpersonal relations orientation inventory, and a test of perception of nonverbal communication, to normal and LD students (identified as such by the school). They found that children with LD did in fact
have greater difficulty with nonverbal communication. These students also had lower self-esteem scores overall. However, there was no difference between normal and LD children with respect to interpersonal orientation: That is, the LD students reported a comparable need for interpersonal relations (i.e., needs for affection and inclusion). These investigators argued that this normal need for interpersonal relations coupled with reduced ability to function in those relations (because of problems with nonverbal communication) might be the cause of reduced self-esteem observed in children with LD. These results are consistent with findings reported by Bruininks (1978b).

In a study by Sobol, Earn, Bennett, and Humphries (1983), the attributions and self-concepts of children with LD (selected from clinic referrals on the basis of exclusionary criteria) in social situations were contrasted with those of normal children. Overall, the measure of social self-esteem did not discriminate between normal and LD subjects. However, these investigators found that the children with LD were more likely to ascribe both positive and negative outcomes in social interactions to luck than were normal children. The children with LD also had lower expectations of social success relative to the normal children. Sobol et al. (1983) argued that these results were consistent with a condition of learned helplessness.

*Relationship to Abrasive Behaviour*
Finally, few investigators have tried to determine if attributions/locus of control and self-concept are related to aberrant behaviours in children with LD. Some studies, such as that of Pickar and Tori (1986, reviewed above), appear to provide indirect evidence regarding such a relationship. These investigators found that children with LD were no more likely to engage in delinquent behaviours than were normal children, despite finding lower self-concept in some domains in some of these children. McWhirter, McWhirter, and McWhirter (1985) provide an interesting examination of the relationship between self-concept and relatively benign disruptive behaviour in the classroom from the perspective of a child with LD.

One study that has addressed this issue directly is that of Bender (1987). Bender examined the in-classroom problem behaviours of normal and LD students (identified by the school system), and attempted to relate these to measures of self-concept, locus of control, and temperament (task orientation, flexibility, and reactivity). In the LD group, overall, the relationships between self-concept and locus of control with problem behaviours in the classroom were trivial. Indeed, statistical analyses showed that only 19% of the variance in problem behaviours could be accounted for by the self-concept, locus of control, and temperament measures.

Summary

There is some evidence that some children with LD do
demonstrate reduced self-concept with respect to academic and, perhaps, intellectual domains. However, the evidence that children with LD have lower self-concept/self-esteem either globally or in other specific domains is not convincing. There is no evidence that children with LD demonstrate a particular pattern of attributions with respect to success or failure in academic and other settings (see also Bender, 1987). Thus, there is no convincing evidence that, in children with LD, reduced self-concept is related to attributions and locus of control. There is no compelling evidence that (a) children with LD demonstrate a pattern of attributions and behaviours consistent with a condition of learned helplessness, (b) self-concept and attribution patterns of LD children are adversely affected by experience of failure, and (c) self-concept and attribution patterns are related to aberrant behaviour in children with LD.

Methodological Considerations

Considering the studies reviewed above, research relating to the interpersonal environments of children with LD has not been terribly contributory. The results of many studies are trivial, contradictory to one another, and not supported in replication attempts. There is little to suggest that the factors identified as "characteristic" of children with LD in these studies are related to one another in any meaningful fashion. In sum, the evidence regarding socioemotional functioning that emerges from the aforementioned research is,
at best, equivocal. A coherent and meaningful pattern of personality characteristics (including psychopathology, problems with self-concept/self-esteem, attributions and locus of control, social status, and so on) of children with LD does not emerge from this literature. This may very well be the case because such an univocal pattern does not obtain. At this juncture, it would be well to point out some of the more obvious methodological inadequacies of this research.

**Definition of learning disabilities**

There was no consistent formulation of the criteria for learning disabilities in these studies. For example, some employed vague or undefined groups, whereas others used the ratings of teachers and other school personnel that remain otherwise unspecified. It is obvious that this lack of clarity and consistency had a negative impact on the generalizability of such findings. Clear, consensually validatable definitions are vital in this area of investigation.

**Measurement of Maladjustment**

"Emotional disturbance", "socioemotional adjustment", "behaviour disorder", "antisocial behaviour", and other constructs of psychosocial functioning have been operationalized as or more inadequately than has "learning disability" in many of these studies. It is clear that the use of reliable and valid psychometric instruments would be preferable to the largely subjective nature of the judgments
of these crucial dependent variables that has characterized much of this research.

**Developmental Considerations**

Several studies offer support for the notion that the nature of the skill and ability deficits of (some subtypes of) learning-disabled children varies with age (e.g., McKinney, Short, & Feagans, 1985; Morris, Blashfield, & Satz, 1986; Ozols & Rourke, 1988; Rourke, Dietrich, & Young, 1973). Since it would seem reasonable to infer that the socioemotional functioning of (some subtypes of) learning-disabled children would also vary as a function of age (considered as one index of developmental change), the aforementioned inconsistencies in research results may reflect differences in the ages of the subjects employed. To properly investigate this possibility, cross-sectional or longitudinal studies, such as those carried out by Spreen (1988) and colleagues, are necessary.

**Heterogeneity**

Virtually all of the studies mentioned above have employed a research design that involves comparisons of undifferentiated groups of learning-disabled children to equally undifferentiated groups of normal achievers. This approach (which aims to identify the particular pattern of socioemotional disturbance of learning-disabled children) tends to obscure within-group differences. As Applebee (1971) has pointed out, employment of this "comparative-populations" approach can only be justified if one can safely assume that
children and adolescents with LD are homogeneous in terms of their abilities and deficits.

Homogeneity of psychosocial functioning, or the lack thereof, has become an increasingly important topic of investigation in recent years. Although some investigators had previously noted that not all children with LD behave in a similar manner in the psychosocial domain, discussion of this issue has been largely confined to brief, post-hoc descriptions. These descriptions are often couched as explanations for unexpected or contradictory findings, rather than as the subject of specific investigations. However, research into the neuropsychological aspects of LD has suggested strongly that (a) children with LD constitute a markedly heterogeneous population in terms of their skills and abilities, and (b) meaningful subtypes of learning-disabled children can be identified in a reliable fashion using a variety of methods (e.g., Fletcher, 1985; Morris et al., 1981; Rourke & Finlayson, 1978; Rourke & Strang, 1978; Strang & Rourke, 1983).

In the next section, a series of four investigations of patterns of psychosocial functioning of children with LD are discussed (see Fuerst & Rourke, 1989, for a more detailed presentation of this material). These studies are the first steps in a comprehensive research program aimed at the development of a psychosocial typology of children with LD and, for want of a better term, they will be referred to as
the "Windsor Taxonomic Research"

The Windsor Taxonomic Research

In the first study of this series, Porter and Rourke (1985) investigated whether the assumption of psychosocial homogeneity can be justified on an empirical basis by application of a multivariate statistical subtyping technique (Q-factor analysis) to the PIC (Wirt et al., 1977, 1984) scores of 100 LD children. On the basis of the resulting factor pattern, 77 LD children were assigned to one of four subtypes; these were then examined in terms of the mean PIC profiles exhibited by the subjects within them.

The first and largest subtype (37 subjects) showed no elevations on PIC scales reflecting psychosocial disturbance, and had an essentially normal, well adjusted profile. The parents of these children were most concerned with the cognitive development and academic functioning of their children. The second subtype (20 subjects) had a mean PIC profile that was strongly suggestive of seriously disturbed socioemotional functioning of an "internalized" type (for example, symptoms suggestive of depression, withdrawal, and anxiety). The third subtype (13 subjects) had a mean PIC profile that was suggestive of "externalized", "hyperkinetic" behavioural disturbance. The fourth, and smallest, group derived (10 subjects) showed relatively normal psychosocial adjustment overall, but evidenced a variety of somatic complaints. As the four subtypes derived through Q-factor
analysis exhibited clearly different patterns of psychosocial functioning, Porter and Rourke (1985) concluded that the personality characteristics of LD children are heterogeneous, and that there is no unique LD personality type. In a subsequent study (Rourke, Pohlman, Fuerst, Porter, & Fisk, 1985), it was demonstrated that the first ("normal") and fourth ("psychosomatic") subtypes could not be differentiated on the basis of PIC factor scales.

Of course, statistical subtyping techniques, such as Q-factor analysis and cluster analysis, will always produce some grouping of observations, even if purely random data are input to the techniques. Thus, in the next study in this series, Fuerst, Fisk, and Rourke (1989) concentrated on establishing the reliability of the Porter and Rourke (1985) subtypes, using a new sample of children and a variety of statistical subtyping techniques. The scores of 132 children with LD, between the ages of 6 and 12 years, on nine selected PIC scales were investigated using Q-factor analysis, four hierarchical-agglomerative clustering techniques, and one iterative partitioning clustering technique. The results revealed excellent correspondence between the subtypes derived by all grouping methods, in terms of both misclassifications and mean PIC profile similarity of the subtypes across techniques.

Three subtypes were found in the study. The mean PIC profile of one subtype indicated normal psychosocial
adjustment. This group was almost identical to the Normal children reported by Porter and Rourke (1985) in terms of both general PIC profile shape and elevation, and relative size. The second subtype exhibited evidence of significant internalized psychopathology, and was very similar to the corresponding children found in the Porter and Rourke (1985) study. There were only minor discrepancies in mean profiles between the subtypes that were generated in the two studies. These were overshadowed by overall similarity of shape and general elevation. The relative sizes of the two groups were also comparable. The third subtype had a mean PIC profile suggestive of externalized, "hyperkinetic" psychopathology, and was very similar to the corresponding Porter and Rourke (1985) subtype. The profile of this group also bore a striking resemblance to one reported by Breen and Barkley (1983) in a study of 26 children diagnosed as hyperactive or as having Attention Deficit Disorder with Hyperactivity. Indeed, the two profiles were highly correlated (r = .89), confirming substantial similarity of profile shape. The fourth "Somatic Concern" subtype of Porter and Rourke (1985) was not found in this study.

While these three general patterns of psychosocial functioning are consistent with patterns of PIC profiles seen in clinical practice, experience would suggest that a greater diversity of psychosocial functioning is, in fact, presented by children with LD. In the next study (Fuerst, Fisk, &
Rourke, 1990), more sophisticated clustering techniques, and a somewhat wider range of PIC scales, were used to develop a more "fine grained" typology of psychosocial functioning. The same 132 children that took part in the Fuerst et al. (1989) investigation were used in this study.

In this investigation, six, rather than three, subtypes were identified within the sample. These could be readily replicated using a variety of clustering methods. One subtype exhibited a mean PIC profile that suggested normal psychosocial functioning, with elevations only on scales related to academic and intellectual functioning, and was very strongly related to the Fuerst et al. (1989) Normal group. A second subtype was also relatively normal, with some indications of mild hyperactive or acting-out forms of behaviour. A third subtype was characterised chiefly by elevation of the Somatic Concern scale. This subtype was not related to any of the three found in the Fuerst et al. (1989) study, but was very similar to the Somatic Concern group found by Porter and Rourke (1985). Two of the subtypes were related to the internalized psychopathology group found in Fuerst et al. (1989): one subtype showed evidence of mild anxiety and depression, while the other showed evidence of severe internalized psychopathology. Finally, an Externalized Psychopathology or hyperactive subtype, very similar to the one found in the Fuerst et al. (1989) study, was evident.

The results of last study to be reviewed in this section
are drawn from the preliminary findings of a more comprehensive investigation still in progress (Fuerst & Rourke, in preparation). One purpose of this study was to replicate the subtypes found in Fuerst et al. (1990) in a large and diverse sample of children. In this study, the subjects were 500 children between the ages of 6 and 12 years, with normal psychometric intelligence, and, to ensure an adequate sample of psychopathology, at least one PIC clinical scale score greater than 70 T. The subjects were clustered by the k-means method using the same PIC scales that were employed in Fuerst et al. (1990). The result was six subtypes, five of which were extremely similar to the subtypes found in the latter study (viz., Normal, Somatic Concern, Mild Anxiety, Internalized Psychopathology, and Externalized Psychopathology or Hyperactive). In this study, a Mild Hyperactive group was not found; however, a sixth subtype did have a mean PIC profile suggestive of conduct disorder.

There were no significant age differences between the PIC-generated subtypes in any of the four studies reviewed above. Strang (1981) also found no indication of any increased incidence of psychopathology (as measured with the PIC) over cross-sectional comparisons of undifferentiated groups of learning-disabled children between the ages of 8 and 12 years. These results contrast sharply with suggestions of increased incidence of psychopathology in children with LD over this age span (Lorin, Cowen, & Caldwell, 1974; Routh &
Mesibov, 1980).

Other Taxonomic Studies

Relatively few systematic attempts to develop a psychosocial typology of children with LD have been reported in the literature. Some fairly recent studies have attempted to identify LD behavioural syndromes using R-type factor analysis. Although, at first glance, this may seem somewhat less appropriate than more direct techniques, such as Q-type factor analysis and cluster analysis, this approach does make some theoretical sense, as both R and Q-type factor analysis tend to recover the same dimensions when applied to the same data (Lorr, 1983). For example, if R-factor analysis reveals a "hyperactive" factor in a given data set, Q-factor analysis on the same data will likely reveal a "hyperactive" subtype (for an example of this phenomenon, see Fuerst et al., 1989, in which the results of both R and Q-type factor analyses are reported). This method has been used with some success in identifying major syndromes of psychopathology in children and adolescents (Achenbach, Conners, Quay, Verhulst, and Howell, 1989).

With respect to LD populations, this method has been applied to the BPC scores of children with LD. For example, Epstein, Cullinan, and Rosemier (1983) applied principal components analysis with varimax rotation to the BPC scores of 559 male LD elementary school students (identified by the school system). The resulting factor structure was similar to
that which had been found in previous studies with normal children. Four major factors were identified: "attention deficit" (hyperactive), "anxiety", "conduct problem", and "social incompetence". Epstein, Bursuck, and Cullinan (1985) have also used principal components analysis on the BPC scores of (school system identified) 316 older (12 to 18 years) males, 77 older females, and 225 younger (6 to 11 years) females. For all three groups, a "conduct problem" factor was identified as the most salient. An "attention deficit" factor was not found for the older males in the study; instead, items which typically load on this factor merged with the "conduct problem" dimension. The "attention deficit" factor was found in females; however, in older LD females it tended to have a "flavour" of conduct disorder. In the older males, a "socialized delinquency" factor (e.g., stealing, profanity, fighting, truancy) was found, and a somewhat similar "aggression delinquency" factor was found in older females. Additional factors of "anxiety-withdrawal" and "inadequacy-immaturity" were found in all three groups. These results suggest that the expression of pathology in children with LD may vary with both age and sex.

Although studies using R-factor analysis provide interesting information regarding possible dimensions of psychopathology in children with LD, more direct approaches using classification methods (e.g., cluster analysis) are required for the development of typologies. A series of
studies by McKinney and his colleagues is of considerable interest within this context (see McKinney, 1989, for a detailed summary). Speece, McKinney, and Pelbaum (1985) were able to classify 63 school-identified children with ID (average age, approximately 7 years) into 7 "behavioural" subtypes by means of one type of cluster analysis. The Classroom Behavior Inventory (CBI; Schaefer, Edgerton, & Aronson, 1977), a teacher rating instrument completed by classroom teachers, was the measure used for clustering. The investigators went to some lengths to examine the internal validity (reliability) and external validity of the subtypes generated. In addition to demonstrating that these learning-disability "behavioural" subtypes were different from one another, they showed that the profile patterns generated were quite different from those evident among normal achieving controls. Yet, it was also the case that approximately one-third of the children with LD who were classified exhibited profiles on the CBI that were completely normal. Some of the other subtypes generated exhibited profiles that were, at most, within the borderline or very mildly impaired range. It was also the case that subtypes characterized by conduct disorder, withdrawn behaviour, and fairly serious, global behaviour problems were isolated. These normal and deviant behavioural subtypes bear a strong resemblance to those isolated by Porter & Rourke (1985) and Fuerst et al. (1989).

A three-year longitudinal follow-up of 47 of these
youngsters (McKinney & Speece, 1986) yielded evidence of some stability of the subtypes and some change in subtype membership over time. Interestingly, the subtype membership change for the children with LD was very clearly from "normal" to "pathological, or one "pathological" group to another, rather than to the "normal" subtype patterns. Except for the use of a criterion for the determination of learning disability that is difficult to verify or replicate, and some questionable regrouping of the behavioural subtypes in the longitudinal phases of these studies, these studies are marked by a degree of care and precision that makes for an important contribution to the testing of the hypothesis under consideration.

Summary

The results of these studies constitute a formidable, perhaps irrefutable, challenge to the view that children with LD are relatively uniform in terms of their socioemotional functioning. Furthermore, these studies cast doubt on the notion that learning disability, broadly considered, constitutes a sufficient condition for the production of emotional disturbance. The results of these studies suggest strongly that some children who meet commonly accepted definitions of learning disability show signs of significant socioemotional disturbance, whereas others do not; on balance, it appears that most do not. The important question at this juncture becomes one of determining whether there is a set of
characteristics that differentiates: (a) children with LD who develop adaptive socioemotional functioning from those children who develop maladaptive socioemotional functioning (i.e., presence or absence of psychopathology, and/or level of psychopathology); and (b) children with LD who develop particular patterns of psychosocial functioning (i.e., type of pathology, such as internalized vs. externalized). This issue is discussed in greater detail when relationships between neuropsychological skill/ability patterns and socioemotional disturbance are examined in the Hypothesis 3 section of this paper.

Within the context of the consideration of Hypothesis 2, a review of some research dealing with the social competence of learning-disabled youngsters will be presented. This area of investigation dovetails rather well with the series of studies outlined above and with those that will be considered in conjunction with Hypothesis 3 below.

Social Competence

As was seen to be the case with the investigations of socioemotional disturbance, the experimental hypothesis most often tested in this area is that of a causal link between LD and social competence: specifically, that learning disabilities lead to deficiencies in social competence. Social competence may be conceptualized as a child's ability to satisfy interpersonal needs in ways that are both effective and acceptable to society. The importance of the study of
this dimension in children with LD is highlighted by evidence that adult mental health is correlated with childhood social competence (Cowen, Pederson, Babigian, Izzo, & Trost, 1973). Social competence is difficult to define in operational terms, and researchers interested in determining characteristics of socially competent children (e.g., Nakamura & Finck, 1980) acknowledge the variability of effective social behaviour and recognize the importance of situational determinants of such behaviour. Nevertheless, the componential analysis of effective social functioning (e.g., Anderson & Messick, 1974; Greenspan, 1981; Gresham & Elliot, 1987; Healey, 1987; Jackson, 1987; Wallander & Hubert, 1987; Weller, Strawser & Buchanan, 1985) appears to have considerable heuristic value. For example, the large number of skills and abilities identified by a component analysis of social competence can be classified into three groups: (1) perceptual skills, such as those needed for the perception of facial expressions; (2) cognitive abilities, such as those required to discern cause-and-effect relationships in social events; (3) motor and language skills, by which children manifest their social behaviour. Competent social behaviour can be seen as a result of a complex interaction and coordination of these and related variables. It is also widely held that attitudinal characteristics, such as differentiated self-concept and consolidation of identity, a concept of oneself as an initiating and controlling agent, and
a realistic appraisal of oneself, accompanied by feelings of personal worth, are crucial factors in the development of social competence.

As outlined in detail above, literature in the LD area reveals frequent claims that such children experience problems in their social relationships, and that their socioemotional difficulties persist into adolescence and adulthood (Bryan, Donahue, & Pearl, 1981; Kronick, 1980; Siegel, 1974). Variables that have been utilized to investigate the validity of such claims include parent observations (Owen, Adams, Forrest, Stolz, & Fisher, 1971), teacher ratings (Bryan & McGrady, 1972; Keogh, Tchir, & Windeguth-Behn, 1974; Margalit, 1989), peer ratings (Bryan, 1974b), classroom observations of the interactions of learning-disabled students (Bryan, 1974a; Bryan & Wheeler, 1972), and behaviour checklists (McConaughy & Ritter, 1986). The results of these studies have demonstrated that, in comparison to their normally achieving peers, LD youngsters tend to be judged in more negative and rejecting terms by parents, teachers, and classmates, and/or that they are perceived as much less competent in social adaptation. Some studies have also shown that some children with LD may be relatively deficient in perceiving their own social status (Bruininks, 1978b).

Explanations for these deficiencies have usually focused on a single perceptual, cognitive, or behavioural skill that is said to be lacking in learning-disabled children. For
example, various investigators have searched for the following: a schematic judgment deficit, or an inability to realize the organization of an interactional situation (Kronick, 1980); deficits in role-taking skills (Bruck & Hebert, 1982); a linguistic deficit that results in poor interpersonal communication skills and problems in understanding the rules that govern socially appropriate speech (Bryan, 1982); deficits in emitted nonverbal signals (Raskind, Drew & Regan, 1983); abnormal interpersonal goals and strategies (Carlson, 1987); deficits in ability to draw appropriate inferences from nonverbal stimuli (Gerber & Zinkgraf, 1982). Other studies have investigated the ability of children with LD to perceive and interpret accurately the affective states of others. Ability to label emotions expressed through nonverbal means (Axelrod, 1982; Wiig & Harris, 1974), select appropriate facial expressions for material presented in stories (Bachara, 1976), and describe emotional scenarios from videotaped displays of emotion (Bryan, 1977; Pearl & Cosden, 1982; Stone & La Greca, 1984; Weiss, 1984) have been examined, with inconsistent results.

There would appear to be at least two major reasons why the results of these studies are not very contributory to the testing of Hypothesis 2, as follows (elements of each of these are alluded to by LaGreca, 1981, 1987):

(1) Lack of a Conceptual Model. There is an obvious absence in these studies of a conceptual model to
elucidate the skills involved in social competence and that are deficient in children with LD (see Goldman & Hardin, 1962, for an example of this problem). (A notable exception to this is the formulation of Wiener, 1980). For example, at the very minimum, a componential analysis of social competence should sensitize the researcher to the possibility that, whereas some subtypes of learning-disabled children may experience social competence problems because they lack certain perceptual, cognitive, or behavioural skills, others may manifest such problems as a more direct result of attitudinal/motivational difficulties. It should also be clear that different patterns of perceptual, cognitive, and behavioural skills and abilities may encourage different types or degrees of socially incompetent behaviour.

(2) Definitional Problems and Subtypes. Related to (1) is the use of inconsistent and/or unclear definitions of learning disabilities in these studies, and an almost total lack of sensitivity to the notion that there may be subtypes of learning-disabled children for whom various types of social competence may be more or less difficult to achieve. Notable exceptions to the latter problem are the work of Loveland, Fletcher, and Bailey (1989), McConaughty and Ritter (1986), and, to a lesser extent, Silver and Young, 1985).
An example of research (Ozols & Rourke, 1985) that has attempted to grapple with some of these difficulties is presented below. Before presenting these results, however, it is necessary to place this particular piece of research within the context of a general approach to the neuropsychological investigation of central processing abilities and deficits in LD and frankly brain-damaged youngsters that gave rise to this type of investigation.

It is unfortunate that the utilization of a neuropsychological framework for this purpose has so often been misinterpreted as reflecting an emphasis on static, intractable (and, therefore, limited) notions of the effects of brain impairment on behaviour. Indeed, although specific statements to the contrary have been made on many occasions (e.g., Rourke, 1975; 1978b), y otherwise competent researchers and clinicians persist in the notion that such an approach assumes that brain damage, disorder, or dysfunction lies at the basis of learning disabilities. Nothing could be further from the truth, since the thrust of much work in this area (see reviews by Benton, 1975 and Rourke, 1978a) has been to demonstrate whether and to what extent such might be the case.

Be that as it may, the emphasis of a neuropsychological approach is to attempt to integrate dimensions of social and emotional development on the one hand with relevant central processing features on the other, in order to fashion a useful
model by which to study crucial aspects of individual human development, including learning disabilities. That models and explanatory concepts developed with this aim in mind (e.g., Rourke, 1976a, 1982, 1983, 1987) contain explanations that are thought to apply both to some types of frankly brain-damaged and learning-disabled children as well as to some aspects of normal human development should come as no surprise since maximum generalizability is one goal of any scientific model or theory. Specifically with respect to the child with LD, the aspects of these concepts and models that are most relevant are those that have to do with proposed linkages between patterns of central processing abilities and deficits that may predispose a youngster to predictably different patterns of social as well as academic learning disabilities. In addition, these models are designed to encompass developmental change and outcome in patterns of learning and behavioural responsivity.

For example, since 1971, at the University of Windsor researchers have been investigating two subtypes of children with LD that were the focus of investigation in the Ozols and Rourke (1985) study. Children in one group (referred to as Group R-S) are those who exhibit many relatively poor psycholinguistic skills in conjunction with very well-developed abilities in visual-spatial-organizational, tactile-perceptual, psychomotor, and nonverbal problem-solving skills. They exhibit very poor reading and spelling skills and
significantly better, though still impaired, mechanical
arithmetic competence. The other group (Group A) exhibits
outstanding problems in visual-spatial-organizational,
tactile-perceptual, psychomotor, and nonverbal problem-solving
skills, within a context of clear strengths in some
psycholinguistic skills such as rote verbal learning, regular
phoneme-grapheme matching, amount of verbal output, and verbal
classification. Group A children experience their major
academic learning difficulties in mechanical arithmetic, while
exhibiting advanced levels of word-recognition and spelling.
Both of these subtypes of learning-disabled children —
especially the second subtype of child, characterized as
having a "nonverbal learning disability" (NLD) — have been the
subject of much scrutiny in our laboratory (for reviews see
Strang & Rourke, 1985a, 1985b). The results of one of the
studies in this series (Ozols & Rourke, 1985) are of
particular relevance with respect to the investigation of
social competence; the relevant aspects of this investigation
may be summarized as follows (see also Bergman, 1987).

The performances of two groups of learning-disabled
children, one exhibiting a pattern of relatively poor
auditory-perceptual and language-related skills within a
context of well-developed visual-spatial-organizational skills
(similar to Group R-S), the second exhibiting the opposite
pattern of abilities and deficits (similar to Group A), were
compared on four exploratory measures of social judgment and responsiveness. As predicted on the basis of the Rourke (1982) model, one result of this study revealed that children in the language-disorder group performed more effectively than did those in the visual-spatial disorder group on tasks requiring nonverbal responses; in contrast, tasks requiring verbal responses yielded exactly the opposite results. These results suggest that social awareness and responsiveness vary markedly for these two subtypes of learning-disabled children, probably as a result of an interaction between their particular patterns of central processing abilities and deficits and the specific task demands of the four measures employed. A recent study by Loveland et al. (1989) has replicated and extended these findings.

The results of the Ozols and Rourke (1985) study should be viewed within the context of a study by Ackerman and Howes (1986). In the latter study, it was demonstrated that, although social competence deficits often occur in many children with LD, it is the case that some children with LD do not exhibit such deficits and are seen as popular with their peers and active in after-school interests. These findings, taken together, would suggest that a study designed along the lines of the Porter and Rourke (1985) investigation may reveal an analogous set of "social competence" subtypes (i.e., some "normal" and others "disturbed" in terms of social competence). (The studies by Speece et al., 1985, and
McKinney and Speece, 1986, contain some data that could be used to address this question directly.) It is clear that, as in the case of the investigation of emotional disturbance in youngsters with LD, the examination of their social competence should eschew the homogeneous, contrasting groups methodology that has heretofore characterized all but a few studies in the field in favour of one that does justice to the heterogeneity of subtypes evident in the LD population.

Furthermore, it would appear to be the case that efforts to relate patterns of abilities and deficits on the one hand and components of social competence on the other may generate much more interesting data and conclusions than do approaches which simply search for correlates of LD (considered as a univocal phenomenon) and either emotional disturbance or problems in social competence. The studies reviewed in connection with the examination of Hypothesis 3 constitute another step further along the road away from the latter type of contrasting groups/unitary deficit methodologies.

Hypothesis 3:
Specific Patterns of Central Processing Abilities and Deficits Cause Specific Manifestations (Subtypes) of Learning Disabilities and Specific Forms of Socioemotional Disturbance

The second major hypothesis that has been investigated in this area is one that proposes a causal connection between particular patterns of central processing abilities and deficits on the one hand and particular subtypes of both
learning disabilities and socioemotional functioning on the other (Rourke & Fisk, 1981). In other words, the academic and behavioural adaptation of children with LD are not seen as directly related (except in a correlational sense) as in Hypothesis 2 approaches, but are instead primarily determined by neurocognitive or neuropsychological strengths and deficiencies.

This formulation of the interrelationships between LD and psychosocial functioning is relatively new. Unfortunately, some of the research in this area has been of less than stellar quality (see Weller and Strawser, 1987, for a brief review of relevant studies). A rather extreme example is found in a study by Stellern, Marlowe, Jacobs, and Cossairt (1985), in which they attempted to relate hemispheric cognitive modes (or styles) to academic performance, classroom behaviour, and emotional disturbance in a sample of behaviourally disordered and normal control children. Cognitive style (i.e., left hemisphere preferred, right hemisphere preferred, or integrated) was assessed by means of a paper-and-pencil self-report scale. Briefly, Stellern et al. (1985) found that emotional disturbance was weakly associated with a right hemisphere cognitive mode. In addition to poor subject selection procedures, unsophisticated and questionable statistical methods, and the use of an unvalidated measurement instrument, the entire premise of left versus right hemisphere cognitive modes reveals a rather
limited and largely erroneous view of brain-behaviour relationships.

A marginally better study is one by Glosser and Koppell (1987). In this investigation, the authors divided 67 children with learning problems (so identified by referral sources with no other criteria used) into left hemisphere impaired, right hemisphere impaired, or nonlateralized impairment. Unfortunately, the classification scheme used was only vaguely described by the authors, and appeared to be have been developed more to provide adequate coverage when the sample was partitioned than on a rational or empirical basis. The three groups were compared on scores derived from behavioural checklists created by the investigators. Overall, children showing left hemisphere impairment (as judged by the authors) tended to show more evidence of depression and anxiety, whereas children showing right hemisphere impairment tended to have more somatic complaints. Those children with nonlateralized impairment tended to show more distractibility, motor activity, and aggression. Roughly comparable results have been reported by Nussbaum and Bigler (1986), who found that children with putative left hemisphere impairment (judged on the basis of measures of psychometric intelligence and academic achievement) showed somewhat greater levels of personality and behavioural deviance.

More recently, Nussbaum, Bigler, Koch, Ingram, Rosa, and Massman (1988) administered a battery of neuropsychological
tests to 219 children, from 7 to 12 years old, referred for testing because of learning problems. The investigators developed composite "anterior" and "posterior" cortical impairment scores based on neuropsychological measures used in the assessment. On the basis of these composite scores they classified 33 subjects into either anterior or posterior impairment groups. These two groups were then compared on CBC (Achenbach & Edelbrock, 1983) and PIC (Wirt et. al., 1982) measures completed by parents. The results showed that the anterior impairment group showed more evidence of social withdrawal, aggression, hyperactivity, and externalizing pathology, whereas the posterior impairment group showed somewhat greater levels of anxiety.

While these, and other, studies fall within the framework of Hypothesis 3 investigations, they clearly represent little or no improvement over many of the Hypothesis 2 investigations reviewed above, for much the same methodological reasons (poor or absent definitions of LD, poor operationalization of psychological constructs, questionable classification procedures, and so on). Disregard of developmental considerations is also of particular concern in these investigations.

There is a tendency in some studies to assume that brain-behaviour relationships derived from research with adults can be extrapolated without modification to children with LD: for example, that a particular test that may have some value for
localization of dysfunction in adults with demonstrated cerebral insult necessarily has similar significance across all age ranges and populations. As Rourke et al. (1983) have pointed out, there are numerous reasons (e.g., rapid maturation of the nervous system, loss of existing ability versus failed acquisition of ability, abnormal or atypical development) why generalization of adult models of cerebral functioning to children must be done with extreme caution, and be subject to careful empirical testing. Similarly, in some studies there is a tendency to frame research problems within static models of limited scope (or, worse still, to present entirely atheoretic investigations). Research undertaken within a limited or trivial theoretical framework tends to produce limited or trivial results. Recent review and theoretical papers by Spreen (1989), and Rourke (1988), have emphasized the need to consider both the components and the dynamics of neurologic, cognitive, academic, and psychosocial development and adaptation when developing models to account for the socioemotional difficulties faced by children with LD. Although this is clearly a monumental task, choosing to ignore complexity when formulating research questions does not make a phenomenon under investigation simpler.

A more sophisticated test of Hypothesis 3 involves an examination of the results of several LD subtype investigations aimed at the determination of patterns of central processing abilities and deficits that characterize
such subtypes, and the patterns of socioemotional responsivity that appear to be related to them. Regarding the first issue, the results of studies by Rourke and Finlayson (1978), Rourke & Strang (1978), and Strang and Rourke (1983) demonstrated that 9- to 14-year-old children with LD who exhibit a pattern of impaired reading (word-recognition) and spelling within a context of a significantly better, though still impaired, level of performance in mechanical arithmetic (Group R-S) differ markedly in their patterns of neuropsychological abilities and deficits from those who exhibit a pattern of above-average reading and spelling and an outstandingly deficient level of mechanical arithmetic performance (Group A).

As summarized in Strang and Rourke (1985b), these differences cover a wide range of skills and abilities. Specifically, Group A children exhibit below-normal performances on tasks requiring visual-spatial-organizational, psychomotor, tactile-perceptual, and conceptual skills and abilities, within a context of normal performances on verbal tasks that require rote, overlearned verbal skills; they also have difficulties on measures that involve novel task requirements, whether these are "verbal" or "nonverbal" in nature. Group R-S children exhibit the virtually opposite pattern of neuropsychological skills and abilities: mild to moderate difficulties in almost all areas of linguistic endeavour and marked problems in auditory-perceptual tasks
that tax their capacities for exact hearing of speech-sounds; normal visual-spatial-organizational, psychomotor, tactile-perceptual, and nonverbal concept-formation skills and abilities. In addition, complex problem-solving, hypothesis-testing, and concept-formation in situations where verbal instructions and response requirements are kept to a minimum pose no difficulties for Group R-S children.

In the following section, a review of studies carried out at the University of Windsor that have focused on the psychosocial functioning of subtypes of children and adolescents with LD is presented. These studies have their origins in the discovery of the neuropsychological dimensions of the Group R-S and Group A children, and they have followed a course best described as an attempt to develop a nomological net and the exploitation of a form of the multitrait-multimethod approach to validity (Cook & Campbell, 1979).

**Strang & Rourke (1985a)**

When the average PIC profiles of children chosen to approximate the characteristics of these two subtypes of learning-disabled children were compared (Strang & Rourke, 1985a), it was clear that the profile for Group A was similar to that exhibited by the "emotionally disturbed" group in the Porter & Rourke (1985) and Fuerst et al. (1989) studies, whereas the profile for Group R-S children was virtually identical to that exhibited by the "normal" group in those studies. Additional examination of three factor scores
derived from the PIC revealed that Groups R-S and A did not differ significantly on the concern over academic achievement factor, but that they differed sharply on the factors of "personality deviance" and "internalized psychopathology." In both of the latter cases, the Group A levels of deviation were significantly higher (i.e., more pathological) than were those for Group R-S.

These two sets of results, taken together, offer strong support for Hypothesis 3: viz., that particular patterns of central processing abilities can eventuate in (a) markedly different subtypes of learning disabilities (Groups R-S and A) and (b) markedly different patterns of socioemotional functioning (one characterized by normalcy; the other, by an internalized form of psychopathology and personality deviance). Since such group results can be deceiving when applied to the individual case, it should be emphasized that there was very little variance evident in the PIC protocols of the children classified into Groups R-S and A in these studies. Furthermore, the interested reader may wish to consult case studies of such youngsters in three recent works (Rourke, 1989; Rourke et al., 1983; Rourke, Fisk, & Strang, 1986) for evidence of such consistent differences in socioemotional manifestations.

The Fuerst et al. (1990), and Fuerst and Rourke (in preparation) investigations (reviewed above) also attempted to address Hypothesis 3 considerations. However, in these
studies the investigators took the opposite approach to that employed in the Strang and Rourke (1985a) investigation, in that they first attempted to develop a psychosocial typology (using the PIC and statistical methods), and then examined the manner in which these subtypes differed on cognitive and academic measures.

**Fuerst et al. (1990)**

In this study, the subjects were selected so as to comprise three (equal-sized) groups with distinctly different patterns of WISC (Wechsler, 1949, 1974) Verbal and Performance IQ scores. One group had VIQ greater than PIQ by at least 10 points (VIQ>PIQ), a second had VIQ less than PIQ by at least 10 points (VIQ<PIQ), and a third had VIQ-PIQ scores within 9 points of each other. As discussed above (see The Windsor Taxonomic Research), the application of several cluster analytic techniques yielded an apparently reliable solution suggesting the presence of six distinct personality subtypes. The frequencies of the three VIQ-PIQ groups within each of these psychosocial subtype were calculated and compared.

The investigators found that, within the Normal subtype, children with VIQ>PIQ occurred at a much lower frequency (roughly 6% of the subtype) than did either children with the opposite pattern of VIQ-PIQ discrepancy, or those with no significant difference between VIQ and PIQ. This was also the case in the Mild Anxiety subtype, in which subjects with VIQ>PIQ were found at a rate significantly below expectation.
(about 5% of the subtype). In the Mild Hyperactivity subtype, the frequencies of subjects from the three VIQ-PIQ groups were approximately equal. These results indicated that, overall, within normal and mildly disturbed subtypes of children with LD, there was a tendency for VIQ>PIQ children to occur at lower frequencies than do VIQ=PIQ or VIQ<PIQ children. There were only about half as many VIQ>PIQ children in these three groups as there were VIQ=PIQ or VIQ<PIQ children.

In the Internalized Psychopathology subtype, subjects with VIQ=PIQ were found at significantly lower than expected frequencies (about 15% of the subtype). On the other hand, subjects with VIQ>PIQ were found at a higher frequency than would be expected (roughly 46% of the subtype), and at a higher frequency than VIQ<PIQ subjects (39%). Within the Externalized Psychopathology subtype, subjects with VIQ>PIQ were found at a much higher frequency (about 63% of the group) than were children with either VIQ=PIQ or VIQ<PIQ. Thus, unlike the normal and mildly disturbed groups, within subtypes showing severe psychosocial disturbance there was a strong tendency for VIQ>PIQ subjects to be found at higher frequencies than either the VIQ=PIQ or VIQ<PIQ subjects. In total there were about twice as many VIQ>PIQ children in these two "severe" groups as there were VIQ=PIQ or VIQ<PIQ children.

Fuerst & Rourke (in preparation)

In this investigation, six personality subtypes were also generated (see The Windsor Taxonomic Research, above). With
one minor exception, these were the same subtypes as those found in the Fuerst et al. (1990) study. The differences between these six subtypes on WRAT Reading, Spelling, and Arithmetic standard scores were examined. Overall, the six subtypes were indistinguishable on WRAT Arithmetic. However, there were significant differences between some of the subtypes on WRAT Reading and Spelling. The Externalized Psychopathology and Internalized Psychopathology subtypes had mean WRAT Reading scores that were significantly higher than those of the Somatic Concern and Normal subtypes. Similarly, the Externalized and Internalized Psychopathology subtypes scored higher on WRAT Spelling than did the Conduct Disorder and Normal groups, and the Internalized Psychopathology group also scored higher than did the Somatic Concern group.

These findings were echoed when WRAT Reading, Spelling, and Arithmetic were considered simultaneously in a canonical discriminant analysis. The first canonical function was significant, providing better than chance discrimination between the groups. When the standardized scoring coefficients for this function were considered, it was apparent that scores on this variable were virtually simple sums of WRAT Reading and Spelling scores (i.e., approximately equal weights), with Arithmetic playing a trivial role. Examination of group means on the canonical variables indicated that the Normal, Somatic Concern, and Conduct Disorder groups were indistinguishable on this variable.
These three groups were, however, clearly separated from the higher-scoring Externalized and Internalized Psychopathology Groups, which appeared to form a second "clump" on their own. The Mild Anxiety group fell about midway between these two sets of subtypes.

These results suggest that children with relatively well-developed reading and spelling skills are more likely to appear in PIC subtypes with profiles suggestive of severe psychopathology, be it of the internalizing or externalizing type. On the other hand, children with relatively mild somatization or conduct disorder problems are indistinguishable from normal children on the basis of reading and spelling skills. Children with symptoms of mild anxiety and depression appear to fall between these two extremes, and cannot be distinguished from either on the basis of these abilities.

Fuerst and Rourke (in preparation) also compared the groups on differences between WRAT Reading and Spelling minus Arithmetic scores (RA and SA). Overall, the Internalized Psychopathology group showed not only the largest absolute difference on these two measures, but also showed deficient Arithmetic relative to both Reading and Spelling (i.e., a pattern identical to that shown by the Group A subtype in previous studies). Specifically, on the Reading minus Arithmetic measure the Internalized Psychopathology group was significantly different from the Somatic Concern group; on the
Spelling minus Arithmetic measure they were significantly different from the Normal group. None of the other subtypes could be differentiated on either RA or SA.

**Implications**

While the results of these studies are quite straightforward, the pattern of relationships revealed by the studies, and the implications that follow, are fairly complex and require detailed explanation.

(1) Strang and Rourke (1985a) demonstrated that Group A subjects (good reading and spelling performance relative to arithmetic) evidence greater, clinically significant, psychopathology as compared to Group R-S subjects (poor reading and spelling relative to arithmetic). Fuerst and Rourke (in preparation) also demonstrated that children evidencing severe psychopathology tend to perform better in reading and spelling relative to children with normal psychosocial functioning or relatively benign psychosocial problems. Both the Strang and Rourke (1985a) and Fuerst and Rourke (in preparation) studies also revealed that children showing a Group A pattern of academic performance tend to evidence a particular type of psychopathology (internalized). Thus, there is a relationship between patterns of academic functioning and patterns of psychosocial functioning (both level and type of pathology) in children with LD.

(2) It is difficult to argue that patterns of academic performance (i.e., good reading and spelling relative to
arithmetic, or vice versa) influence psychosocial functioning. That is, there is no obvious explanation for the observation that Group A children evidence greater psychopathology as compared to Group R-S children. Similarly, it is also difficult to argue that different patterns of psychosocial functioning can directly produce different patterns of academic achievement. (An exception to this assertion might be cases of primary psychopathology, such as major depressive disorder or attention deficit disorder. As explained in the Hypothesis 1 section above, these cases lie outside the realm of LD.)

(3) Considering point (2), it is logical to propose that there is a third factor accounting for the apparent relationship between patterns of academic functioning and psychosocial functioning. While it is certainly possible that there could be many different factors producing this apparent relationship, a single factor would provide the most parsimonious explanation.

(4) The most likely candidate for this intervening factor is cognitive functioning. Previous research has clearly indicated that patterns of academic functioning are strongly related to patterns of cognitive functioning, as measured by neuropsychological/psychometric instruments. These measures include, but are by no means limited to, WISC VIQ-PIQ discrepancies (Rourke, Dietrich, & Young, 1973; Rourke & Finlayson, 1978; Rourke & Telegdy, 1971; Rourke, Young, &
Flewelling, 1971). The logical direction of causation in this relationship is that cognitive factors influence academic performance.

(5) The results of Fuerst et al. (1990) have demonstrated that patterns of cognitive functioning, measured by WISC VIQ-PIQ discrepancy, are associated with psychosocial functioning. Specifically, children showing the pattern of WISC VIQ>PIQ tend to be found in subtypes demonstrating severe psychopathology, whereas children with VIQ=PIQ or VIQ<PIQ tend to be found in subtypes with normal or mildly disturbed psychosocial functioning. As before, it is difficult to conceive of patterns of psychosocial functioning as causing patterns of cognitive functioning (with the exceptions noted above). It is more logical to propose that patterns of cognitive functioning influence psychosocial functioning.

(6) Thus, it follows that cognitive/neuropsychological functioning may, at one and the same time, influence academic performance on the one hand and psychosocial functioning on the other. Patterns of cognitive/neuropsychological functioning may be the intervening factors accounting for the apparent relationship between academic performance and socioemotional adjustment. However, further investigation, using more direct and detailed measures of cognitive and neuropsychological functioning, is required in order to have greater confidence in this conclusion.

Other Studies
Finally, two studies that were designed to determine the developmental outcome for Group A children are also useful for evaluating Hypothesis 3. Rourke, Young, Strang, & Russell (1986) compared the performances of Group A children and a group of clinic-referred adults on a wide variety of neuropsychological variables. The adults presented with VIQ-PIQ discrepancies and WRAT patterns that were virtually identical to the analogous patterns in Group A children. It was demonstrated that the patterns of age-related performances of the adults and the children on the neuropsychological variables were remarkably similar. In addition, the adults were characterized by internalized forms of psychopathology that bore a striking resemblance to those exhibited by Group A youngsters. In a related study, Del Dotto, Rourke, McFadden, and Fisk (1987) confirmed the stability of the neuropsychological and personality characteristics of this subtype of learning-disabled persons over time.

It should also be noted that Weintraub and Mesulam (1983) have described the socioemotional, cognitive, and neurological status of 14 adults who were very similar to the Group A subtype. The patients showed neurological abnormalities, large discrepancies (as much as 36 points) between Verbal and Performance IQ in favour of the latter (with the exception of one case), poor memory for nonverbal material relative to verbal material, poor eye contact in interview, and reduced speech prosody. Chronic shyness, introversion, social
isolation, and depression were very common in the sample. Denckla (1983) has also reported clinical experiences consistent with those of Weintraub and Mesulam (1983).

**Summary**

It would appear that children who exhibit the Group A (nonverbal learning disabilities) profile of neuropsychological abilities and deficits are likely to be described by parents as emotionally or behaviourally disturbed. In contrast, Group R-S children (with outstanding difficulties in many aspects of psycholinguistic functioning) are so described at much lower frequencies. More generally, it may be that the pattern of nonverbal learning disabilities described approximates a sufficient condition for the development of some sort of socioemotional disturbance (Rourke, 1987, 1989), whereas the pattern of central processing abilities and deficits exhibited by the subtype of psycholinguistically impaired child examined in this series of studies may not constitute the same sufficient basis for such an outcome.

This is not meant to imply that children characterized by the Group R-S (language deficient) pattern will never experience socioemotional disturbance. Indeed, clinical experience (e.g., Rourke et al., 1983; Rourke, Fisk, & Strang, 1986) suggests that many do. Rather, these results suggest that, for the Group R-S subtype, factors in addition to psycholinguistic deficiency may be necessary for disturbed
socioemotional functioning to occur. Such "additional" factors may include some of those mentioned in connection with the emotional disturbance-learning problem relationship outlined in the initial section of this review (e.g., teacher-pupil personality conflicts, unrealistic demands by parents and teachers, inappropriate motivation and social expectancies). Others would appear to include the presence of salient anti-social models, selective reinforcement of nonadaptive and socially inappropriate behaviours, and any number of other factors that have the potential for encouraging problems in the socioemotional functioning of even normally achieving youngsters.

Refinements of these findings and detailed theoretical explanations of their interrelationships are contained in several recent publications (e.g., Rourke, 1982, 1987, 1989; Rourke & Fisk, 1988; Strang & Rourke, 1985a). While it is relatively easy to demonstrate and outline this pattern of relationships, as was done in the Implications section above, the development and articulation of a model capable of accounting for those relationships is a far more complex undertaking, and beyond the scope of this review. For example, a detailed model which accounts for the propensity of the Group A (nonverbal learning-disabled, or NLD) child to develop a particular configuration of academic learning difficulties and a specific type of severe socioemotional disturbance (plus many other unusual features often noted by
clinicians when dealing with Group A children) is presented in Rourke (1989).

Briefly, and at the risk of oversimplification, these tendencies of the NLD child have been characterized in terms of the development of, and interaction between, deficits in primary (e.g., basic perceptual and motor skills), secondary (e.g., attention to stimuli in various modalities), and tertiary (e.g., mnemonic, concept-formation, and problem-solving abilities) neuropsychological functions. Well developed processing capacities within auditory-verbal domains, but poor capacity within perceptual-motor, concept-formation, problem-solving, and other nonverbal domains, is seen as resulting in the development of good rote reading and spelling skills but pronounced difficulty with mechanical arithmetic. Given deficits in nonverbal skills, and difficulty in dealing with complex, novel, situations, but relative strengths in many aspects of psycholinguistic abilities, these children also come to rely excessively on rote auditory-verbal skills for interacting with others. As a result, NLD children tend to misperceive/mis-emit, or simply miss/fail to emit, most of the subtle and not so subtle nonverbal information in their interchanges with others. NLD children also lack the capacity to deal effectively with the complex and novel problems that inevitably arise in dealing with others. As a result, they tend to have grave problems in interpersonal relationships. As they grow older, and the
demands of interpersonal relationships become more complex and the price of failure higher, they tend to become socially isolated and withdrawn. Concurrently, their academic problems also become more pronounced, as they are faced with the much more complex demands of secondary and post-secondary education that their circumscribed strengths in rote verbal abilities cannot meet, and their educational/vocational outlook becomes quite poor. Their psychosocial adaptation deteriorates and pronounced internalized psychopathology may become evident.

The actual model presented by Rourke (1989) is much more complex than this brief synopsis. The dynamic interplay and development of the components within the model is further cast upon a foundation of empirical and theoretical models of central nervous system development in children. Thus, the model is also capable of encompassing some of the complex manifestations of specific neuropathological conditions (such as head injury, extensive radiotherapy of the central nervous system, and neurotoxic conditions) that are likely to produce the NLD syndrome. At the same time, it is clear that the etiologies of NLD are by no means limited to frank cerebral insult. While there is a good fit between the model and clinical experience, and some empirical evidence to support it, further research is required to test many aspects of the model.

Principal Conclusions

Clearly, our understanding of the psychosocial
development and functioning of children with LD is far from complete. However, this review of the literature suggests that, while many studies have been less informative than might be hoped, research efforts in this area have not been wasted. The conclusions which flow from this review are as follows:

(1) There is no single, unitary pattern of personality characteristics, psychosocial adaptation, social competence, self-concept, locus of control, or other facet of socioemotional functioning examined in this review, that is characteristic of all children with LD.

(2) Some children with LD experience mild to severe disturbance of socioemotional functioning. However, most children with LD appear to achieve adequate psychosocial adaptation.

(3) There are distinct types of socioemotional disturbance and behaviour disorder that may be displayed by children with LD. These various manifestations of emotional and behavioural disorder may be more frequent among children with LD than among their normally achieving peers; however, the precise types and incidence of emotional and behavioural problems in children with LD is, as yet, not accurately known.

(4) One pattern of central processing abilities and deficits (nonverbal learning disabilities) appears to lead to both a particular configuration of academic achievement (well developed word-recognition and spelling as compared to significantly poorer mechanical arithmetic), increased risk of
psychopathology, and a tendency to develop an internalized form of socioemotional disturbance. Other patterns of central processing abilities and deficits (those marked by outstanding difficulties in psycholinguistic skills) appear to lead to particular patterns of academic achievement (striking problems in reading and spelling, and varying levels of performance in mechanical arithmetic), with some correlative effect upon the incidence of psychopathology but no particular effect upon its specific manifestations.

(5) There is no conclusive evidence that children with LD are prone to developing problems with substance abuse, truly antisocial behaviour, or delinquency. Carefully conducted longitudinal research suggests that, as a group, children with LD are no more likely to develop these problems than are normal children.

(6) There is no conclusive evidence that children with LD, as a group, tend to become more prone to socioemotional disturbance with advancing age relative to normally achieving peers.

(7) One exception to point (6) is the worsening in the manifestations of psychopathology and the increasing discrepancies between abilities and deficits that are exhibited by children and adolescents of the nonverbal learning disabilities subtype. This is the case in spite of the fact that the pattern of neuropsychological abilities and deficits and the specific manifestations of psychopathology in
such individuals remain quite stable over time.

Rationale for the Present Study

The purpose of this study was to replicate and extend the findings of the Fuerst et al. (1989, 1990) and Fuerst and Rourke (in preparation) studies. In this study, two specific methodological shortcomings of these previous investigations were addressed:

Failure to Explore the Developmental Dimension

In previous attempts to develop psychosocial typologies of children with LD (Fuerst et al., 1989, 1990; Fuerst & Rourke, in preparation; Porter & Rourke, 1985), the subjects covered a wide range of ages (6 to 15 years) but were treated as a single sample in the generation of subtypes. As argued above, this may not be appropriate, as several studies have indicated that the nature of the skill and ability deficits of some children with LD varies with age (e.g., McKinney, Short, & Feagans, 1985; Morris et al., 1986; Ozols & Rourke, 1988; Rourke et al., 1973). It would seem reasonable to also infer that the socioemotional functioning of some children with LD might also vary as a function of age (considered as one index of developmental change).

On the surface, a study by Strang (1981) would seem to argue against this supposition. In this investigation, the mean PIC profiles and scores on 3 PIC factor scales of 20 children with LD at each of three age levels (viz., 8, 10, and 12 years old) were compared. Overall, there were very few
statistically significant differences between the three groups. The parents of younger (8-year-old) children were more concerned about the intellectual functioning of their children than were the parents of older (12-year-old) children. Conversely, the 10-year-old children scored significantly higher (more pathological) on the Delinquency scale of the PIC than did the 8-year-old children. However, the overall mean PIC profiles of the three age groups were extremely similar in all other respects, and suggested normal psychosocial functioning.

This failure to find an association between psychosocial functioning and age is at variance with commonly held notions of the socioemotional development of children with LD (e.g., cumulative effects of persistent academic failure) and evidence from some longitudinal studies (e.g., Mcgee et al., 1986). It is also contrary to recent formulations of the psychosocial development of children with NLD (Rourke, 1989) which, based on clinical observations and rational extrapolations from theory, predict changes in both the nature and severity of psychopathology manifested by such children. Indeed, in the Strang (1981) study, there were some curious trends in mean PIC factor scores at the three age levels. Although these trends did not reach statistical significance (perhaps due to the small sample size), there was a clear trend towards greater internalized psychopathology and personality deviance at higher age levels, with reduced
parental concern over intellectual development and achievement. Had Strang (1981) taken the additional step of separating the pathological from normal PIC profiles (a simple form of subtype generation), which, as reviewed above, are typically predominant in LD samples, comparisons of the PIC profiles and factor scores across the different age levels may have been more informative. The simple contrasting-groups design employed in that study may have obscured any association between age and socioemotional adjustment.

In this study, relatively sophisticated techniques for assessing the possibility of an association between age and psychosocial functioning in children with LD were used. Perhaps of primary importance, a sufficient number of subjects (more than 700) were included in this study to allow proper evaluation of potential differences in psychosocial functioning at different age levels. In addition, rather than simply comparing relatively undifferentiated children at different age levels, the relationship between age and patterns of psychosocial functioning were explored using two different methods. In the first approach, an attempt was made to derive psychosocial subtypes at three age levels (viz., 7-8, 9-10, and 11-13 years of age) using five methods of cluster analysis, allowing comparisons of patterns of psychosocial functioning at different age levels. In the second approach, a profile-matching technique using prototypical PIC profiles developed in previous research was applied to all subjects,
allowing age differences in the composition of known subtypes to be assessed. Given the exploratory nature of this study, it was impossible to predict with precision the subtypes that would emerge within and across the three age levels, or differences in composition of known subtypes with respect to age. However, in general it was expected that:

1. There would be some similarities between the subtypes derived at all age levels. Specifically, subtypes corresponding to the Normal, Internalized Psychopathology, and Externalized Psychopathology subtypes (i.e., the most reliable subtypes) derived in previous research (Fuerst et al., 1989, 1990; Fuerst & Rourke, in preparation; Porter & Rourke, 1985) would be found.

2. With increasing age there should be a greater diversity of psychosocial subtypes (e.g., the emergence of Conduct Disorder and Mild Anxiety subtypes).

3. With increasing age, within frankly pathological groups there should be, overall, a greater level of pathology manifested.

Comprehensive Measures of Cognitive Functioning

As should be clear from the literature review above, investigations in this area must make use of comprehensive measures of neuropsychological-cognitive (hereafter abbreviated as neurocognitive) and psychosocial functioning.
In the psychosocial domain, investigators should choose psychometric instruments that (a) provide good coverage of behavioural categories, (b) have acceptable norms, and (c) have demonstrated internal and external validity. Fortunately, the PIC meets all of these criteria.

The neurocognitive domain, however, is not so easily addressed. Both the WISC and WRAT are useful tools for both clinical and research applications. However, used in isolation, neither is direct or detailed enough to adequately sample neurocognitive functioning. Research in progress by Francis, Fletcher, and Rourke (see, for example, Francis, Fletcher, & Rourke, 1988) has produced detailed information regarding the major dimensions of cognitive functioning in children with LD, and identified a core set of instruments capable of accurately assessing those dimensions. These measures, some 19 in all, were used to explore the relationships between psychosocial and neuropsychological functioning at the three age levels used in this study. WISC IQ scores and WRAT Reading, Spelling, and Arithmetic standard scores were also included, given the relationships between these measures and psychosocial functioning demonstrated in previous research (Fuerst et al., 1990; Fuerst & Rourke, in preparation).

As before, given the exploratory nature of this study specific predictions as to the relationships between psychosocial subtypes and the neuropsychological measures were
difficult to make. However, it was expected that:

1. As the impact of specific patterns of neurocognitive strengths and deficits take time to impact on psychosocial development (Rourke, 1989), it was expected that, overall, there would be relatively little association between neurocognitive and psychosocial functioning at the lowest age level, but more prominent associations at higher age levels.

2. Considering clinical observations and theoretical models of NLD, it was expected that children showing severe internalized psychopathology would demonstrate a pattern of neurocognitive strengths and deficits consistent with the NLD syndrome (Rourke, 1989). Briefly, such children should show relatively good word-knowledge, semantic-acoustic, and simple motor skills, but relatively poor visual-spatial and complex psychomotor skills.
CHAPTER II: METHOD

Subjects

The 728 subjects used in this study (564 males and 164 females) were selected from a group of more than 5200 children examined at a large urban clinic. These children had been referred for neuropsychological assessment because of learning or "perceptual" difficulties to which it was suspected that cerebral dysfunction could be a contributing factor. All children had completed an extensive neuropsychological test battery, administered by competent technicians, in the manner recommended by Rourke (1976b). The selected children met the following criteria: (a) chronological age between 7 and 13 years (inclusive); (b) WISC Full Scale IQ (FSIQ) of 80 or above; (c) at least one WRAT centile score below 30; (d) no evidence of educational or cultural deprivation; (e) complete PIC scale scores available. Detailed information regarding the socioeconomic status of the selected children was not available, although almost all subjects were drawn from a very homogeneous lower to middle class urban/suburban area.

For some analyses the sample was partitioned into three subgroups based on age. One subgroup (201 subjects) contained subjects between the ages of 7 and 8 years of age; a second subgroup (258 subjects) contained subjects between the ages of 9 and 10 years of age; a third subgroup (269 subjects) contained subjects between the ages of 11 and 13 years of age. The mean WISC FSIQ, Verbal IQ (VIQ), and Performance IQ
Table 1

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

<table>
<thead>
<tr>
<th>Source</th>
<th>FSIQ</th>
<th>VIQ</th>
<th>PIQ</th>
<th>RSS</th>
<th>SSS</th>
<th>ASS</th>
</tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ages 7-8 (n = 201)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Males</td>
<td>97.9</td>
<td>94.3</td>
<td>102.3</td>
<td>83.6</td>
<td>82.8</td>
<td>89.2</td>
</tr>
<tr>
<td>Females</td>
<td>94.6</td>
<td>91.7</td>
<td>99.4</td>
<td>86.7</td>
<td>84.4</td>
<td>90.2</td>
</tr>
<tr>
<td>Overall</td>
<td>97.0</td>
<td>93.6</td>
<td>101.6</td>
<td>84.4</td>
<td>83.2</td>
<td>89.4</td>
</tr>
<tr>
<td>Ages 9-10 (n = 258)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>99.4</td>
<td>94.5</td>
<td>105.0</td>
<td>89.2</td>
<td>84.7</td>
<td>86.2</td>
</tr>
<tr>
<td>Females</td>
<td>94.7</td>
<td>90.7</td>
<td>100.1</td>
<td>89.4</td>
<td>86.8</td>
<td>85.4</td>
</tr>
<tr>
<td>Overall</td>
<td>98.4</td>
<td>93.7</td>
<td>104.0</td>
<td>89.2</td>
<td>85.1</td>
<td>86.0</td>
</tr>
<tr>
<td>Ages 11-13 (n = 269)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>99.0</td>
<td>93.3</td>
<td>104.7</td>
<td>91.5</td>
<td>82.6</td>
<td>78.5</td>
</tr>
<tr>
<td>Females</td>
<td>94.6</td>
<td>88.9</td>
<td>102.0</td>
<td>90.1</td>
<td>84.7</td>
<td>79.4</td>
</tr>
<tr>
<td>Overall</td>
<td>97.7</td>
<td>92.3</td>
<td>104.1</td>
<td>91.2</td>
<td>83.0</td>
<td>78.7</td>
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</tbody>
</table>
(PIQ) scores are summarized in Table 1. Overall, the WISC FSIQ, VIQ, and PIQ scores were 98.7, 94.0, and 104.2, respectively, for males, 94.6, 90.4, and 100.5, respectively, for females, and 97.8, 93.2, and 103.4, respectively, for the entire sample.

It should be noted that for the subsets of males and females, and for the entire combined sample, the mean WISC PIQ was higher than WISC VIQ. This suggested that few subjects evidenced a pattern of VIQ>PIQ. Indeed, the breakdown of subjects by VIQ-PIQ discrepancy was: VIQ<PIQ (by 10 or more points), 368 subjects or 50.5% of the sample; VIQ=PIQ (VIQ-PIQ difference of less than 10 points), 319 subjects or 43.8%; VIQ>PIQ (by at least 10 points), 41 subjects or 5.6%. The relative paucity of VIQ>PIQ subjects is, unfortunately, typical of clinic-referred samples of children with LD.

Mean standard scores on WRAT Reading, Spelling, and Arithmetic are also shown in Table 1. The mean Reading, Spelling, and Arithmetic scores were 88.6, 83.4, and 84.1, respectively, for males, 88.78, 85.3, and 84.8, respectively, for females, and 88.7, 84.3, and 84.5, respectively, for the complete sample.

**Measures**

The Personality Inventory for Children (PIC) is comprised of 600 descriptive statements that are answered 'true' or 'false' according to the respondent's opinion of the child (Wirt et al., 1977). It is administered to the child's
primary caretaker, usually the biological mother. While up to 33 separate scales can be derived from the 600 PIC items, only 16 of these scales are typically used (see Table 2 for a brief synopsis of the scales). Of these 16 scales, three are measures of the validity of the profile (Lie, F, and Defensiveness), one is a general measure of psychological adjustment (Adjustment), and the remaining 12 constitute 'clinical' scales measuring specific behavioural domains (Achievement, Intellectual Screening, Development, Somatic Concern, Depression, Family Relations, Delinquency, Withdrawal, Anxiety, Psychosis, Hyperactivity, and Social Skills). A child's profile on these scales is expressed in the form of T-scores, with positive elevations above the mean suggesting greater likelihood of pathology.

The neuropsychological measures used in the study have been identified as the best measures of six major domains of neurocognitive functioning using confirmatory factor analysis by Francis, Fletcher, and Rourke (see, for example, Francis, Fletcher, & Rourke, 1988; Rourke, personal communication, June 25, 1989). The domains and measures (in parentheses) were: (1) simple motor (right and left finger tapping, right and left grip strength [Reitan & Davison, 1974]); (2) eye-hand coordination (Klove-Matthews Mazes total time, Klove-Matthews Holes total time, and right and left times on the Grooved Pegboard Test [Klove, 1963]); (3) visual-spatial (WISC Block Design, Object Assembly, and Picture
<table>
<thead>
<tr>
<th>Table 2</th>
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<tbody>
<tr>
<td><strong>The PIC Scales (From Wirt et al. 1977)</strong></td>
</tr>
<tr>
<td><strong>Lie</strong></td>
</tr>
<tr>
<td>The Lie scale was designed to identify a defensive response set marked</td>
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<tr>
<td>by a tendency to ascribe virtuous behaviour to, and to deny commonly</td>
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<tr>
<td>occurring behaviour problems for, the child (such as bad habits or a</td>
</tr>
<tr>
<td>messy room).</td>
</tr>
<tr>
<td><strong>F</strong></td>
</tr>
<tr>
<td>The F scale was designed to identify deviant response sets, such as</td>
</tr>
<tr>
<td>exaggeration of symptoms or random responding. <strong>F</strong> scale elevation</td>
</tr>
<tr>
<td>may be indicative of intensity or severity of symptoms.</td>
</tr>
<tr>
<td><strong>Defensiveness</strong></td>
</tr>
<tr>
<td>This scale was designed to measure the respondent's tendency to be</td>
</tr>
<tr>
<td>defensive about the child's behaviour during an assessment. It may be</td>
</tr>
<tr>
<td>indicative of tendencies to be vigilant and hostile, and withholding</td>
</tr>
<tr>
<td>of information.</td>
</tr>
<tr>
<td><strong>Adjustment</strong></td>
</tr>
<tr>
<td>The Adjustment scale is a screening device meant to identify children</td>
</tr>
<tr>
<td>in need of psychological evaluation, and provide a measure of general</td>
</tr>
</tbody>
</table>
Achievement

The Achievement scale was designed to identify children with academic achievement below age expectation. It is most strongly related to level of reading comprehension, and is a relatively poor predictor of arithmetic achievement.

Intellectual Screening

This scale was designed to identify children whose problems may be due to impaired intellectual functioning and may be in need of intellectual assessment.

Development

This scale provides a measure of intellectual and physical development. It primarily reflects retardation in the development of motor coordination, academic abilities, and individual potential.

Somatic Concern

This scale is a measure of a number of health related variables, such as somatic complaints and illness, adjustment to illness, eating habits, sleep patterns, general energy and strength, headaches, stomach aches, and other somatic symptoms.
Depression  The Depression scale consists of items deemed to reflect signs of childhood depression. Such signs include brooding, social isolation, crying spells, low energy level, pessimism, anhedonia, poor self concept, and withdrawal.

Family Relations  This scale is a measure of family effectiveness and cohesion. It is indicative of the family's stability and adaptiveness, happiness, and parental effectiveness and emotional adjustment.

Delinquency  This scale was designed as a measure of delinquent and antisocial tendencies. It reflects a lack of sensitivity for the rights and feelings of others, a disregard for parents and rules, and characteristics such as hostility, intolerance, and frustration.

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

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

Psychosis

The Psychosis scale was designed to identify children manifesting psychotic symptomatology. High scores are indicative of reality distortion, cognitive disorientation, poor pragmatic skills, social withdrawal, anxiety, and inappropriate affect.

Hyperactivity

This scale was designed to identify children who display characteristics of the "hyperkinetic syndrome". High scores are indicative of emotional instability, hostility, impulsivity and restlessness, poor peer relationships, and discipline problems.

Social Skills

The Social Skills scale was designed to measure the effectiveness of interpersonal skills and the reasons
for failure in social situations. It is indicative of social comprehension and tact, self-confidence and poise in social situations, and appropriate role taking behaviour.
Completion subtests); (4) executive (Trail Making Test parts A and B [Reitan & Davison, 1974], and WISC Coding); (5) word knowledge (WISC Vocabulary and Comprehension subtests, and Peabody Picture Vocabulary Test [Dunn, 1965]); (6) semantic-acoustic (Speech-Sounds Perception Test [Reitan & Davison, 1974], and the Auditory Closure Test [Kass, 1964]). Brief descriptions of these tests can be found in Table 3.

Scales summarizing performance on these factors were created by conversion of the original variables to T-scores (see Chapter III for details) and calculation of the mean score of the variables associated with each factor. For example, the semantic-acoustic factor scale score was generated by finding a subject's mean score on the Speech-Sounds Perception and Auditory Closure tests. Hereafter these variables are referred to as the confirmatory factor analysis (CFA) factor scales (more accurately, "factor-based" scales [Kim & Mueller, 1978]). Note that, as Young children did not receive the Trail Making Test, any analyses involving Young children and the CFA factors could not include the executive factor scale. Note also that a seventh factor, designated as freedom from distractibility, was also constructed from WISC Digit Span and Arithmetic scores.

A number of additional tests were also included in the analyses because of their known relevance to the study of brain-behaviour relationships in children with LD. These measures included: (1) WISC FSIQ, VIQ, and PIQ; (2) all WISC
subtests; (3) WRAT Reading, Spelling, and Arithmetic standard scores; (4) for Younger children, Matching Pictures (Reitan & Davison, 1974); (5) for Middle and Old children, the Halstead Category Test (Reitan & Davison, 1974).
Table 3

**Neuropsychological Measures**

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger Tapping</td>
<td>This test requires the child to tap a key, using the index finger only, as quickly as possible for 10 seconds. Four trials are administered to each hand. Scores are the average number of taps for each hand.</td>
</tr>
<tr>
<td>Grip Strength</td>
<td>This test measures strength of grip for each hand using a dynamometer. Three trials are given with each hand. Scores are the mean strength of grip, in kilograms, for each hand.</td>
</tr>
<tr>
<td>Maze Test</td>
<td>This test requires the child to run a stylus through a maze of narrow grooves cut into a metal plate. Two trials are administered to each hand. Scores are the total time for which the stylus is in contact with the sides of the grooves for each hand.</td>
</tr>
</tbody>
</table>
| Graduated Holes Test      | The child is required to insert and hold (for 10 seconds) a
stylus in a series of increasingly narrow holes without touching the sides. Total time spent in contact with the sides of holes is recorded for each hand.

The child is asked to insert 25 key-shaped pegs into similarly keyed holes in a 4"X4" board as quickly as possible. One trial per hand is administered. Time to complete the test for each hand is recorded.

(Age 9 and above) This test requires the child to rapidly navigate a pencil through a visual array following either a simple numeric sequence (Part A) or a more complex alternating numeric-alphabetic sequence (Part B). The time required to complete both parts are recorded separately.

In this test the child is asked to listen to a tape recording of nonsense syllables and select
the corresponding printed nonsense word from three alternatives. Scoring is the number of correct responses.

**Auditory Closure Test**

In this test, words of increasing length broken into discrete sound elements are presented on tape. The score is the number of words which the child can correctly identify.

**Matching Pictures**

(Ages 5 to 8) This test requires the child to match appropriate pairs of pictures on a printed page. While early items only require simple matching, later items demand some degree of categorization and generalization.

**Category Test**

(Age 9 and above) This test requires the child to select one of four visual stimuli according to various principles (e.g., number, spatial position). The principles are never revealed to the child, only whether an answer is right or wrong.
Note: Some tests produce additional measures which are not described in this table. Only those scores used in this study are included above. The reader is referred to Rourke (1989), the source of this synopsis, for more detailed descriptions of these tests.
CHAPTER III: RESULTS

Subtype Generation by Cluster Analysis: Strategy

In the interests of clarity, and to avoid redundant descriptions of the analytic approach used in this phase of the study, an overview of the methods used to derive clusters is provided first. Note that the following analyses were carried out at each of three different age levels (7-8 [Young], 9-10 [Middle], and 11-13 years [Old]). The relevant results are reported separately for each of the age categories. The differences and similarities between the pattern of results which emerged across age ranges are addressed in Chapter IV: Discussion.

Outlier Detection and Deletion

Before undertaking any additional analyses, steps were taken to identify and eliminate outliers from the data. This was necessary as all of the cluster analysis algorithms used in this study are known to be sensitive to the presence of outliers. A three-step process was used.

First, each subject's scores on the 10 PIC scales that were to be used to form clusters were standardized in such a manner as to eliminate profile elevation and dispersion. The transformation is outlined in detail below; briefly, however, this was accomplished by standardizing each subject's 10 PIC scale scores across that subject's profile. Next, the Euclidean distance between a subject and all other subjects was calculated. As each distance was calculated, it was
compared to a pre-selected constant value. A running frequency count of all distances less than or equal to this value (the "radius") was made for each subject. Finally, a certain percentage of subjects with the lowest frequency counts were discarded. The exact percentage of subjects deleted depended on the performance of the hierarchical-agglomerative clustering techniques used in the replication attempts. For each of the three age levels, 5% of subjects were initially deleted as outliers. This percentage was found to be adequate for both the Young and Middle subjects; however, it was increased to 10% of subjects for the Old children when replication attempts using the initial value were unsuccessful. The SAS macro implementation of this method of outlier deletion is presented in Appendix A.

The rationale for this method of outlier detection and elimination can be understood as follows. Given the transformation used to eliminate profile elevation and dispersion, the Euclidean distance between subjects provides a measure of similarity of PIC profile shape, with larger values indicating less similarity. By calculating the number of subjects which fall within a hypersphere of a given radius centred on a case, a measure of the density of subjects in the space around that case is obtained (actually, as 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 that are
relatively similar to others will be found in higher density regions of the space defined by the variables used in clustering. On the other hand, cases found in low density regions will be relatively dissimilar to other cases in the sample, and will be, by definition, outliers.

This approach was chosen over two other methods of outlier detection considered for use in this study. One simple method involves calculating the distance between a case and the centroid of all other cases, and deleting those cases which are judged to have excessively large distances. The problem with this method is that it would perform best given a single, hyperspherical cluster of cases. Given more than one cluster of cases it is likely to perform poorly. For example, consider two compact hyperspherical clusters well-separated in space, with a single case positioned midway between them. This case will fall close to the centroid of the entire sample, and will appear to be much "less" of an outlier than some cases on the fringes of the two compact clusters. However, with the method used in this study such a case would be correctly identified as an outlier.

A second method of outlier detection involves calculating the distance between a case and every other case in the sample (as in the density technique). By noting the minimum distance obtained for that case, and deleting subjects with large minimum distance values, cases that are relatively dissimilar from any case in the sample are removed. (Note that, although
this method of outlier detection and deletion was not used in this study, for illustrative purposes a SAS macro implementation of this algorithm is provided in Appendix A.) This technique would detect the lone outlier posed in the example of the previous paragraph. However, if there was a second outlier relatively close by, this technique would fail, and would certainly perform poorly if the true clusters were relatively diffuse. Once again, even in such circumstances, the method of outlier detection used in this study would still correctly identify such cases as outliers.

Cluster Analysis

Initial K-Means Analysis

Subjects were initially clustered using an iterative partitioning method, k-means analysis (MacQueen, 1967), that has demonstrated good performance in previous research (Fuerst et al., 1989; Fuerst & Rourke, in preparation) and is algorithmically and computationally well-suited for clustering of large data sets. The subjects' scores on the Development, Somatic Concern, Depression, Family Relations, Delinquency, Withdrawal, Anxiety, Psychosis, Hyperactivity, and Social Skills PIC scales (10 in all) were subjected to k-means clustering using Euclidean distances as the similarity measure. The Achievement and Intellectual Screening scales were not included in this analysis as previous experience has shown that these two scales and the Development scale tend to be very highly correlated in samples of children with LD, and
provide little novel or useful information. The SAS Version 5.18 implementation of the k-means algorithm (PROCedure FASTCLUS) was used (Sarle, 1985).

As grouping on the basis of similarity of profile shape was of primary concern, and given that SAS clustering software limits similarity measures to Euclidean distance, the elements of profile elevation and dispersion were first eliminated from the data. This was accomplished by standardizing each subject's 10 PIC scale scores across that subject's profile. The transformation used was \( z = \frac{X - M}{SD} \), where \( X \) is a subject's raw scale score, \( M \) and \( SD \) are the mean and standard deviation (respectively) of that subject's profile (calculated across the 10 scales), and \( z \) is the resulting standard score (Lorr, 1983).

The number of clusters present in the data was determined by examination of \( R^2 \) and pseudo-F values, internal reliability of the solution (see below), and by the interpretability of the resulting mean PIC profiles, at various partition levels (from 3 to 10 clusters). While the latter criterion may appear somewhat "subjective" (and indeed it is), it should be noted that none of the quantitative criteria that have been suggested for determining the true number of clusters have proven to be effective across all techniques and samples (e.g., Everitt, 1974). Previous experience with data similar to that used in this study (Fuerst et al., 1989, 1990; Fuerst & Rourke, in preparation) has strongly suggested that
replicability (reliability) and clinical interpretability are, in general, superior to quantitative methods when evaluating the adequacy of a specific cluster solution.

**Subtype Replication by Hierarchical Cluster Analysis**

To assess the internal validity (reliability) of the subtypes derived using k-means cluster analysis, five additional clustering methods were applied to the same subjects and PIC scales used in the initial k-means analysis. The rationale behind this approach can be found in Fletcher (1985) and Fuerst et al. (1989). Briefly, however, reliability is of particular concern when multivariate subtyping techniques are applied in an exploratory fashion to data with relatively unknown statistical properties. Multivariate subtyping techniques, such as any of the many forms of cluster analysis, will always produce some grouping of data, even if purely random data are used in the procedures. Furthermore, different statistical subtyping techniques can, and often do, produce disparate solutions when applied to the same data. Replicability of solutions across different samples from the same population, and across different subtyping techniques, is a crucial first step in determining the validity of the subtypes so derived.

As has often been pointed out in the cluster analysis literature, there are a wide variety of clustering techniques available, and there is relatively little compelling evidence to suggest the superiority of one particular technique over
others, given the complex interaction between methods, measures, and samples (Aldenderfer & Blashfield, 1984; Lorr, 1983). For the replication attempts, four widely used and relatively well understood hierarchical agglomerative clustering methods, Ward's Minimum-Variance method (Ward, 1963), the complete linkage method (Sorensen, 1948), the weighted pair-group method using arithmetic averages (WPGMA, Sokal & Michener, 1958), and the unweighted pair-group method using arithmetic averages (UPGMA, Sokal & Michener, 1958), plus one relatively new technique, equal-variance maximum likelihood method (EML, Sarle, 1985), for which there is little published information, were selected. The SAS version 5.16 implementation of these algorithms was used (Sarle, 1985).

One undesirable feature of hierarchical agglomerative clustering techniques is that once a subject is assigned to a cluster, that subject is never removed: clusters can only be joined, never split. To help guard against the effects of fusion errors, the following procedure was used. First, a k-means solution for a large number of clusters (between 50 and 80) was derived using the SAS FASTCLUS algorithm (Sarle, 1985). These initial clusters were then used as input to the Ward's, WPGMA, and EML hierarchical clustering techniques. The preliminary results of the hierarchical clustering were examined and the optimal number of clusters selected. Finally, a k-means relocation pass, with seeds determined by
cluster membership at the chosen level of the hierarchy, was performed using the BMDP k-means algorithm. Although not as sophisticated or flexible as the k-means relocation techniques implemented in some dedicated cluster analysis software (e.g., CLUSTAN, Wishart, 1978), this method was judged to provide adequate protection against potential fusion errors in hierarchical clustering.

These five hierarchical clustering techniques were applied to the same subjects and 10 PIC scales used in the initial k-means analysis. As before, since grouping on the basis of similarity of profile shape was of primary concern, and given that SAS clustering software limits similarity measures to Euclidean distance, the elements of profile elevation and dispersion were first eliminated from the data. This was accomplished by standardizing each subject's 10 PIC subscale scores across that subject's profile, using the same transformation employed in the initial k-means analysis.

For all hierarchical methods, the level at which the hierarchy was "cut" (i.e., number of clusters) was set to the number of clusters settled on in the initial k-means analysis. An initial k-means solution was deemed reliable if it was replicated by at least three of the five hierarchical methods. The degree to which these five hierarchical clustering methods replicated the initial subtypes derived using k-means analysis was assessed quantitatively using three different techniques.

As the principal method of assessing agreement between
solutions, three external criteria measures were calculated: Rand's statistic (Rand, 1971), and the two adjustments to Rand's statistic suggested by Morey and Agresti (1984) and Hubert and Arabie (1985). Rand's statistic is a measure of the agreement between two different cluster solutions as assessed by the extent to which pairs of subjects are clustered together or apart (i.e., for there to be agreement, pairs of subjects clustered together in one solution must be clustered together in the second solution, and vice-versa for pairs of subjects not clustered together). The Morey and Agresti (1984) and Hubert and Arabie (1985) adjustments to Rand's statistic are slightly different corrections for chance agreement between solutions. The SAS macro used to calculate these statistics is found in Appendix A (computational formulas were taken from Milligan & Cooper, 1986).

As a second means of assessing agreement between solutions, the percentage of subjects misclassified by the hierarchical techniques, using the k-means cluster solution as a reference, was calculated. While not as elegant as Rand's statistic and its two common variations, this method provides information regarding agreement of solutions that is easy to understand. Finally, correlations between the mean PIC profiles of the subtypes derived by k-means analysis and those derived by the five hierarchical techniques were also calculated. These correlations provide a measure of the degree of similarity of mean PIC profile shape between the
initial and replicated subtypes. Although this can also be done by eye (by visually matching mean PIC profiles from different clustering methods), as the correlation coefficient is a quantitative measure it allows somewhat more objective comparisons to be made.

**Relationship to Known Subtypes**

The subtypes that emerged from the k-means cluster analysis were compared to those derived in previous research by Porter and Rourke (1985), Fuerst et al. (1989, 1990), and Fuerst and Rourke (in preparation). Rather than attempting to intercorrelate all of the subtypes generated in both this study and the previous studies (which would result in a matrix with a few hundreds unique correlations), steps were taken to reduce the number of comparisons made. Fuerst and Rourke (1990) reviewed the results of Porter and Rourke (1985), Fuerst et al. (1989, 1990), and Fuerst and Rourke (in preparation), and, using correlation coefficients, matched up corresponding subtypes across studies. The result was seven distinct subtypes (viz, Normal, Mild Hyperactive, Mild Anxiety, Somatic Concern, Conduct Disorder, Internalized Psychopathology, and Externalized Psychopathology), some of which were found in all four studies and appeared to be quite reliable, and some of which were found in but a single study. By averaging the PIC scores of corresponding subtypes across studies (e.g. PIC scores of all of the Normal subtypes found in previous studies) "prototypical" mean PIC profiles were
generated for the seven subtypes. These profiles are presented in Figures 1 to 7.

Two methods were used to assess the relations between the cluster analysis derived subtypes in this study and the prototypical subtypes found in previous research. First, and foremost, correlations between the subtypes, using mean PIC scores on all 16 scales, were calculated and compared. These correlations provide a measure of the degree of similarity of mean PIC profile shape between the subtypes and prototypes. Second, the subtypes were also compared to the prototypes in terms of the proportion of assigned subjects falling into each of the subtypes. This allowed comparisons of the relative sizes of the subtypes and prototypes to be made. Note that, as with the prototypical PIC profiles, where multiple instances of a subtype had been found in previous studies, the proportions of assigned subjects were averaged across those studies.

Relationships Between Subtypes and Neurocognitive Measures

Prior to further analysis, the scores of the subjects on the neurocognitive measures were normalized by transformation to T-scores. In addition, the direction of scoring for measures was, where necessary, adjusted so that good performance was indicated by scale elevations, and, conversely, poor performance by scale depressions. For those tests lacking proper normative populations and/or proper scale characteristics (e.g., WISC FSIQ, which has a mean of 100 and
Figure 1. Prototypical mean PIC profile for the Normal subtype.
Figure 2. Prototypical mean PIC profile for the Mild Hyperactive subtype.
Figure 3. Prototypical mean PIC profile for the Mild Anxiety subtype.
Figure 4. Prototypical mean PIC profile for the Somatic Concern subtype.
Figure 5. Prototypical mean PIC profile for the Conduct Disorder subtype.
Figure 6. Prototypical mean PIC profile for the Internalized Psychopathology subtype.
Figure 7. Prototypical mean PIC profile for the Externalized Psychopathology subtype.
a standard deviation of 15, and is easily converted to a T-score, versus grip strength in kilograms, which has a variable mean and standard deviation depending on the age and sex of the subject, normative information was taken from data provided by Knights (1970), and Knights and Norwood (1980).

Univariate Analyses

Univariate analysis of variance (ANOVA) tests, with subtype membership as the independent variable, were carried out with the following dependent variables: (a) WISC FSIQ, VIQ, PIQ, and all WISC subtests; (b) WRAT Reading, Spelling, and Arithmetic standard scores (RSS, SSS, and ASS), plus RSS-ASS and SSS-ASS measures (as in Fuerst & Rourke, in preparation); (c) all neuropsychological measures; (d) all CFA factor scales. Where significant group differences were found, post-hoc comparisons were made using Tukey's studentized range test (also known as the honestly significant difference [HSD] test).

Although such a large number of statistical tests produces inflation of the experimentwise Type I error rate, Bonferroni adjustment or other measures to control the Type I error rate were not employed in this study. The rationale for this approach follows: 1. Given that this was an exploratory investigation, there were few a priori hypotheses to be tested; 2. The use of statistical tests in such a context in fact amounts to using the p-value as an index of effect size; 3. Given that the judgement as to how large an effect must be
to be considered interpretable ("significant") is subjective, in this context adjusting the p-value (or similar manipulations) to "control" the Type I error rate is also a subjective decision, although the quantitative nature of the procedure may lend an unwarranted air of objectivity. In addition, while not controlling the Type I error rate may result in the acceptance of chance differences as being significant, exploratory research involves some degree of inherent unreliability, and the findings of such investigations always require replication before validity can be assessed.

**Multivariate Analyses**

Canonical discriminant analysis, with subtype membership as the criterion, were carried out with the following sets of predictors: (a) WISC subtest scores; (b) all CFA neurocognitive measures. Where significant relationships were found, the nature of the relationships was determined through interpretation of the canonical discriminant functions using subtype means on the canonical variate and inspection of the between groups loading matrix.

**Subtype Generation by Cluster Analysis: Results**

**Young Children**

**Subtype Derivation**

As outlined above, 5% of Young subjects (11 in all) were deemed to be outliers and deleted from the sample. With the k-means clustering method, examination of the $R^2$ and pseudo-$F$
values for 2 to 10 cluster solutions suggested the presence of 4 subtypes. For each of the four subtypes, mean PIC scale scores on all 16 scales were calculated, and used to plot Figures 8 through 11.

These four subtypes were replicated with good accuracy by Ward's method, EML, and WPGMA clustering techniques. As shown in Table 4, all versions of Rand's statistic were greater than 0.7. The "pure" Rand's statistic is difficult to interpret directly: However, theoretically, an adjusted value of 0.0 indicates purely chance agreement, whereas 1.0 indicates complete agreement. Empirical studies have shown that adjusted values above 0.2 indicate better-than-chance agreement between solutions (Milligan & Cooper, 1986). Finding adjusted values of Rand's statistic greater than 0.7 is indicative of good cluster recovery.

The results of the initial k-means analysis and the replication attempts using Ward's method, EML, and WPGMA, were also compared by determining the number of subjects misclassified by the three methods using the subtypes derived through k-means analysis as a reference. The results of this comparison are presented in Table 5. As shown in Table 5, of the three hierarchical-agglomerative methods, WPGMA performed the best overall, producing only 15 misclassifications (7.9% of the Young children). Both Ward's method and EML fared slightly worse, producing 20 (10.5%) and 22 (11.6%) misclassifications, respectively. However, all three
Figure 8. Mean PIC profile for the Normal subtype, Young children.
Figure 9. Mean PIC profile for the Mild Hyperactive subtype, Young children.
Figure 10. Mean PIC profile for the Internalized Psychopathology subtype, Young children.
Figure 11. Mean PIC profile for the Externalized Psychopathology subtype, Young children.
Table 4


<table>
<thead>
<tr>
<th>Method</th>
<th>Statistic</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rand</td>
<td>Morey</td>
<td>Hubert</td>
</tr>
<tr>
<td>Ward</td>
<td>0.90</td>
<td>0.74</td>
<td>0.73</td>
</tr>
<tr>
<td>EML</td>
<td>0.89</td>
<td>0.72</td>
<td>0.71</td>
</tr>
<tr>
<td>WPGMA</td>
<td>0.93</td>
<td>0.80</td>
<td>0.80</td>
</tr>
</tbody>
</table>
Table 5

Number of Subjects From Each K-Means Subtype Misclassified by Ward's, EML, and WPGMA Methods (Young Children)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Normal (n = 51)</th>
<th>Mild Hpr (n = 53)</th>
<th>Internal (n = 48)</th>
<th>External (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>EML</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>WPGMA</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>
techniques recovered the k-means subtypes with very good accuracy.

The mean PIC profiles of the groups derived from Ward's method, EML, and WPGMA cluster analysis were also derived (see Figures 8-11), and correlations were calculated between the mean PIC profiles of the k-means subtypes and each of the replicated subtypes. These correlations are presented in Table 6. It is apparent from Table 6 that there were very strong relationships between the k-means and corresponding Ward's method, EML, and WPGMA subtypes. All subtypes produced by the latter three methods correlated better than .98 with their corresponding k-means subtypes, and most subtypes showed correlations at or above .99. Thus, in terms of PIC profile shape, Ward's method, EML, and WPGMA produced subtypes that were virtually identical to their corresponding k-means derived subtypes.

**Relationship to Known Subtypes**

Visual inspection of Figures 8-11 indicated that the subtypes appeared very similar to four of the seven prototypical PIC subtypes derived in previous research (see above). To confirm these impressions, the mean PIC profiles of the subtypes were visually matched with those of the prototypes and correlations calculated between corresponding profiles. These correlations are reported in Table 7. As shown in Table 7, the prototypical Mild Hyperactive subtype was replicated with excellent accuracy in the Young sample
Table 6

**Mean Profile Intercorrelations Between K-means Subtypes and Corresponding Ward's Method, EML, and WPGMA Subtypes (Young Children)**

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>K-means Subtype</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>Ward</td>
<td>0.98</td>
</tr>
<tr>
<td>EML</td>
<td>0.98</td>
</tr>
<tr>
<td>WPGMA</td>
<td>0.98</td>
</tr>
<tr>
<td>Prototype</td>
<td>Normal</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>Normal</td>
<td>0.83</td>
</tr>
<tr>
<td>Mild Hpr</td>
<td>0.62</td>
</tr>
<tr>
<td>Mild Anx</td>
<td>0.63</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.80</td>
</tr>
<tr>
<td>Conduct</td>
<td>0.77</td>
</tr>
<tr>
<td>Internal</td>
<td>0.56</td>
</tr>
<tr>
<td>External</td>
<td>0.44</td>
</tr>
</tbody>
</table>
(r = .95). The PIC profiles of the Internalized Psychopathology and Externalized Psychopathology subtypes found in the Young sample deviated somewhat from their corresponding prototypes, but were still very similar (for both subtypes r = .91).

The Normal subtype of the Young sample was least like its corresponding prototype, with an r of .83. When the profiles of this subtype and prototype were compared, it was apparent that, whereas the prototype showed an essentially flat profile apart from the "cognitive triad" scales (Achievement, Intellectual Screening, and Development), the subtype evidenced minor peaks on the Somatic Concern and Delinquency scales. Indeed, this subtype was found to correlate .80 and .77 with the Somatic Concern and Conduct Disorder prototypes, respectively. These results suggest that, within the Young sample, the Normal subtype may be somewhat more heterogeneous than has been previously found.

The subtypes derived by cluster analysis were also compared to the prototypes in terms of the proportion of assigned subjects falling into each of the subtypes. These proportions are summarized in Table 8. As shown in Table 8, there were no substantial differences between the proportions of Young subjects assigned to the four subtypes and the proportions for the corresponding prototypes. Thus, in terms of relative size, the four subtypes were very similar to the prototypes.
Table 8

Percentages of Assigned Subjects Within Prototypical Subtypes and Subtypes Derived by Cluster Analysis (CA) and Profile Matching

<table>
<thead>
<tr>
<th>Source</th>
<th>Normal</th>
<th>Mld Hr</th>
<th>Mld Ax</th>
<th>Somatic</th>
<th>Conduct</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prototypical</td>
<td>33</td>
<td>26</td>
<td>16</td>
<td>13</td>
<td>10</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Young CA</td>
<td>27</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Middle CA</td>
<td>17</td>
<td>20</td>
<td>11</td>
<td>13</td>
<td></td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Old CA</td>
<td>27</td>
<td></td>
<td>19</td>
<td></td>
<td></td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td>Profile Matching</td>
<td>28</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>8</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>
Subtype Differences on the WISC

For each subtype, mean scores on WISC FSIQ, VIQ, PIQ, and all subtests were calculated, and used to plot Figure 12. As shown in Figure 12, there were no striking differences between subtypes on any of the WISC IQ measures. Comparisons between groups using ANOVA showed no significant differences.

On individual WISC subscales, no subtype comparisons using ANOVA reached statistical significance, although the p-value on WISC Comprehension approached commonly accepted levels of statistical significance ($F(3,186) = 2.55$, $p = .057$). While the Internalized Psychopathology subtype obtained the lowest score on this measure, post-hoc comparisons using Tukey's HSD revealed no significant differences between subtypes.

A direct discriminant function analysis was performed using all WISC subtest scores as predictors of subtype membership. Using Wilk's criterion, there was no statistically significant relationship between performance on the WISC subtests and subtype membership.

Subtype Differences on the WRAT

Mean WRAT standard scores on Reading, Spelling, and Arith. were calculated and used to plot Figure 13. Inspection of Figure 13 revealed that, for all subtypes, performance on WRAT Arithmetic exceeded that on Reading and Spelling. However, it was also apparent from Figure 13 that there were no clear differences between subtypes on WRAT.
Figure 12. Mean WISC scores for all subtypes, Young children.
Figure 13. Mean WRAT scores for all subtypes, Young children.
scores. This impression was confirmed using ANOVA: no comparisons reached, or even approached, commonly accepted levels of statistical significance.

The differences between WRAT Reading and Arithmetic (RA), and Spelling and Arithmetic (SA), for each subtype were also compared. As before, there were no significant differences between subtypes on these measures.

**Subtype Differences on Neuropsychological Measures**

Mean scores for the four subtypes on Finger Tapping, Grip Strength, Maze Test, Graduated Holes Test, Grooved Pegboard Test, Matching Pictures, Peabody Picture Vocabulary Test, Speech-Sounds Perception, and the Auditory Closure Test were calculated and used to plot Figure 14. Inspection of Figure 14 revealed no striking differences between subtypes on these tests. Subtype comparisons using ANOVA reached statistical significance only on Grip Strength ($F(3,185) = 2.60, p < .05$). Post-hoc comparisons using Tukey's HSD revealed that the Mild Hyperactive subtype scored significantly higher than the Internalized Psychopathology subtype on this measure.

**Subtype Differences on Factor Scales**

Mean scores on the simple motor, eye-hand coordination, visual-spatial, word knowledge, semantic-acoustic, and freedom from distractibility factor scales were calculated for each subtype and used to plot Figure 15. Inspection of Figure 15 indicated that there were no substantial differences between the subtypes on any of the scales. This impression was
Figure 14. Mean scores on neuropsychological measures for all subtypes, Young children.
Figure 15. Mean scores on factor scales for all subtypes, young children.
confirmed by ANOVA: none of these analyses reached statistical significance.

A direct discriminant function analysis was performed using the simple motor, eye-hand coordination, visual-spatial, word knowledge, semantic-acoustic, and freedom from distractibility factor scales as predictors of subtype membership. Using Wilk's criterion, there was no statistically significant relationship between performance on the factor scales and subtype membership.

**Middle Children**

**Subtype Derivation**

As outlined above, 5% of Middle subjects (13 in all) were deemed to be outliers and deleted from the sample. With the k-means clustering method, examination of the $R^2$ and pseudo-$F$ values for 2 to 10 cluster solutions suggested the presence of 6 subtypes. For each of the six subtypes, mean PIC scale scores on all 16 scales were calculated, and used to plot Figures 16 through 21.

These six subtypes were replicated with good accuracy by Ward's method, EML, and UPGMA clustering techniques. As shown in Table 9, all versions of Rand's statistic were .72 or higher. As adjusted values above 0.2 have been shown to indicate better-than-chance agreement between solutions (Milligan & Cooper, 1986), adjusted values greater than 0.7 are evidence of good cluster recovery.

The results of the initial k-means analysis and the
Figure 16. Mean PIC profile for the Normal subtype, Middle children.
Figure 17. Mean PIC profile for the Mild Hyperactive subtype, middle children.
Figure 18. Mean PIC profile for the Mild Anxiety subtype, Middle children.
Figure 19. Mean PIC profile for the Somatic Concern subtype, middle children.
Figure 20. Mean PIC profile for the Internalized Psychopathy subtype, Middle children.
Figure 21. Mean PIC profile for the Externalized Psychopathology subtype, Middle children.
Table 9

Rand's Statistic, Plus the Morey & Agresti (1984) and Hubert & Arabie (1985) Adjustments to Rand's Statistic, for Ward's Method, EML, and UPGMA Solutions Using the K-means Solution as a Reference (Middle Children)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Statistic</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rand</td>
<td>Morey</td>
<td>Hubert</td>
</tr>
<tr>
<td>Ward</td>
<td>0.98</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>EML</td>
<td>0.93</td>
<td>0.77</td>
<td>0.76</td>
</tr>
<tr>
<td>UPGMA</td>
<td>0.92</td>
<td>0.73</td>
<td>0.72</td>
</tr>
</tbody>
</table>
replication attempts using Ward's method, EML, and UPGMA, were also compared by determining the number of subjects misclassified by the three methods using the subtypes derived through k-means analysis as a reference. The results of this comparison are presented in Table 10. As shown in Table 10, of the three hierarchical-agglomerative methods, Ward's method performed the best overall, producing only 7 misclassifications in total (2.9% of the Middle sample). Both EML and UPGMA fared somewhat worse, producing 28 (11.4%) and 34 (13.9%) misclassifications, respectively. However, all three techniques recovered the k-means subtypes with acceptable accuracy.

The mean PIC profiles of the groups derived from Ward's method, EML, and UPGMA cluster analysis were also derived (see Figures 16-21), and correlations were calculated between the mean PIC profiles of the k-means subtypes and each of the replicated subtypes. These correlations are presented in Table 11. It is apparent from Table 11 that there were very strong relationships between the k-means and corresponding Ward's method, EML, and UPGMA subtypes. All subtypes produced by the latter three methods correlated better than .94 with their corresponding k-means subtypes, and 16 of 18 correlations were at or above .98. Thus, in terms of PIC profile shape, Ward's method, EML, and UPGMA produced subtypes that were virtually identical to (and, in some cases, exactly the same as) their corresponding k-means derived subtypes.
Table 10

Number of Subjects From Each K-Means Subtype Misclassified by Ward's, EML, and UPGMA Methods (Middle Children)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Normal (n = 42)</th>
<th>Mld Hr (n = 50)</th>
<th>Mld Ax (n = 27)</th>
<th>Somatic (n = 32)</th>
<th>Internal (n = 57)</th>
<th>External (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>EML</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>UPGMA</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>
Table 11

Mean Profile Intercorrelations Between K-means Subtypes and Corresponding Ward's Method, EML, and UPGMA Subtypes (Middle Children)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Normal</th>
<th>Mld Hr</th>
<th>Mld Ax</th>
<th>Somatic Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
<td>1.00</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>1.00</td>
</tr>
<tr>
<td>EML</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
</tr>
<tr>
<td>UPGMA</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Relationship to Known Subtypes

Visual inspection of Figures 16-21 indicated that the subtypes appeared very similar to six of the seven prototypical PIC subtypes derived in previous research (with the exception being the Conduct Disorder prototype). To confirm these impressions, the mean PIC profiles of the subtypes were visually matched with those of the prototypes and correlations calculated between corresponding profiles. These correlations are reported in Table 12. As shown in Table 12, the prototypical Internalized Psychopathology and Externalized Psychopathology subtypes were replicated with excellent accuracy in the Middle sample ($r = .97$, $r = .99$, respectively). The mean PIC profiles of the Mild Hyperactive and Normal subtypes were also quite similar to their corresponding prototypes ($r = .94$, $r = .89$, respectively). The PIC profiles of the subtypes matching the Mild Anxiety and Somatic Concern prototypes, while showing somewhat lower correlations ($r = .87$ in both cases), were nevertheless clearly recognizable as instances of these prototypes.

The subtypes derived by cluster analysis were also compared to the prototypes in terms of the proportion of assigned subjects falling into each of the subtypes. These proportions are summarized in Table 8. As shown in Table 8, for five of the six subtypes (Mild Hyperactive, Mild Anxiety, Somatic Concern, Internalized Psychopathology, and Externalized Psychopathology) there were no substantial
Table 12

**Mean PIC Profile Intercorrelations Between K-means Subtypes and Previously Derived Prototypes (Middle Children)**

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Normal</th>
<th>Mld Hr</th>
<th>Mld Ax</th>
<th>Somatic</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0.89</td>
<td>0.95</td>
<td>0.74</td>
<td>0.61</td>
<td>0.41</td>
<td>0.51</td>
</tr>
<tr>
<td>Mild Hpr</td>
<td>0.57</td>
<td>0.94</td>
<td>0.69</td>
<td>0.63</td>
<td>0.27</td>
<td>0.73</td>
</tr>
<tr>
<td>Mild Anx</td>
<td>0.61</td>
<td>0.33</td>
<td>0.87</td>
<td>0.48</td>
<td>0.86</td>
<td>0.57</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.46</td>
<td>0.28</td>
<td>0.44</td>
<td>0.87</td>
<td>0.57</td>
<td>0.42</td>
</tr>
<tr>
<td>Conduct</td>
<td>0.68</td>
<td>0.76</td>
<td>0.74</td>
<td>0.59</td>
<td>0.44</td>
<td>0.80</td>
</tr>
<tr>
<td>Internal</td>
<td>0.68</td>
<td>0.35</td>
<td>0.58</td>
<td>0.35</td>
<td>0.97</td>
<td>0.62</td>
</tr>
<tr>
<td>External</td>
<td>0.36</td>
<td>0.57</td>
<td>0.62</td>
<td>0.40</td>
<td>0.61</td>
<td>0.99</td>
</tr>
</tbody>
</table>
differences between the proportions of subjects assigned to the subtypes and the proportions for the corresponding prototypes. Thus, in terms of relative size, these five subtypes were very similar to the prototypes. However, the Normal subtype was considerably smaller (17%) than the Normal prototype (33%).

**Subtype Differences on the WISC**

For each subtype, mean scores on WISC FSIQ, VIQ, PIQ, and all subtests were calculated, and used to plot Figure 22. As shown in Figure 22, there were no striking differences between subtypes on any of the WISC IQ measures. Comparisons between groups using ANOVA showed no significant differences.

On individual WISC subscales, inspection of Figure 22 suggested subtype differences on some subtests. However, comparisons using ANOVA reached statistical significance only on the Comprehension ($F(5,239) = 2.85, p < .05$) subtest. Post-hoc tests using Tukey's HSD indicated that the Somatic Concern subtype scored significantly higher on this measure than did the Normal and Internalized Psychopathology subtypes.

A direct discriminant function analysis was performed using all WISC subtest scores as predictors of subtype membership. Using Wilk's criterion, there was no statistically significant relationship between performance on the WISC subtests and subtype membership.

**Subtype Differences on the WRAT**

Mean WRAT standard scores on Reading, Spelling, and
Figure 22. Mean WISC scores for all subtypes, Middle children.
Arithmetic were calculated and used to plot Figure 23. Inspection of Figure 23 revealed that, in contrast to the pattern of WRAT scores found with the Young children, in all subtypes performance on WRAT Reading exceeded that on Arithmetic. Although it is clear from Figure 23 that the Internalized Psychopathology had a mean WRAT Reading score that was higher than that for all other subtypes, using ANOVA no comparisons reached, or even approached, statistical significance.

The differences between WRAT Reading and Arithmetic (RA), and Spelling and Arithmetic (SA), for each subtype were also compared. As before, there were no significant differences between subtypes on these measures.

Subtype Differences on Neuropsychological Measures

Mean scores for the six subtypes on Finger Tapping, Grip Strength, Maze Test, Graduated Holes Test, Grooved Pegboard Test, Category Test, Trail Making Test, Peabody Picture Vocabulary Test, Speech-Sounds Perception, and Auditory Closure Test were calculated and used to plot Figure 24. Inspection of Figure 24 revealed no striking differences between subtypes on these tests. Subtype comparisons using ANOVA approached statistical significance only on Finger Tapping \((F(5,238) = 2.14, \ p = .06)\). Post-hoc comparisons using Tukey's HSD revealed that the Mild Hyperactive subtype scored significantly lower than the Externalized Psychopathology subtype on this measure.
Figure 23. Mean WRAT scores for all subtypes, Middle children.
Figure 24. Mean scores on neuropsychological measures for all subtypes, Middle children.
Subtype Differences on Factor Scales

Mean scores on the simple motor, eye-hand coordination, visual-spatial, executive, word knowledge, semantic-acoustic, and freedom from distractibility factor scales were calculated for each subtype and used to plot Figure 25. Inspection of Figure 25 indicated that there were no substantial differences between the subtypes on any of the scales. This impression was confirmed by ANOVA: none of these analyses reached statistical significance.

A direct discriminant function analysis was performed using the simple motor, eye-hand coordination, visual-spatial, executive, word knowledge, semantic-acoustic, and freedom from distractibility factor scales as predictors of subtype membership. Using Wilk's criterion, there was no statistically significant relationship between performance on the factor scales and subtype membership.

Old Children

Subtype Derivation

As outlined above, 10% of Old subjects (27 children in all) were deemed to be outliers and deleted from the sample. With the k-means clustering method, examination of the $R^2$ and pseudo-$F$ values for 2 to 10 cluster solutions suggested the presence of 4 subtypes. For each of the four subtypes, mean PIC scale scores on all 16 scales were calculated, and used to plot Figures 26 through 29.

These four subtypes were replicated with good accuracy by
Figure 25. Mean scores on factor scales for all subtypes, middle children.
Figure 26. Mean PIC profile for the Normal subtype, Old children.
Figure 27. Mean PIC profile for the Somatic Concern subtype, old children.
Figure 28. Mean PIC profile for the Internalized Psychopathology subtype, Old children.
Figure 29. Mean PIC profile for the Externalized Psychopathology subtype, Old children.
Ward's method, UPGMA, and complete linkage clustering techniques. As shown in Table 13, all versions of Rand's statistic were .76 or higher. Adjusted values above 0.2 have been shown to indicate better-than-chance agreement between solutions (Milligan & Cooper, 1986), adjusted values of this magnitude are evidence of good cluster recovery.

The results of the initial k-means analysis and the replication attempts using Ward's method, UPGMA, and complete linkage were also compared by determining the number of subjects misclassified by the three methods using the subtypes derived through k-means analysis as a reference. The results of this comparison are presented in Table 14. As shown in Table 14, of the three hierarchical-agglomerative methods, UPGMA performed the best overall, producing only 16 misclassifications (6.6% of the Old children). Both Ward's method and complete linkage fared slightly worse, producing 22 (9.1%) and 25 (10.3%) misclassifications, respectively. However, all three techniques recovered the k-means subtypes with very good accuracy.

The mean PIC profiles of the groups derived from Ward's method, UPGMA, and complete linkage cluster analysis were also derived (see Figures 26-29), and correlations were calculated between the mean PIC profiles of the k-means subtypes and each of the replicated subtypes. These correlations are presented in Table 15. It is apparent from Table 15 that there were very strong similarities between the k-means and corresponding
Table 13


<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Rand</th>
<th>Morey</th>
<th>Hubert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
<td>0.92</td>
<td>0.79</td>
<td>0.78</td>
</tr>
<tr>
<td>UPGMA</td>
<td>0.94</td>
<td>0.84</td>
<td>0.84</td>
</tr>
<tr>
<td>Complete</td>
<td>0.91</td>
<td>0.76</td>
<td>0.76</td>
</tr>
</tbody>
</table>
Table 14

**Number of Subjects From Each K-Means Subtype Misclassified by Ward's, UPGMA, and Complete Linkage Methods (Old Children)**

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>Normal (n = 65)</th>
<th>Somatic (n = 45)</th>
<th>Internal (n = 79)</th>
<th>External (n = 53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
<td>14</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>UPGMA</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Complete</td>
<td>12</td>
<td>4</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 15

Mean Profile Intercorrelations Between K-means Subtypes and Corresponding Ward's Method, EML, and UPGMA Subtypes (Old Children)

<table>
<thead>
<tr>
<th>Cluster Method</th>
<th>K-means Subtype</th>
<th>Normal</th>
<th>Somatic</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward</td>
<td></td>
<td>0.98</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>UPGMA</td>
<td></td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>Complete</td>
<td></td>
<td>0.98</td>
<td>0.98</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>
better than .98 with their corresponding k-means subtypes, and most subtypes (9 of 12 total comparisons) showed correlations at or above .99. Thus, in terms of PIC profile shape, Ward's method, UPGMA, and complete linkage produced subtypes that were virtually identical to the k-means subtypes.

**Relationship to Known Subtypes**

Visual inspection of Figures 26-29 indicated that the subtypes appeared very similar to four of the seven prototypical PIC subtypes derived in previous research (as above). To confirm these impressions, the mean PIC profiles of the subtypes were visually matched with those of the prototypes and correlations calculated between corresponding profiles. These correlations are reported in Table 16. As shown in Table 16, the prototypical Normal, Somatic Concern, Internalized Psychopathology, and Externalized Psychopathology subtypes were replicated with excellent accuracy in the Old sample. All correlations between the mean PIC profiles of corresponding subtypes exceeded .96.

The subtypes derived by cluster analysis were also compared to the prototypes in terms of the proportion of assigned subjects falling into each of the subtypes. These proportions are summarized in Table 8. As shown in Table 8, for three of the four subtypes (Normal, Mild Hyperactive, and Externalized Psychopathology) there were no substantial differences between the proportions of subjects assigned to the subtypes and the proportions for the corresponding
**Table 16**

**Mean PIC Profile Intercorrelations Between K-means Subtypes and Previously Derived Prototypes (Old Children)**

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Normal</th>
<th>Somatic</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0.96</td>
<td>0.58</td>
<td>0.47</td>
<td>0.49</td>
</tr>
<tr>
<td>Mild Hpr</td>
<td>0.89</td>
<td>0.45</td>
<td>0.29</td>
<td>0.74</td>
</tr>
<tr>
<td>Mild Anx</td>
<td>0.50</td>
<td>0.57</td>
<td>0.82</td>
<td>0.57</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.31</td>
<td>0.97</td>
<td>0.44</td>
<td>0.34</td>
</tr>
<tr>
<td>Conduct</td>
<td>0.84</td>
<td>0.60</td>
<td>0.50</td>
<td>0.81</td>
</tr>
<tr>
<td>Internal</td>
<td>0.49</td>
<td>0.48</td>
<td>0.97</td>
<td>0.58</td>
</tr>
<tr>
<td>External</td>
<td>0.59</td>
<td>0.36</td>
<td>0.60</td>
<td>0.99</td>
</tr>
</tbody>
</table>
prototypes. Thus, in terms of relative size, these three subtypes were very similar to the prototypes. However, the Internalized Psychopathology subtype was somewhat larger (33%) than the Internalized Psychopathology prototype (22%).

**Subtype Differences on the WISC**

For each subtype, mean scores on WISC FSIQ, VIQ, PIQ, and all subtests were calculated, and used to plot Figure 30. As shown in Figure 30, there were no striking differences between subtypes on any of the WISC IQ measures. Comparisons between groups using ANOVA showed no significant differences. On individual WISC subscales, no subtype comparisons using ANOVA reached statistical significance.

A direct discriminant function analysis was performed using all WISC subtest scores as predictors of subtype membership. Using Wilk's criterion, there was no statistically significant relationship between performance on the WISC subtests and subtype membership.

**Subtype Differences on the WRAT**

Mean WRAT standard scores on Reading, Spelling, and Arithmetic were calculated and used to plot Figure 31. Inspection of Figure 31 revealed that, in contrast to the pattern of WRAT scores found with the Young children, in all subtypes performance on WRAT Reading exceeded that on Arithmetic. Comparisons between subtypes using ANOVA were significant for both Reading ($F(3,238) = 2.52, p < .05$) and Spelling ($F(3,238) = 2.70, p < .05$). However, post-hoc
Figure 30. Mean WISC scores for all subtypes, Old children.
Figure 31. Mean WRAT scores for all subtypes, old children.
comparisons using Tukey's HSD failed to reveal significant pairwise differences.

The differences between WRAT Reading and Arithmetic (RA), and Spelling and Arithmetic (SA), for each subtype were also compared. There were no significant differences between subtypes on these measures.

Subtype Differences on Neuropsychological Measures

Mean scores for the four subtypes on Finger Tapping, Grip Strength, Maze Test, Graduated Holes Test, Grooved Pegboard Test, Category Test, Trail Making Test, Peabody Picture Vocabulary Test, Speech-Sounds Perception, Auditory Closure Test were calculated and used to plot Figure 32. Inspection of Figure 32 revealed no striking differences between subtypes on these tests. Subtype comparisons using ANOVA reached statistical significance only on Finger Tapping ($F(3, 237) = 2.79, p = .05$). Post-hoc comparisons using Tukey's HSD revealed that the Internalized Psychopathology subtype scored significantly lower than the Externalized Psychopathology subtype on this measure.

Subtype Differences on Factor Scales

Mean scores on the simple motor, eye-hand coordination, visual-spatial, executive, word knowledge, semantic-acoustic, and freedom from distractibility factor scales were calculated for each subtype and used to plot Figure 33. Inspection of Figure 33 indicated that there were no substantial differences between the subtypes on any of the scales. This impression
Figure 32. Mean scores on neuropsychological measures for all subtypes, Old children.
Figure 33. Mean scores on factor scales for all subtypes, old children.
was confirmed by ANOVA: none of these analyses reached statistical significance.

A direct discriminant function analysis was performed using the simple motor, eye-hand coordination, visual-spatial, executive, word knowledge, semantic-acoustic, and freedom from distractibility factor scales as predictors of subtype membership. Using Wilk's criterion, there was no statistically significant relationship between performance on the factor scales and subtype membership.

Subtype Generation by Simple Profile Matching

In this stage of the analyses, rather than using cluster analysis to generate novel subtypes, the results of previous research were used to classify subjects into prototypical subtypes using a method reminiscent of Q-factor analysis (see Fuerst et al., 1989, and Porter & Rourke, 1985, for examples of Q-factor analysis). Note that in the following analyses, the subjects were combined into a single sample spanning the entire age range addressed by this study (7-13 years of age). In these analyses, rather than assessing the contribution of the developmental dimension to psychosocial functioning by examining the differences between subtypes that emerged from cluster analysis at different age levels, variations in the ages of subjects assigned to the different prototypical subtypes could be directly compared. The relationships between subtypes and neurocognitive measures was assessed in precisely the same manner as was done with the subtypes.
derived by cluster analysis.

Profile Matching

As outlined above, previous research by Porter and Rourke (1985), Fuerst et al. (1989, 1990), and Fuerst and Rourke (in preparation) has produced a typology of seven psychosocial subtypes (viz, Normal, Somatic Concern, Mild Anxiety, Mild Hyperactivity, Conduct Disorder, Internalized Psychopathology, and Externalized Psychopathology) based on PIC scores. By calculating the mean PIC scores on all 16 scales for the seven previously derived subtypes, "prototypical" PIC profiles for those subtypes were created (see Figures 1 through 7). Next, correlations between each subject's PIC profile and the seven prototypical PIC profiles were calculated. Subjects were assigned to the subtype to which their PIC profile correlated most strongly (and positively). Subjects showing all negative correlations or only trivial correlations (i.e., < .40) with the prototypical profiles were deemed outliers and dropped from subsequent analyses. (Note: When using this method of generating subtypes, there is no need to screen the data for outliers prior to subtype formation. The assignment of a case to a subtype is completely independent of the assignment of other cases, as the prototype profiles are in no way altered by the assignment.)

For ease of use in future studies, this simple profile matching algorithm was implemented using the SAS macro programming language. The source code used can be found in
Appendix A. Note that, in this study, correlations were used in the algorithm, as classification on the basis of similarity of profile shape was of primary concern. However, the algorithm could easily be rewritten to use any suitable similarity/dissimilarity measure.

Use of the above algorithm resulted in the assignment of 679 subjects to one of the seven subtypes. Forty-nine subjects (6.7% of the total sample) were rejected as outliers. The largest number of subjects, 192 (28.2% of assigned subjects) were matched to the Normal prototype. Approximately equal numbers of subjects, 108 and 105 (15.9% and 15.5% of assigned subjects, respectively), were matched to the Externalized Psychopathology and Internalized Psychopathology prototypes. Similarly, 77 subjects (11.3% of assigned subjects) were matched to the Somatic Concern prototype, 74 subjects (10.9%) were matched to the Mild Anxiety prototype, and 71 subjects (10.5%) were matched with the Mild Hyperactivity prototype. The fewest number of subjects, 52 (7.7% of assigned subjects) were matched to the Conduct Disorder prototype.

Mean PIC profiles for each of the seven subtypes were calculated and used to plot Figures 34 through 40. The visual similarity between the subtypes' PIC profiles and the corresponding prototypical profiles (see Figures 1-7) is obvious. Correlations were calculated between the mean PIC profiles of the subtypes and each of the prototypical
Figure 34. Mean PIC profile for the Normal subtype derived by profile matching.
Figure 35. Mean PIC profile for the Mild Hyperactive subtype derived by profile matching.
Figure 36. Mean PIC profile for the Mild Anxiety subtype derived by profile matching.
Figure 37. Mean PIC profile for the Somatic Concern subtype derived by profile matching.
Figure 38. Mean PIC profile for the Conduct Disorder subtype derived by profile matching.
Figure 39. Mean PIC profile for the Internalized Psychopathology subtype derived by profile matching.
Figure 40. Mean PIC profile for the Externalized Psychopathology subtype derived by profile matching.
profiles. These correlations are presented in Table 17. As shown in Table 17, there were very strong relationships between the prototypes and the corresponding subtypes derived by profile matching. All correlations between corresponding prototypes and subtypes were greater than .98, indicating a very high degree of similarity.

The subtypes derived by profile matching were also compared to the prototypes in terms of the proportion of assigned subjects falling into each of the subtypes. These proportions are summarized in Table 8. As shown in Table 8, for six of the seven subtypes (Normal, Mild Anxiety, Somatic Concern, Conduct Disorder, Internalized Psychopathology, and Externalized Psychopathology) there were no substantial differences between the proportions of subjects assigned to the subtypes and the proportions for the corresponding prototypes. Thus, in terms of relative size, these six subtypes were very similar to the prototypes. However, the Mild Hyperactive subtype was somewhat smaller (11%) than the Mild Hyperactive prototype (26%).

Relationships Between Age and Subtype Membership

Four methods were used to investigate relationships between age and subtype membership. First, each subtype was (further) broken down into age three age categories: viz. Young (7-8 years old), Middle (9-10 years), and Old (11-13 years). Mean PIC profiles for each of the three age categories within each subtype were calculated and compared
Table 17

Mean PIC Profile Intercorrelations Between Profile Matching Subtypes and Previously Derived Prototypes (Middle Children)

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Normal</th>
<th>Mid Hr</th>
<th>Mid Ax</th>
<th>Somatic</th>
<th>Conduct</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0.98</td>
<td>0.86</td>
<td>0.52</td>
<td>0.31</td>
<td>0.74</td>
<td>0.46</td>
<td>0.34</td>
</tr>
<tr>
<td>Mild Hpr</td>
<td>0.77</td>
<td>0.99</td>
<td>0.43</td>
<td>0.22</td>
<td>0.74</td>
<td>0.30</td>
<td>0.57</td>
</tr>
<tr>
<td>Mild Anx</td>
<td>0.47</td>
<td>0.39</td>
<td>1.00</td>
<td>0.49</td>
<td>0.60</td>
<td>0.79</td>
<td>0.65</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.36</td>
<td>0.25</td>
<td>0.54</td>
<td>0.98</td>
<td>0.48</td>
<td>0.47</td>
<td>0.37</td>
</tr>
<tr>
<td>Conduct</td>
<td>0.67</td>
<td>0.77</td>
<td>0.62</td>
<td>0.45</td>
<td>0.99</td>
<td>0.46</td>
<td>0.69</td>
</tr>
<tr>
<td>Internal</td>
<td>0.42</td>
<td>0.36</td>
<td>0.82</td>
<td>0.49</td>
<td>0.99</td>
<td>0.99</td>
<td>0.70</td>
</tr>
<tr>
<td>External</td>
<td>0.35</td>
<td>0.67</td>
<td>0.65</td>
<td>0.34</td>
<td>0.78</td>
<td>0.61</td>
<td>0.98</td>
</tr>
</tbody>
</table>
(these profiles are also found in Figures 34-40). Overall, there were no striking differences between the (within-subtypes) mean PIC profiles of the Young, Middle, and Old groups. The overall mean PIC profile elevation of the Young children was significantly higher than that of the Old children in the Normal ($F(1,121) = 6.30, p < .01$) and Somatic Concern ($F(1,46) = 5.06, p < .05$) subtypes. Profile analysis (Harris, 1985) also established that, in the Externalized Psychopathology subtype, the mean PIC profiles of the Young and Old children had significantly different shapes ($GCR = 0.511, F(15,60) = 2.046, p < .05$). No other comparisons across age categories within subtypes reached statistical significance.

Second, within each subtype the frequencies at which each age category achieved the highest mean score on a PIC subscale were determined and compared. These frequencies are reported in Table 18. As shown in Table 18, there was a tendency for Younger subjects to receive the highest mean scores on more PIC scales relative to the Middle and Older subjects. In the Normal and Internalized Psychopathology subtypes, Younger children obtained the highest mean scores on 11 of 16 PIC scales, and in the Mild Hyperactive, Somatic Concern, and Conduct Disorder subtypes they received the highest mean scores on 10 of 16 PIC scales. Note, however, that the distribution of these frequencies across age categories did not deviate significantly ($p < .01$) from expected values in
Table 18

Frequencies at Which Young, Middle, and Old Children Obtained the Highest Mean Score on the PIC Scales Within Each Subtype

<table>
<thead>
<tr>
<th>Subtype</th>
<th>Normal</th>
<th>Mid Hr</th>
<th>Mid Ax</th>
<th>Somatic</th>
<th>Conduct</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>11</td>
<td>10</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Middle</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Old</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
any of the subtypes.

Third, frequency crosstabulations for subtype membership and age categories were also calculated, and used to plot Figure 41. (Note that, as there were unequal numbers of subjects at the three age levels, the percentages reported in Figure 41 were calculated relative to the size of the appropriate age group. For example, the percentage associated with Young children in the Mild Hyperactive subtype was about 10%. This percentage does not mean that 10% of the Mild Hyperactive subtype were Young subjects, but rather that 10% of Young subjects were assigned to this subtype.) Visual inspection of Figure 41 revealed no striking age differences across subtypes, although three trends were apparent. First, the percentage of subjects classified as Normal tended to decrease with increased age, indicating that, at higher age levels, more children fell into pathological subtypes. Second, Middle and Old children were slightly more prevalent in the Internalized Psychopathology subtype than were Young children. Third, a somewhat greater proportion of Old subjects were assigned to the Conduct Disorder relative to the Young and Middle subjects.

Finally, the mean ages of subjects assigned to the seven subtypes were calculated (see Figure 42) and compared. As shown in Figure 42, the mean age of the Conduct Disorder subtype appeared to be slightly higher than that of the Normal subtype, and, indeed, the difference was statistically
Figure 41. Percentages of Young, Middle, and Old subjects in the subtypes derived by profile matching.
Figure 42. Mean age of children in the subtypes derived by profile matching.
significant ($t(242) = 2.40, p < .05$). While less visually prominent, the mean age of the Internalized Psychopathology subtype was also significantly higher than that of the Normal subtype ($t(295) = 2.24, p < .05$). There were no other significant differences in mean age between subtypes.

Subtype Differences on the WISC

For each subtype, mean scores on WISC FSIQ, VIQ, PIQ, and all subtests were calculated, and used to plot Figure 43. As shown in Figure 43, there were no striking differences between subtypes on any of the WISC measures. Comparisons between groups using ANOVA showed no significant differences.

On individual WISC subscales, ANOVA indicated significant group differences on the Arithmetic ($F(6,672) = 2.14, p < .05$) and Object Assembly ($F(6,672) = 2.55, p < .05$) subtests; however, post hoc comparisons using Tukey's HSD failed to reveal any statistically significant comparisons between groups.

Significant overall differences were also found for the Information ($F(6,672) = 3.18, p < .01$) and Digit Span ($F(6,672) = 2.26, p < .05$) subtests. On the Information subscale, Tukey's HSD indicated that the Mild Hyperactive subtype scored significantly higher than the Normal subtype. On the Digit Span subscale the Somatic Concern subtype scored significantly lower than the Externalized Psychopathology subtype.

A direct discriminant function analysis was performed
Figure 43. Mean WISC scores for all subtypes derived by profile matching.
using all WISC subtest scores as predictors of subtype membership. Using Wilk's criterion, the first discriminant function, which accounted for about 41% of the between-group variability, was found to be statistically significant ($\Lambda = .88$, $F(54, 3380.15) = 1.58$, $p < .01$). Group means on the canonical variate were calculated and used to plot Figure 44. As shown in Figure 44, the discriminant function maximally separated the Externalized Psychopathology and, to a lesser extent, Mild Hyperactive subtypes from the Internalized Psychopathology subtype. Inspection of the between-groups loading matrix, shown in Table 19, indicated that the Comprehension, Arithmetic, Digit Span, Block Design, and Object Assembly subtests of the WISC were the most important predictors for distinguishing between these subtypes.

**Subtype Differences on the WRAT**

Mean WRAT standard scores on Reading, Spelling, and Arithmetic were calculated and used to plot Figure 45. As shown in Figure 45, there were clear differences between subtypes on WRAT Reading ($F(6, 672) = 8.84$, $p < .01$). Post-hoc comparisons using Tukey's HSD indicated that the Externalized Psychopathology subtype scored higher on WRAT Reading than did the Normal, Mild Anxiety, Somatic Concern, and Conduct Disorder subtypes. The Internalized Psychopathology subtype obtained a mean WRAT Reading subtest score that exceeded that of the Normal and Somatic Concern subtypes. Similarly, there were significant differences on WRAT Spelling ($F(6, 672) =$
Figure 44. Mean scores on the WISC based canonical variate for all subtypes derived by profile matching.
Table 19

Between-Groups Loadings for the Canonical Function Predicting Subtype Membership Using WISC Subtest Scores

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>-0.16</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.93</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>0.86</td>
</tr>
<tr>
<td>Similarities</td>
<td>-0.28</td>
</tr>
<tr>
<td>Digit Span</td>
<td>0.84</td>
</tr>
<tr>
<td>Picture Completion</td>
<td>-0.00</td>
</tr>
<tr>
<td>Block Design</td>
<td>-0.50</td>
</tr>
<tr>
<td>Object Assembly</td>
<td>-0.53</td>
</tr>
<tr>
<td>Coding</td>
<td>-0.19</td>
</tr>
</tbody>
</table>
Figure 45. Mean WRAT scores for all subtypes derived by profile matching.
7.38, \( p < .01 \). On this measure, the Internalized Psychopathy subtype scored significantly higher than did the Mild Anxiety, Somatic Concern, and Normal subtypes. The Externalized Psychopathy subtype also performed significantly better than the Normal and Somatic Concern subtypes. There were no significant subtype differences on WRAT Arithmetic.

The differences between WRAT Reading and Arithmetic (RA), and Spelling and Arithmetic (SA), for each subtype were also compared. On both of these measures there were significant differences between subtypes (\( F(6,672) = 6.11, \ p < .01 \), and \( F(6,672) = 6.25, \ p < .01 \), respectively). While inspection of Figure 45 suggested that the Reading-Arithmetic discrepancy was largest in the Externalized Psychopathy and Internalized Psychopathy subtypes (and, somewhat less so, in the Mild Hyperactive subtype), post-hoc tests using Tukey's HSD were only significant between the Externalized Psychopathy and Internalized Psychopathy subtypes. As shown in Figure 45, the Spelling-Arithmetic discrepancy was largest in the Internalized Psychopathy subtype; however, post-hoc tests using Tukey's HSD failed to reveal any statistically significant subtype differences.

**Subtype Differences on Neuropsychological Measures**

Mean scores for the seven subtypes on Finger Tapping, Grip Strength, Maze Test, Graduated Holes Test, Grooved Pegboard Test, Peabody Picture Vocabulary Test, Speech-Sounds
Perception, Auditory Closure Test were calculated and used to plot Figure 46. Inspection of Figure 46 suggested that there were some differences between subtypes on these measures. The subtypes were clearly most divergent on the Speech-Sounds Perception test; an impression confirmed by ANOVA (F(6,656) = 4.61, p < .01). Post-hoc tests with Tukey's HSD revealed that the Normal and Somatic Concern subtype performed significantly worse than the Conduct Disorder, Mild Anxiety, Internalized Psychopathology, and Externalized Psychopathology subtypes. On the other hand, the Conduct Disorder subtype performed the best on this measure, significantly more so than did the Normal, Somatic Concern, and Mild Hyperactive subtypes.

Significant differences between subtypes were also found on the Graduated Holes (F(6,665) = 2.60, p < .05) and Finger Tapping (F(6,670) = 2.44, p < .05) tests. Post-hoc tests on Graduated Holes indicated that the Mild Hyperactive subtype showed the worst performance on this measure. They scored significantly lower than the Normal, Conduct Disorder, Somatic Concern, Internalized Psychopathology, and Externalized Psychopathology subtypes. The Conduct Disorder subtype, with the highest mean score, also performed significantly better than the Normal subtype. On Finger Tapping, the Externalized Psychopathology subtype received the highest mean score, and post-hoc tests showed that their performance was significantly better than that of the Normal, Somatic Concern, and Internalized Psychopathology subtypes. The Mild Anxiety
Figure 46. Mean scores on neuropsychological measures for all subtypes derived by profile matching.
subtype also received a significantly higher mean Finger Tapping score than did the Internalized Psychopathology subtype.

**Subtype Differences on Factor Scales**

Mean scores on the simple motor, eye-hand coordination, visual-spatial, word knowledge, semantic-acoustic, and freedom from distractibility factor scales were calculated for each subtype and used to plot Figure 47. Inspection of Figure 47 indicated that there were significant differences between the subtypes on the acoustic-semantic factor scale; ANOVA $(F(6, 654) = 4.51, p < .01)$ confirmed this impression. Post-hoc tests revealed that the Normal and Somatic Concern subtypes received significantly lower scores than did the Conduct Disorder, Mild Anxiety, Internalized Psychopathology, and Externalized Psychopathology subtypes. Significant differences were also found on the freedom from distractibility factor scale $F(6, 672) = 3.34, p < .01$. Post-hoc tests revealed that the Externalized Psychopathology subtype scored significantly higher than the Normal, Somatic Concern, and Internalized Psychopathology subtypes. On the other hand, the Somatic Concern subtype scored lowest on this factor scale, significantly more so than the Conduct Disorder and Mild Anxiety subtypes.

A direct discriminant function analysis was performed using the simple motor, eye-hand coordination, visual-spatial, word knowledge, semantic-acoustic, and freedom from
Figure 47. Mean scores on factor scales for all subtypes derived by profile matching.
distractibility factor scales as predictors of subtype
membership. Using Wilk's criterion, both the first and second
discriminant functions, which accounted for about 46% and 37%
of the between-group variability, respectively, were found to
be statistically significant (U = .89, F(36,2817.59) = 2.03, p
< .01, U = .94, F(25,2386.43) = 1.57, p < .05, respectively).
Group means on the two canonical variates were calculated and
used to plot Figures 48 and Figure 49. As shown in Figure
48, the first discriminant function maximally separated the
Externalized Psychopathology subtype from the Somatic Concern
and, to a lesser extent, Normal subtypes. Inspection of the
between-groups loading matrix, shown in Table 20, indicated
that, on the first canonical function, the freedom from
distractibility, simple motor, and word knowledge factor
scales were the most important predictors for distinguishing
between these subtypes. Examination of Figure 49 suggested
that the second discriminant function produced maximal
separation between the Internalized Psychopathology subtype
versus the Externalized Psychopathology and Normal subtypes.
As shown in the between-groups loading matrix (Table 20), the
visual-spatial and semantic-acoustic factor scales were the
most important predictors for discriminating between these
subtypes.
Figure 48. Mean scores on the first CFA factor scales canonical variate for all subtypes derived by profile matching.
Figure 49. Mean scores on the second CFA factor scales canonical variate for all subtypes derived by profile matching.
Table 20

Between-Groups Loadings for the Canonical Functions Predicting Subtype Membership Using Factor Scales

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Loading 1</th>
<th>Loading 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Motor</td>
<td>0.90</td>
<td>-0.35</td>
</tr>
<tr>
<td>Coordination</td>
<td>0.08</td>
<td>-0.07</td>
</tr>
<tr>
<td>Visual-Spatial</td>
<td>-0.33</td>
<td>0.82</td>
</tr>
<tr>
<td>Work Knowledge</td>
<td>0.75</td>
<td>-0.18</td>
</tr>
<tr>
<td>Semantic-Acoustic</td>
<td>0.69</td>
<td>0.72</td>
</tr>
<tr>
<td>Freedom From Distract</td>
<td>0.98</td>
<td>-0.15</td>
</tr>
</tbody>
</table>
CHAPTER IV: DISCUSSION

There were three major components in this investigation: derivation of a psychosocial typology of children with LD, examination of the external validity of the typology, and exploration of the relations between age and psychosocial functioning in children with LD. Overall, the typology that emerged was virtually identical to that which has been developed in previous investigations (Fuerst et al., 1989, 1990; Fuerst & Rourke, in preparation; Porter & Rourke, 1985). There is strong evidence that most of the subtypes in this typology are very reliable, as they are readily replicable across different samples and classification techniques. While the external validity of this typology has received support in previous studies (Clemanshaw, 1990; Fuerst et al., 1990; Fuerst & Rourke, in preparation), in this investigation only limited evidence for external validity was found, although this may have been due to methodological problems, perhaps the most important of which was sample bias. While some extremely weak, perhaps illusory, relations were found between age and psychosocial functioning, overall, patterns of psychosocial adaptation were very stable across the age ranges covered in this study. These conclusions are explored in detail below.

Description of The Typology

To this point, depiction of the subtypes has been largely restricted to simple visual inspection of PIC profiles and the application of descriptive labels. Of course, presentation of
PIC profiles without interpretation does not describe behaviour, as the scale labels are, in some respects, arbitrary. For example, elevation of the Psychosis scale above 70 T does not mark a child as psychotic. Similarly, the labels given to the subtypes in Chapter III (and previous studies), such as Normal or Mild Hyperactive, were used more as descriptions of the pattern of scores on the mean PIC profiles than as descriptions of behaviour. For example, the PIC profile of the Normal subtype is, in fact, abnormal, with clinically meaningful elevations on some PIC scales. However, elevations on the Academic Achievement, Intellectual Screening, and Development scales in the context of an otherwise roughly flat profile are unremarkable, or normal, in samples of children with LD.

In this section, the subtypes are discussed in terms of psychosocial adaptation, or expected patterns of behavioural function/dysfunction based on our current understanding of the PIC. Note that these characterizations are really expectations or predictions that, in the process of establishing the external validity of the typology, should be tested in future research (see Limitations, below). Note also that, for the sake of clarity, in the following descriptions minor variations in the profiles of subtypes with the same labels (e.g, Somatic Concern) but derived from different samples (Young, Middle, Old, and complete) and using different methods (cluster analysis and profile matching) have been
ignored, and the most salient features emphasized.

Two of the subtypes had mean PIC profiles that suggested relatively normal psychosocial functioning. The profile of the Normal subtype showed mean elevations above 70 T on the Achievement, Intellectual Screening and Development scales (the so-called cognitive triad; a pattern found, to a greater or lesser extent, in all subtypes), and a very flat profile on all other clinical scales. The caretakers of these children were most concerned with cognitive development and academic performance. The mean PIC profile of the Somatic Concern subtype was similar to that of the Normal subtype; however, it was marked by an elevation of the Somatic Concern scale in addition to those scales comprising the cognitive triad. The caretakers of these children are likely to express distress about their child's physical well-being and health. Physical complaints could span a wide range of difficulties, including visual problems, dizziness, headaches, syncope, fatigue, and gastrointestinal dysfunction. However, it should be noted that, as with other psychosocial measures tapping somatic domains, it is not possible to determine the degree to which such complaints might be functional, rather than organic, in nature.

Two of the subtypes evidenced moderate degrees of psychosocial dysfunction. Children in the Mild Hyperactive subtype showed a relatively unremarkable PIC profile that was distinguished by a single significant elevation above 70 T on
the Intellectual Screening scale, and a somewhat higher than usual mean score on the Hyperactivity scale. This suggests fairly good psychosocial adaptation in most domains, as in the Normal subtype, with the possibility of rather mild acting-out behaviours. The profile of the Mild Anxiety subtype suggested moderate psychosocial disturbance, with notable, but relatively modest, peaks on the Intellectual Screening, Depression, and Anxiety scales. Overall, this profile suggests symptoms of mild anxiety and depression, and is somewhat reminiscent of the PIC profile of the Internalized Psychopathology subtype.

In some respects, the PIC profile of the Conduct Disorder subtype (found only using profile matching) also suggests modest psychosocial dysfunction, with a single peak on the Delinquency scale. However, the behaviours that may be demonstrated by such children are likely to be more problematic for caretakers and peers than are those demonstrated by children in the Mild Hyperactive or Mild Anxiety subtypes. Children with this profile may show insensitivity towards others, a disregard for rules and limits, impulsivity, and hostility. Truly delinquent behaviour, such as verbal and physical aggression, destructiveness, lying, and stealing, may be exhibited by some children.

The mean PIC profile of the Internalized Psychopathology subtype showed prominent elevations on a number of subscales
that suggest significant, internalized, socioemotional difficulties. This profile showed high mean scores on the Adjustment, Depression, Withdrawal, Anxiety, and Psychosis scales, with moderate, though clinically relevant, elevations on Achievement, Development, and Social Skills scales. Children in the Internalized Psychopathology subtype are likely to be depressed, anxious, and emotionally labile. Inappropriate affect, difficulties with cognition and orientation to reality, and social isolation have been associated with this profile. Social interaction and general interpersonal functioning may present serious problems for these children.

The mean PIC profile of the Externalized Psychopathology subtype was also elevated on a number of scales. These children had particularly high mean scores on the Adjustment, Delinquency, Hyperactivity, and Social Skills scales. This profile also suggests significant behavioural disturbance; however, unlike the Internalized Psychopathology subtype, these children are apt to exhibit hyperkinetic, acting-out types of behaviour. Such children may be hostile, impulsive, restless, and emotionally unstable, and have low frustration tolerance. Aggressive, violent, and destructive behaviour may also be part of the clinical picture.

Internal Validity (Reliability) of The Typology

Ideally, subtyping methods of any type should produce reliable, homogeneous groups that can be replicated across
different samples and classification techniques (Everitt, 1980). This issue is of particular concern when multivariate subtyping techniques are applied in an exploratory fashion to data with relatively unknown statistical properties. Multivariate subtyping techniques, such as cluster analysis and Q-factor analysis, will always produce some grouping of cases, even if purely random data are used in the procedures. Furthermore, different statistical subtyping techniques can, and often do, produce disparate solutions when applied to the same data. Replicability of solutions across different samples from the same population, and across different subtyping techniques, is a crucial step in determining the validity of the subtypes so derived (Fletcher, 1985). When the results of the present investigation, and the four previous studies of Porter and Rourke (1985), Fuerst et al. (1989, 1990) and Fuerst and Rourke (in preparation), are considered, it is apparent that four of the subtypes are readily replicable using different samples, statistical techniques, and selection of PIC scales.

Perhaps the most reliable subtype that has been found is the Externalized Psychopathology or hyperactive group. This subtype has been found in all five studies (counting the three age levels used in this study, 6 samples in total); and in all studies the subtype has been quite consistent in terms of both profile shape and relative size. In the context of the present study, the cluster analysis derived (CAD) versions of
the Externalized Psychopathology subtype were quite consistent across the three age categories. At all three age levels, the CAD Externalized Psychopathology subtypes correlated strongly with the prototypical Externalized Psychopathology PIC profile ($r=.91$, $r=.99$, and $r=.99$ for the Young, Middle, and Old children, respectively). At all three age levels, the percentages of subjects assigned to the subtype were also consistent with the mean percentage for the prototypical Externalized Psychopathology subtype (20%, 15%, and 22%, respectively, versus 19% for the prototypical subtype). Similar results were found for the profile matching derived (PMD) Externalized Psychopathology subtype. The very strong correlation between the mean PIC profile of this subtype and the Externalized Psychopathology prototype was not surprising given the method used for subject assignment (indeed, all correlations between PMD subtypes and corresponding prototypes were extremely high); however, the relative size of this group was also roughly equivalent to that of the prototype (16% of assigned subjects as compared to 19% in the prototype).

The second most consistent subtype has been the Internalized Psychopathology cluster. As with the Externalized Psychopathology subtype, this group has been found in all studies to date (6 samples). The mean PIC profiles of the CAD Internalized Psychopathology subtypes were very consistent across age levels, and were very similar to the profile of the prototypical subtype ($r=.91$, $r=.97$, and
\( r = .97 \), for Young, Middle, and Old children, respectively). At the Young and Middle age levels, the percentages of subjects assigned to the subtype were also consistent with that of the prototype (25\% and 23\%, respectively, versus 22\% for the prototype). A greater percentage of Old children were assigned to this subtype (33\%); however, this difference was not outstanding. In the PMD version of the Internalized Psychopathology subtype there was a slightly lower percentage of assigned subjects, but the difference (6\%) was relatively trivial.

The third most consistent subtype has been the Normal group. This subtype has also been in evidence in all previous investigations (6 samples). In this study, the CAD Middle and Old instances of the Normal subtype were quite similar to the prototypical Normal PIC profile (\( r = .89 \) and \( r = .96 \), respectively). As mentioned in Chapter III, the CAD Young Normal subtype evidenced some minor peaks on the Somatic Concern and Delinquency scales, and was, compared to the Middle and Old children, least similar to the prototypical Normal PIC profile (\( r = .83 \)), which suggests that this instance of the subtype was relatively more heterogeneous. Across previous studies, on average about 33\% of subjects have been assigned to this subtype; similar values were found for the CAD Young and Old children (27\% for both subtypes). The PMD Normal subtype was slightly closer to the prototypical value, with 28\% of assigned subjects falling into this group. The
relative size of the CAD Middle instance of the subtype was only about half as large (17%) as the prototypical subtype. However, similar results were found in the Fuerst et al. (1990), and Fuerst and Rourke (in preparation) studies (14% and 16%, respectively). It is interesting to note that in the CAD Middle, Fuerst et al. (1990), and Fuerst and Rourke (in preparation) samples, there were a relatively large number of subtypes (six, versus three or four) in the typologies. This pattern suggests that, when subtypes are formed using cluster analysis -- with a greater number of subtypes formed and finer discriminations made between patterns of psychosocial functioning -- subjects who might be classified as Normal in relatively coarse typologies do show some differences, perhaps contributing (to an as yet unknown extent) to Mild Hyperactive, Conduct Disorder, or Mild Anxiety groups.

The fourth most reliable subtype found to date is Somatic Concern. Although this subtype was not found in the Fuerst et al. (1989) study, nor in the CAD Young typology, it has now been found in five different samples of children with LD. In the present study, the mean PIC profile of the Old CAD Somatic Concern subtype was very similar to the prototypical profile ($r = .97$), and while the profile of the Middle subtype was somewhat less so, the correlation with the prototype was still substantial ($r = .87$). In terms of relative size, the percentage of subjects assigned to the Middle CAD Somatic Concern subtype was identical to the mean percentage for the
prototype (13%), whereas the relative size of the Old subtype was slightly larger (19%). The percentage of subjects assigned to the PMD Somatic Concern subtype (11%) was roughly equivalent to the mean percentage for the prototype.

There is some evidence that suggests, but does not establish, that two of the remaining seven subtypes, Mild Hyperactive and Mild Anxiety, have some internal validity. The Mild Hyperactive subtype was first derived in the Fuerst et al. (1990) investigation (note that this single instance of the subtype constitutes the prototype). Although it was not replicated in the Fuerst and Rourke (in preparation) study, a Mild Hyperactive subtype did appear in the CAD Young and Middle samples of the present investigation. The mean PIC profiles of these two instances of the subtype were very similar to the prototypical Mild Hyperactive PIC profile ($r=.95$ and $r=.94$ for the Young and Middle samples, respectively), as were the percentages of assigned subjects (28% and 20% for the Young and Middle samples, respectively, versus 26% for the prototype). Although a Mild Hyperactive subtype was derived using profile matching, the relative size of this group (11%) was somewhat smaller than the prototype.

The Mild Anxiety subtype has been found in two previous studies (Fuerst et al., 1990; Fuerst & Rourke, in preparation); however, in this study, within the CAD typologies it appeared only in the Middle sample. The percentage of assigned subjects found in the Middle instance
of the subtype was roughly the same as in the prototype (11% versus 16% in the prototype). The PMD Mild Anxiety subtype was exactly the same relative size as the Middle CAD instance (11%).

The least reliable subtype is Conduct Disorder. This group has been derived using cluster analysis in only one study to date (Fuerst & Rourke, in preparation). It was not found using cluster analysis in either the Young, Middle, or Old samples in this study. A Conduct Disorder subtype very similar to that found by Fuerst and Rourke (in preparation) was derived using profile matching. The relative size of the PMD Conduct Disorder subtype (8%) was comparable to that of the prototype (10%). However, until this subtype is replicated in a new sample of children its reliability will remain suspect.

External Validity of The Typology

While demonstrating the reliability of a typology is a crucial step in subtyping research, reliability, per se, provides little information upon which to evaluate a typology. It is possible to develop statistical typologies that are extremely reliable yet provide no useful information about the phenomena under investigation. A useful typology must provide a framework within which existing hypotheses can be tested, allow new relations to be discerned, and have at least some degree of clinical significance (Fletcher, 1985). Quite simply, a useful typology is one that is meaningful. The
following are a series of observations regarding the external validity of the subtypes developed in this study.

Clinical Interpretability

One relatively simple manner in which external validity can be assessed is to determine whether subtypes are interpretable and consonant with patterns of behaviour observed in clinical settings (Del Dotto & Rourke, 1985). In this respect, the groups derived in this study appeared to be valid. The mean PIC profiles of all groups were readily interpretable within the guidelines set forth in the PIC manual (Wirt et al., 1977). In addition, the profiles were consistent with general patterns of PIC profiles seen in clinical practice. The similarity between the PIC profile of the Externalized Psychopathology subtype and the Breen and Barkley (1983) hyperactive PIC profile also provides some additional modest evidence for the external validity of that subtype.

Concurrent Validity

Of course, such a cursory examination of a typology provides only limited support for external validity. To establish the external validity of a typology it is necessary to demonstrate that subtypes differ in a meaningful and predictable manner on measures outside the domain of those used to develop the typology (Fletcher, 1985). For example, if subtypes are developed from patterns of reading, spelling, and arithmetic achievement, there is little point to
demonstrating that the subtypes differ on the same, or similar, measures of reading, spelling, and arithmetic performance. Instead, evidence for external validity must be obtained by demonstrating subtype differences on measures that: (a) might reasonably be assumed to be independent of those used to derive the typology, and (b), for theoretical reasons, might be related. In this study, external validity was assessed using cognitive, neuropsychological, and academic achievement measures.

Cognitive Measures

Both univariate and multivariate comparisons of the CAD subtypes on WISC measures at all three age levels failed to yield any significant differences. At all three age levels, none of the subtypes differed on WISC FSIQ, VIQ, PIQ, or subscale scores. Direct discriminant function analyses using all WISC subscale scores as predictors of subtype membership also failed to produce statistically significant results at all three age levels.

In the PMD subtypes, there were no statistically significant differences between subtypes on WISC FSIQ, VIQ, or PIQ. On individual WISC subscales some comparisons between subtypes did reach statistical significance; however, inspection of the mean scores for the subtypes on WISC measures suggested that these differences, while statistically significant, were trivial. One hazard inherent in using large samples (as in this study) is that very small differences
between groups can, nevertheless, reach statistical significance. The differences between subtypes on the WISC subscales were exceedingly small and almost certainly due to inflated power of the statistical tests, and, consequently, of no importance.

A similar argument can be made against the significant multivariate discrimination between the PMD subtypes using the WISC subscales as predictors. While this finding may be due more to the sample size than the presence of a substantial relationship between psychosocial and cognitive functioning, and thus will not be interpreted, it is interesting to note that the discriminant function provided maximal separation between the Internalized Psychopathology and the Externalized Psychopathology subtypes. Finding a combination of measures that discriminates between these two groups is a novel result that may have both theoretical and practical value, and suggests that the WISC subscales merit further investigation in this regard.

Neuropsychological Measures

The results found on the neuropsychological measures were comparable to those found on the WISC. In the CAD subtypes, very few significant differences were found between some subtypes on Grip Strength (Younger children) and Finger Tapping (Middle and Older children), but the magnitudes of the differences between subtypes on these measures were trivial. However, in the PMD subtypes, some differences on
neuropsychological measures that reached statistical significance were also of a noteworthy size. The Mild Hyperactive subtype showed significantly worse static motor steadiness than did most other subtypes, especially relative to the Conduct Disorder subtype, which showed the best performance on this measure. The Conduct Disorder subtype also demonstrated the highest mean Speech-Sounds Perception test score, a measure on which the Normal and Somatic Concern subtypes performed quite poorly. While, in isolation, these results have no clear interpretation (indeed, any attempt at interpretation would be purely speculative), they do suggest that the Conduct Disorder and Mild Hyperactive subtypes can be dissociated from the other subtypes on some neuropsychological tests. However, in the absence of corroborating evidence from previous research, this finding requires cross validation.

CFA Factor Scales

At all three age levels both univariate and multivariate comparisons of the CAD subtypes on the factor scales failed to reach statistical significance. At all three age levels, none of the subtypes differed on simple motor, eye-hand coordination, visual-spatial, executive, word knowledge, semantic-acoustic, or freedom from distractibility factor scales. Direct discriminant function analyses using these scales as predictors of subtype membership also failed to produce statistically significant results at any of the three age levels.
In the PMD subtypes, there were two factor scales comparisons between subtypes that reached statistical significance. The subtypes differed on the semantic-acoustic factor scale; however, considering that scores on this scale were derived from only two measures, one of which was the Speech-Sounds Perception test, this result was not surprising. Indeed, inspection of Figures 46 and 47 revealed that the ranking of the subtypes' mean scores on the semantic-acoustic factor scale was identical to the ranking on the Speech-Sounds Perception test (i.e., this scale is redundant). Differences between the subtypes were also found on the freedom from distractibility factor scale. However, the pattern of differences between the subtypes was most puzzling (e.g., the Externalized Psychopathology subtype obtained the highest score on this scale). In addition, inspection of the subtypes' mean scores on this scale (Figure 47) strongly suggested that these differences, although statistically significant, were trivial. Similarly, using the factor scales as predictors of subtype membership, two statistically significant multivariate discriminant functions were found. However, as with the WISC subscales, the separation between the subtypes on the discriminant functions was minimal; thus, these "significant" findings are probably due more to the large sample size than to the presence of substantial relations between psychosocial and neurocognitive functioning in this sample (see Sample Bias, below).
Achievement Measures

On WRAT Reading, Spelling, and Arithmetic the Young CAD subtypes showed no significant differences. Although the Young children evidenced a trend for Arithmetic scores to exceed those on Reading and Spelling across subtypes, a pattern exactly opposite to that found in Middle and Older children, it must be kept in mind that, at Young age levels (7-8 years old) there is something of a floor effect in both item difficulty and scoring on the Arithmetic subtest. Although no significant differences between subtypes on WRAT scores were found for the Middle CAD subtypes, the Internalized Psychopathology subtype showed a substantially higher Reading score than did the other subtypes, and a greater discrepancy between Reading and Arithmetic scores. While not statistically significant, this trend was consistent with previous research (Fuerst & Rourke, in preparation). A similar trend was observed in the WRAT scores of the Older CAD subtypes. The Internalized Psychopathology and Externalized Psychopathology subtypes scored somewhat higher on Reading, and showed a higher Reading versus Arithmetic discrepancy, than did the Normal and Somatic Concern subtypes. Although, as with the Middle children, these differences failed to reach statistical significance, they were consistent with previous research (Fuerst & Rourke, in preparation).

The trends seen in the Middle and Old CAD subtypes on the WRAT subtests were more evident in the PMD subtypes. On both
WRAT Reading and Spelling, the Externalized Psychopathology and Internalized Psychopathology subtypes scored significantly higher than did the Normal and Somatic Concern subtypes. In addition, on WRAT Reading the Externalized Psychopathology subtype also scored significantly higher than did the Mild Anxiety and Conduct Disorder subtypes, and on WRAT Spelling, the Internalized Psychopathology subtype obtained a significantly higher mean score than did the Mild Anxiety subtype. The Externalized Psychopathology and Internalized Psychopathology subtypes also showed the largest Reading versus Arithmetic discrepancy, although not significantly more so relative to the other subtypes.

Previous research has shown that WRAT Reading and Spelling measures are associated with verbal and auditory-perceptual skills of children with LD (Rourke, Dietrich, & Young, 1973; Rourke & Finlayson, 1978; Rourke, Young, & Flewelling, 1971). Thus, these results, and those of Fuerst and Rourke (in preparation) indicate that children with LD demonstrating relatively well-developed verbal and auditory-perceptual skills are more likely to appear in PIC subtypes with profiles suggestive of severe psychopathology, be it of the internalizing or externalizing type. On the other hand, children with relatively mild problems in psychosocial adaptation cannot be distinguished from normal functioning children on the basis of these abilities.

As patterns of WRAT scores are also known to be
associated with patterns of WISC VIQ-PIQ discrepancies (Rourke, Dietrich, & Young, 1973; Rourke & Finlayson, 1978; Rourke, Young, & Flewelling, 1971), it is not surprising that these results are consistent with the findings of Fuerst et al. (1990). In that study, children with WISC VIQ>PIQ by at least 10 points were found at lower than expected frequencies in normal and mildly disturbed subtypes, but at higher than expected frequencies in severely disturbed subtypes. Considering the results of the present study, and those of Fuerst et al. (1990) and Fuerst and Rourke (in preparation), it would appear that psychosocial functioning of children is, indeed, related to cognitive functioning, and that children with relatively well developed psycholinguistic skills may be at greater risk for serious socioemotional problems. Contrary to a commonly held notion, relatively deficient linguistic skills do not appear to be related to seriously disordered psychosocial functioning, at least in children with LD. However, the certainty with which this assertion can be made is dependent on the degree to which psycholinguistic abilities are associated with WISC Verbal IQ, and with WRAT Reading and Spelling scores.

At the beginning of this study, two predictions were made regarding the relations between neurocognitive functioning and psychosocial functioning. First, it was expected that the association between psychosocial and neurocognitive functioning would be absent or weak at Young age levels, but
more prominent at higher age levels. This expectation was not supported using the WISC, neuropsychological, or neurocognitive factor scale measures, as no appreciable relations were found between these variables and psychosocial functioning at any of the three age levels. However, the results on the WRAT subtests were consistent with this hypothesis. In the Middle CAD typology, the Internalized Psychopathology subtype showed the highest WRAT Reading score and the largest Reading versus Arithmetic discrepancy. This pattern was also found in the Old CAD typology, and was, in addition, demonstrated by the Externalized Psychopathology subtype as well. To the extent that patterns of performance on WRAT subtests are markers of neurocognitive functioning, this finding provides modest support for the first prediction.

The second expectation was that children showing severe internalized psychopathology would demonstrate a pattern of neurocognitive strengths and deficits that would be roughly consistent with, or at least reminiscent of, the NLD syndrome. With the exception of the patterns of WRAT scores observed in the Internalized Psychopathology subtype, as discussed above, there was no evidence to support this expectation. However, the sample used in this study was strongly biased towards linguistic, as opposed to nonverbal, deficits, as is not uncommon in data generated from clinic referred LD populations (see Limitations, below), and thus did not allow a proper test of this hypothesis. Children demonstrating the NLD syndrome
are, relatively speaking, rarely seen in clinical practice, although increased awareness of the significance of NLD in the educational community should improve referral rates and aid future research efforts.

Relations Between Age and Psychosocial Functioning

At the outset of this study, three predictions were made regarding potential relations between age and psychosocial functioning in children with LD. The first prediction was that Normal, Internalized Psychopathology, and Externalized Psychopathology subtypes would be found at all age levels, as these subtypes have proven to be the most reliable in previous research. Second, it was predicted that, when typologies were compared across age levels, there would be a greater diversity of subtypes with increasing age. The final prediction was that with increased age there would be an increase in the level of pathology evidenced in frankly maladjusted subtypes. Two general approaches were used to test these predictions.

In the first approach, subtypes were derived from Young, Middle, and Old samples of children using cluster analysis (referred to as the CAD subtypes above). Of the three predictions, only the first was supported by the results. At all three age levels, Normal, Internalized Psychopathology and Externalized Psychopathology subtypes were found. While there were minor differences between corresponding subtypes across age levels, they were all clearly recognizable as instances of their respective types. This finding, that the
Internalized Psychopathology and Externalized Psychopathology CAD subtypes were very similar across the Young, Middle and Old samples, also failed to support the third prediction. There was no evidence of greater maladjustment in these two clearly pathological subtypes at higher age levels.

Regarding the second prediction, there was no evidence of greater diversity of subtypes at higher age levels. While more subtypes were found in the Middle sample (six) than in the Young sample (four), only four subtypes could be reliably derived from the Old sample. The discrepancy in the number of subtypes across age levels (four versus six) was trivial. These results suggest that patterns of psychosocial functioning, as measured by the PIC, are quite uniform from ages 7-8 years in children with LD.

In the second approach, all subjects were assigned to subtypes according to similarity to prototypical PIC profiles derived in previous studies (the PMD subtypes referred to above). While subjects were not "forced" to conform to the prototypical typology, this method did place constraints on the maximum number of subtypes that could be formed (seven), and precluded the derivation of novel subtypes. However, given that the assignment of a child to a subtype was entirely independent of the assignments of other children, this method did allow somewhat more direct tests of the three predictions outlined above, as the formation of subtypes was altogether independent of age level and not subject to sample variations
that might perturb traditional methods of cluster analysis.

When the PMD subtypes were broken down by age category some statistically significant differences between age levels (within subtypes) did emerge. The shapes of the PIC profiles of the Young and Old Externalized Psychopathology subtypes were significantly different; however, inspection of the profiles indicated that the actual deviations were trivial. Similarly, while statistical tests indicated that the PIC profiles of the Young Normal and Somatic Concern subtypes were significantly more elevated the profiles of the Old Normal and Somatic Concern subtypes, the actual degree of elevation was of no consequence. In addition, while the Young children tended to score highest on the PIC scales most often in five of the seven subtypes, within none of those subtypes did this trend reach statistical significance. Thus, no evidence was found to support the expectation that greater age would be associated with increased psychopathology.

Examination of the relative sizes of the PMD subtypes at the three age levels revealed no striking differences. Three very weak trends were noted however: 1. the relative size of the Normal subtype decreased slightly with increasing age; 2. a slightly greater proportion of Old children were assigned to the Conduct Disorder subtype than were Young and Middle children; 3. a slightly greater proportion of Middle and Old children were assigned to the Internalized Psychopathology subtype as compared to the Young children. Similarly, the
mean age of the Conduct Disorder (and, perhaps, the Internalized Psychopathology) subtype was very slightly higher than the mean age of the Normal subtype.

These trends were not contrary to expectations; however, they were so weak as to be inconsequential. The preponderance of the evidence indicates that there is no change in the diversity of patterns of psychosocial functioning in children with LD with increasing age. Indeed, there was remarkable stability in patterns of functioning across the age ranges examined in this study. No evidence was found to support the notion that children with LD are likely to develop psychopathology as they grow older. Similarly, the results of this study indicate that, given a particular pattern of psychosocial adaptation, there is no substantial change in level of adaptation with increasing age. Thus, overall, as children with LD grow older (within the age ranges explored in this study), they show no increased risk for the development of pathological patterns of psychosocial adaptation, nor do they show any deterioration in level of psychosocial functioning.

These results are very much at variance with Hypothesis 2 formulations of the psychosocial functioning of children with LD. Recall that such formulations generally hold that the negative consequences of having a learning disability, such as frustration, anxiety, or peer rejection due to continued academic failure, or a discrete cognitive deficit that
perpetually disrupts psychosocial functioning, over time produces maladjustment, grinding down the child's adaptive abilities as it were. While cumulative negative experiences may be deleterious to some children with LD, the results of this study, and others reviewed in Chapter I (e.g., Chapman [1988], Chapman & Boersma [1980], Jorm et al. [1986], Strang [1981]) suggest strongly that this is not generally the case. It is clear that some children with LD evidence significant maladjustment (e.g., the Internalized Psychopathology and Externalized Psychopathology subtypes); however the development of pathological patterns of functioning is not more likely with increasing age, nor is deterioration in level of adaptation. When such changes are observed in clinical settings, factors other than simple increased age and cumulative exposure to negative experiences must be considered.

Limitations and Suggestions For Future Research

Sample Bias

Problems of sample bias are, unfortunately, all but inescapable in archival research designs. Three potential sources of bias are of particular relevance for this study. The first, and most serious, source of bias may lie in the range of patterns of performance demonstrated by the sample on the cognitive and neuropsychological measures used in this study. As mentioned in Chapter II, more than 94% of the children selected for use in this study demonstrated a pattern
of WISC VIQ=PIQ or VIQ<PIQ. Fewer than 6% of the children showed WISC VIQ greater than PIQ by at least 10 points. To the extent that pattern of WISC VIQ-PIQ discrepancy is a marker of patterns of performance on neuropsychological measures -- and there is good evidence that VIQ-PIQ discrepancy is fairly sensitive in this regard -- this bias suggests that the potential range of patterns of cognitive and neuropsychological performance were restricted in this sample. Consequently, the potential for differences between subtypes to emerge on these measures was likewise restricted, and may account for the paucity of statistically significant and meaningful differences between subtypes in cognitive and neuropsychological domains. This is also of concern as the work of Fuerst et al. (1990) has demonstrated that a pattern of WISC VIQ>PIQ is associated with greater likelihood of severe psychosocial dysfunction in children with LD.

The second source of bias stems from the fact that subjects in this study were referred for clinical neuropsychological assessment at the behest of professionals, quasi-professionals, and parents. Obviously, factors underlying the impetus for referral vary, to some degree, from case to case. Children who are low-achieving but relatively compliant and well-behaved in school may be referred for assessment because of their academic difficulties; on the other hand, children that present management problems for teachers and parents, but less worrisome levels of academic
achievement, may also be referred for assessment.

Such a pattern of referrals, and resulting sample bias, could account for the apparent trend of children in severe pathological subtypes to show higher mean WRAT Reading scores than children in relatively well-adjusted subtypes. (Note, however, that this source of bias does not account for the differences in the patterns of WRAT Reading versus Arithmetic performance [i.e., larger discrepancies, in favour of the latter score, in pathological subtypes].) Unfortunately, this bias is, perhaps, unavoidable when data generation is reliant on clinic referrals.

A third source of bias is related to the criteria used to classify children as learning disabled. The approach used in this study, which is sometimes referred to as the "unadjusted discrepancy" or "cutting score" method (Francis, Espy, & Rourke, 1988), is not without problems. These include the assumption of normality at particular age or grade levels, inequivalence of achievement discrepancies across age levels (i.e., discrepancy of a given magnitude may indicate different levels of severity of LD at different age levels), and lack of objective grounds on which to base cutting scores (see Francis, Espy, & Rourke, 1988, for a detailed exposition). With respect to the last problem, the criteria used in this study have demonstrated adequate performance in previous studies; however, past performance in investigations using samples of different composition and size, and having
different research aims and methodologies, does not guarantee suitability within the context of the present study.

Perhaps the most damaging argument against cutting score approaches is that they fail to account for the (not unsubstantial) correlation between WISC FSIQ and achievement test scores (Francis, Espy, & Rourke, 1988). Thus, the application of discrepancy criteria may be influenced by regression toward the mean of extreme scores, resulting in problems of both over and under-identification, at high and low extremes of WISC FSIQ, respectively, of children as being LD (Reynolds, 1984). Future studies should make use of regression-based, or "corrected", discrepancy definitions of LD, which have demonstrated somewhat more desirable properties as compared to the unadjusted discrepancy definition, in empirical research (Francis, Espy, & Rourke, 1988).

Subtype Formation

Multivariate subtyping techniques, such as cluster analysis, are very useful for exploratory investigations of poorly understood populations. Among others things, they provide relatively objective techniques for generating subtypes that are clearly specified and easily replicated across studies. However, these methods are quite "simple-minded," in the sense that subtypes are formed based on restricted "local" criteria and assignment rules. While, in some contexts, it is advantageous to use subtyping techniques that are not influenced by a priori assumptions or prejudices,
wilful ignorance of known properties of the population and
behavioural domain under investigation does not ensure optimal
recovery of clusters.

The simple profile matching algorithm used in this study
is one example of employing prior knowledge of the population
and domain under study in the formation of subtypes. This
classification method shares some of the advantages of cluster
analysis (i.e., clear specification and ease of replication of
the algorithm). However, as implemented in this study, it was
less than ideal as it was dependent on prototypes originally
derived by cluster analysis. The method could not uncover
"new" subtypes not found in the previous cluster-analytic
studies. However, the prototypes could be derived by any
method. For example, it might prove fruitful to use
prototypes derived in studies of specific diagnostic groups
identified using rigorous clinical criteria. The Breen and
Barkley (1985) hyperactive profile would be one example of a
suitable prototype. A search of the literature might uncover
other potential prototypes representing relevant clinical
populations, such as conduct disorder, childhood psychosis,
major depression, and so forth. If these prototypes were
carefully chosen from methodologically sound investigations,
they would have the advantage of possessing some known degree
of external validity.

A second approach would be to use the PIC profile
classification strategy proposed by Lachar, Kline, and Boersma
(1986). As with the simple profile matching algorithm, this method incorporates the benefits of clear specification, and straightforward implementation/replication of the algorithm. There is sufficient empirical evidence supporting the external validity of this classification scheme to make exploration of its applicability to the population of children with LD worthwhile (e.g., Kline, Lachar, & Boersma, 1987).

**Factor Scales**

The work of Francis, Fletcher, and Rourke (e.g., Francis, Fletcher, & Rourke, 1988) has provided some insight into the neuropsychological/cognitive ability structure of 9-10 year old children with LD. The preliminary results of this ongoing research were used in this study to select specific neuropsychological and cognitive measures for use in validation of the psychosocial subtypes. Unfortunately, these measures proved to be largely uninformative. However, there were at least two problems with the manner in which these measures were used in this study. First, the ability structure described by Francis et al. was derived from 9-10 year old children with LD. However, in this investigation that ability structure was also applied to 7-8 and 11-13 year old children. The degree to which this generalization is valid is questionable. Indeed, based on clinical experience, and, more generally, our current understanding of the cognitive development of children, that similar ability structures would obtain across age levels seems unlikely.
While this assumption was reasonable for the purposes of this investigation, given the painstaking and time consuming nature of the Francis et al. methodology, it does constitute a significant shortcoming.

Furthermore, in this study scores summarizing performance on the major dimensions found by Francis et al. were derived by calculating mean scores on neuropsychological and cognitive tests reported as best describing those dimensions. Such an approach is roughly equivalent to deriving factor scores with all scoring coefficients set to 1 (or 0, in the case of measures not included in the scoring of a dimension). Obviously, this ignores both the magnitude of the relationship between a measure and a given dimension, and the interrelationships between measures. While there are arguments in favour of such a "factor-based scale" approach, as opposed to the construction of more sophisticated (e.g., regression based) factor scales (summarized by Kim & Mueller, 1978), in general they rely on the presence of relatively uniform factor loadings and uncorrelated predictors. The extent to which these assumptions hold true with this set of measures is unknown, and it is likely that superior methods of computing factor scales with these data could be developed.

Normative Data

Neuropsychological Functioning

One enduring problem in both child and adult neuropsychology is the lack of comprehensive norms for many
tests. While the norms used in this study, those of Knights (1970) and Knights and Norwood (1980), have proven to be valuable in the clinical neuropsychological assessment of children, they were gathered on rather restricted samples. This statement is not intended to reproach the efforts of these investigators. The development of comprehensive norms on even a single measure is a laborious and resource-intensive undertaking, which few granting agencies are prepared to fund. Unfortunately, in studies where normative data are used to transform scores to a common metric across age ranges, as in this investigation, even very small sampling errors in the normative data can have a significant impact on the results of statistical comparisons. There is a clear and pressing need to develop more extensive norms on neuropsychological measures used in research.

Psychosocial Functioning

As reviewed in Chapter I, it has often been assumed that children with LD are at greater risk for the development of psychopathology than are normally-achieving children. While the results of this study and previous research (e.g., Fuerst et al., 1989, 1990; Fuerst & Rourke, in preparation) have clearly demonstrated that a significant proportion of children with LD evidence normal or relatively normal psychosocial functioning, these investigations cannot assess the extent to which children with LD, as a group, are at increased risk for psychopathology relative to normally-achieving children. In
addition, it is impossible to determine if the patterns of psychosocial functioning found in children with LD differ from the patterns of psychosocial functioning of normally achieving non-LD children. Such research requires the inclusion of a matched sample of normally-achieving children. Unfortunately, such children are rarely seen in clinical practice, certainly in too few numbers to be used in archive-based studies such as this one, and the active recruitment and assessment of an adequate sample of normally-achieving children demands considerable investigative resources.

Validation of Subtypes on Other Psychosocial Measures

The subtypes derived in this study and previous investigations (Fuerst et al., 1989, 1990; Fuerst & Rourke, in preparation; Porter & Rourke, 1985) were formed solely on the basis of patterns of PIC profiles. While the PIC is an excellent clinical instrument, and an extremely useful research tool, it represents only one source of information regarding the psychosocial functioning of subjects. The relation between the patterns of psychosocial functioning demonstrated by the PIC-based subtypes on other measures of psychosocial adjustment is, as yet, poorly understood. There is some preliminary evidence that the subtypes found in this study show predictable differences on the Activity Rating Scale (Werry, 1968) and Behaviour Problem Checklist (Quay & Peterson, 1975); however, there is a need to replicate and extend this research (Clemanshaw, 1990).
Within-Subtypes Differences

In this study, before being subjected to cluster analysis the data were transformed in such a manner as to remove the elements of profile elevation and dispersion. Clusters were formed on the basis of similarity of profile shape, and, once formed, only between-subtypes comparisons were carried out. This approach was judged to be reasonable given the exploratory nature of the study. By ignoring the factors of PIC profile elevation and dispersion, and performing only between-subtypes comparisons, methodological and inferential complexity were held to manageable levels. However, comprehensive exploration of these data demands additional investigation of potential within-subtypes differences.

For example, within the pathological subtypes (e.g., Internalized Psychopathology), it would be interesting to know if \( z \) of the cognitive or neuropsychological measures are related to level of pathology (as opposed to type of pathology, as assessed by the between-subtypes comparisons performed in this study). There is some evidence that, within the Internalized and Externalized Psychopathology subtypes, level of pathology, as indicated by PIC profile elevation, is related to WISC VIQ-PIQ discrepancies, with children evidencing VIQ>PIQ showing greater maladjustment relative to children with VIQ<PIQ (Fuerst, 1985). It should also be mentioned that the use of more traditional (dis)similarity
measures (such as simple Euclidean distance), which take into account differences in profile elevation, might also reveal a subtype structure that embraces level of pathology in addition to type. In that case, between-subtypes comparisons would allow simultaneous consideration of both level and type of pathology without resort to further post-hoc classification.
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APPENDIX A

Macros For Outlier Deletion

/*---------------------- 'OUTDELL' MACRO ------------------------*/
/* THIS MACRO IS DESIGNED TO DELETE OUTLIERS FROM A MASTER */
/* DATA SET BEFORE DOING CLUSTER ANALYSIS. THIS METHOD WORKS*/
/* BY FINDING SUBJECTS WITH THE MAXIMUM MINIMUM DISTANCE TO */
/* ANOTHER CASE IN THE DATA SET (SEE TEXT FOR A DETAILED */
/* EXPLANATION). THIS METHOD WAS NOT USED IN THIS STUDY. */
/* THE PARAMETERS ARE NAME OF THE MASTER DATA SET, THE % */
/* OF SUBJECTS TO BE REMOVED, THE VARIABLE USED TO IDENTIFY */
/* AN OBSERVATION, NAME OF THE DATASET TO BE USED IN THE */
/* KMEANS PASS, NUMBER OF VARS USED FOR CLUSTERING, AND THE */
/* THE VAR LIST, EACH VAR NAME SEPARATED BY A '+' */
/*----------------------------------------------------------*/
%MACRO OUTDELL (MASTER,PERKP,ID,CLSET,NVARS,VARS);
/* USE KMEANS TO CALCULATE THE MINIMUM DISTANCE, GAP, FOR US */
PROC FASTCLUS DATA=&CLSET MEAN=MNS1 MAXC=1000 DRIFT MAXITER=0
NORPRINT
OUT=OBS1;
VAR
%DO I=1 %TO &NVARS;
   %SCAN(&VARS,&I,+
   %END;
ID &ID;
;
PROC SORT DATA=MNS1; /*SORT SUBS BY GAP ASCENDING*/
BY _GAP_;
;
DATA MNS2; /* AND FLAG THE REQUESTED % OF */
I=1; /* SUBJECTS WITH LARGEST VALUES*/
SET MNS1 POINT=I NOBS=NMEMS; /* AS OUTLIERS. */
TK=NMEMS-((&PERKP/100)*NMEMS);
DO I=1 TO (NMEMS);
   SET MNS1 POINT=I;
   IF _ERROR_=1 THEN ABORT;
   KEEPIT=1;
   IF (I > TK) THEN KEEPIT=0;
   OUTPUT;
END;
STOP;
;
PROC PRINT DATA=MNS2;
VAR _GAP_ KEEPIT;
;
PROC SORT DATA=MNS2;
BY CLUSTER;
;
PROC SORT DATA=OBS1;
BY CLUSTER;
;
DATA REDC1;
MERGE MNS2 OBS1;
BY CLUSTER;
KEEP &ID KEEPIT;
;
PROC SORT DATA=&MASTER;
BY &ID;
;
PROC SORT DATA=REDC1;
BY &ID;
;
DATA REDTMP;
MERGE &MASTER REDC1;
BY &ID;
IF KEEPIT=0 THEN DELETE;
DROP KEEPIT;
;
PROC DATASETS NOLIST;
DELETE &MASTER;
;
PROC DATASETS NOLIST;
CHANGE REDTMP=&MASTER;
%MEND;

%*------------------------ END OF 'OUTDEL1' MACRO ------------------------*

%*------------------------ 'OUTDEL2' MACRO ------------------------*
/* THIS MACRO IS DESIGNED TO PRODUCE DELETE OUTLIERS FROM A */
/* MASTER DATA SET BEFORE DOING CLUSTER ANALYSIS. THIS */
/* METHOD WORKS BY FINDING THE NUMBER OF CASES SURROUNDING */
/* AN OBSERVATION WITHIN THE SPECIFIED RADIUS. THIS IS THE */
/* METHOD OF OUTLIER DETECTION AND DELETION USED IN THIS */
/* STUDY. */
/* THE PARAMETERS ARE NAME OF THE MASTER DATA SET, THE NAME */
/* OF A DATASET TO BE USED IN PERFORMING THE CALCULATIONS, */
/* THE % OF SUBJECTS TO BE DELETED, THE VARIABLE USED TO */
/* IDENTIFY AND OBSERVATION, THE RADIUS VALUE TO USE WHEN */
/* CALCULATING FREQUENCIES, THE NUMBER OF VARIABLES TO BE */
/* USED IN CALCULATING DISTANCES, AND THE VARIABLE LIST, */
/* EACH VARIABLE NAME SEPARATED BY A '+'.*
%*-------------------------------------------------------------------*
%Macro OUTDEL2 (MASTER,CSET,PERKP,ID,RADIUS,NVARS,VARS);
DATA TEMP1;
ARRAY X(&NVARS)
   %DO I=1 %TO &NVARS;
    %SCAN(&VARS,&I,+)
    %END;
ARRAY Y(&NVARS) Y1-Y&NVARS;
/*NOW GET THE NUMBER OF OBS */
PT=1;
SET &CSET POINT=PT NOBS=NO;
/*OK, NOW WORK THROUGH EVERY OBSERVATION*/
DO I=1 TO NO;
   RFREQ=0;
   SET &CSET POINT=I;
   /*COPY VALUES FOR THIS PERSON TO SEMIPERM STORAGE*/
   OLDID=&ID;
   DO J=1 TO &NVARS;
      Y(J)=X(J);
   END;
   DO J=1 TO NO;
      IF I=J THEN DIST=20000000; /*IF SAME PERSON SET VERY HIGH*/
      ELSE DO;
         /*OTHERWISE CALC DISTANCE*/
         SET &CSET POINT=J;
         IF _ERROR_=1 THEN ABORT;
         DIST2=0;
         DO K=1 TO &NVARS;
            DIST2=DIST2+(Y(K)-X(K))**2;
         END;
         DIST=SQRT(DIST2);
         END; /*ELSE*/
      IF DIST <= &RADIUS THEN RFREQ=RFREQ+1;
   END; /*I*/
   &ID=OLDID;
   KEEP &ID RFREQ;
   OUTPUT;
   END; /*I*/
STOP;
;
PROC FREQ DATA=TEMP1;
TABLES RFREQ;
;
PROC SORT DATA=TEMP1;
BY DESCENDING RFREQ;
;
DATA TEMP2;
I=1;
SET TEMP1 POINT=I NOBS=NMEMS;
TK=NMEMS-((&PERKP/100)*NMEMS);
DO I=1 TO (NMEMS);
   SET TEMP1 POINT=I;
   IF _ERROR_=1 THEN ABORT;
   KEEPIT=1;
   IF (I > TK) THEN KEEPIT=0;
   DROP TK;/*BUG IN SAS - CANNOT DROP RFREQ AT THIS POINT*/
   OUTPUT;
   END;
STOP;
;
PROC SORT DATA=&MASTER;
BY &ID;
;
PROC SORT DATA=TEMP2;
BY &ID;
;
DATA REDTMP;
MERGE &MASTER TEMP2;
BY &ID;
IF KEEPIT=0 THEN DELETE;
DROP RFREQ KEEPIT;
;
PROC DATASETS Nolist;
DELETE &MASTER;
;
PROC DATASETS Nolist;
CHANGE REDTMP=&MASTER;
%MEND;

SOFTWARE_MODULE

Macro For Calculating External Criteria

SOFTWARE_MODULE

/*------------------------------------ EXTCRIT -------------------------------*/
/* THIS MACRO CALCULATES VARIOUS EXTERNAL CRITERIA FOR */
/* COMPARING TWO CLUSTER SOLUTIONS. THE PARAMETERS ARE THE */
/* NAME OF THE DATASET CONTAINING THE SOLUTIONS, AND THE */
/* NAMES OF TWO NUMERIC CLASS VARIABLES INDICATING CLUSTER */
/* MEMBERSHIP. THE FORMULAS USED IN THIS MACRO ARE FROM */
/* MILLIGAN & COOPER (1986). */
/*--------------------------------------------------------------------------------*/
%MACRO EXTCRIT(DATASET,A,B);
DATA _NULL_
FILE PRINT;
   /* ROUTE OUTPUT TO PRINT FILE */
;
   /* DECLARE ARRAYS TO HOLD CELL AND MARGINAL FREQUENCIES */
   /* NOTE THAT AS WRITTEN THE MAX NUMBER OF CLUSTERS ALLOWED */
   /* IS 50. */
ARRAY FAFB(2500) FAFB1-FAFB2500;/* REALLY FAFB(50,50), BUT */
   /* CMS SAS DOES NOT ALLOW */
   /* MULTIDIMENSIONAL ARRAYS. */
ARRAY FA(50) FA1-FA50;
ARRAY FB(50) FB1-FB50;
;
   /* DECLARE AND INITIALIZE SOME SCALARS */
SSNA=0; /* TOTAL SS */
SSNB=0; /* MARGINAL SS FOR SOLUTION A */
SSNA=0; /* MARGINAL SS FOR SOLUTION B */
Amax=0; /* NUMBER OF CLUSTERS IN SOLUTION A */
Bmax=0; /* NUMBER OF CLUSTERS IN SOLUTION B */
NMEMS=0; /* TOTAL N */
M1=0; /* THESE CORRESPOND TO A, B, C, & D */

SOFTWARE_MODULE
/ * IN MILLIGAN & COOPER */
M2=0;
M3=0;
M4=0;

; /* FIND TOTAL N FROM SIZE OF DATASET */
I=1; /* JUST SET TO 1 FOR NEXT STMT - A SCREWY FEATURE IN SAS */
   /* NOBS= MUST BE ACCOMPANIED BY A POINT= VALUE TO WORK */
SET &DATSET POINT=I NOBS=NMEMS;

; /* CALCULATE A, B, C, AND D */
CRIT1=0;
CRIT2=0;
DO I=1 TO (NMEMS-1);
   SET &DATSET POINT=I;
   IF _ERROR_ =1 THEN ABORT;
   CRIT1=&A;
   CRIT2=&B;
   DO J=I+1 TO NMEMS;
      SET &DATSET POINT=J;
      IF _ERROR_ =1 THEN ABORT;
      IF (CRIT1 = &A) AND (CRIT2 = &B) THEN M1=M1+1;
      IF (CRIT1 ^= &A) AND (CRIT2 = &B) THEN M2=M2+1;
      IF (CRIT1 = &A) AND (CRIT2 ^= &B) THEN M3=M3+1;
      IF (CRIT1 ^= &A) AND (CRIT2 ^= &B) THEN M4=M4+1;
   END;
END;

; /* OK, GOT THE BASIC VALUES DONE */
/* NOW CALC VALUES FOR ADJ RANDS */
DO I=1 TO 50; /* INIT THE ARRAYS */
   FA(I)=0;
   FB(I)=0;
   DO J=1 TO 50;
      FAFB(((I-1)*50)+J)=0; /* THIS EMULATES A 2D ARRAY */
   END;
END;

; /* FIND THE CELL AND MARGINAL FREQUENCIES */
DO I=1 TO NMEMS;
   SET &DATSET POINT=I;
   IF _ERROR_ =1 THEN ABORT;
   FA(&A)=FA(&A)+1;
   FB(&B)=FB(&B)+1;
   FAFB(((&A-1)*50)+&B)=FAFB(((&A-1)*50)+&B)+1;
   IF (&A > AMAX) THEN AMAX=&A;
   IF (&B > BMAX) THEN BMAX=&B;
END;

; /* CALCULATE ALL OTHER TERMS WE NEED */
DO I=1 TO AMAX;
DO J=1 TO BMAX;
    SSNAB=SSNAB+(FAF{((I-1)*50)+J}*2);
END;

DO I=1 TO AMAX;
    SSNA=SSNA+(FA{I}*2);
END;

DO I=1 TO BMAX;
    SSNB=SSNB+(FB{I}*2);
END;

; /* THESE ARE THE CORRECTIONS FOR CHANCE AGREEMENT */
/* FOR ADJUSTED RANDS */
NC1=(NMEMS*(NMEMS-1)/2)-(SSNA/2)-(SSNB/2)+(SSNA*SSNB/
(NMEMS)**2);
NC2=(NMEMS*((NMEMS**2)+1)-(NMEMS+1)*SSNA)-(NMEMS+1)*SSNB+
    (2*SSNA*SSNB/NMEMS))/(2*(NMEMS-1));

; /* OK, NOW CALCULATE THE ACTUAL COEFFICIENTS */
RANST=(M1+M4)/(M1+M2+M3+M4);
ADJR1=(M1+M4-NC1)/(M1+M2+M3+M4-NC1);
ADJR2=(M1+M4-NC2)/(M1+M2+M3+M4-NC2);
JACCST=(M1)/(M1+M2+M3);
FWKNAL=M1/(((M1+M2)*(M1+M3))**(1/2));

; /* FINALLY, PRINT THE RESULTS */
PUT "+-----------------------------------------------+";
PUT "| EXTERNAL CLUSTER CRITERIA |";
PUT "+-----------------------------------------------+";
PUT " ";
PUT "THESE RESULTS ARE FOR CLUSTER SOLUTIONS &A AND &B";
PUT " ";
PUT "VARIOUS TERMS";
PUT "----------------";
PUT "SOLUTION 1";
PUT "-----------------------------------------------+";
PUT "IN SAME CL IN DIFF CL";
PUT "| a= b="@;"
PUT "| c= d="@;"
PUT " ";
PUT "NOTE: N="NMEMS " COL SS="SSNA " ROW SS="SSNB " TOTAL SS="SSNAB;
PUT " ";
PUT " ";
PUT "MEASURE";
PUT "-----------------------------------------------+ VALUE";
PUT "RAND=(a+d)/(a+b+c+d) @44 RANDST;";
PUT " ";
PUT "MOREY & AGRESI ADJUSTED RAND" |"@;
PUT @44 ADJR1;
PUT |
PUT "HUBERT & ARABIE ADJUSTED RAND" |"@;
PUT @44 ADJR2;
PUT |
PUT "JACCARD=a/(a+b+c)" |"@;
PUT @44 JACCS;
PUT |
PUT "FOWLKES & MALLOWS=a/((a+b)(a+c))**(1/2)" |"@;
PUT @44 FWKMAIL;
STOP;
%MEND EXTCRIT;

Macro For Performing Simple Matching

/*-------------------------- PROFMAT --------------------------*/
/* THE PROFMAT MACRO IMPLEMENTS THE SIMPLE PROFILE MATCHING */
/* ALGORITHM USED IN THIS STUDY. THE PARAMETERS ARE THE */
/* NAME OF THE DATASET CONTAINING THE OBSERVATIONS TO BE */
/* ASSIGNED TO SUBTYPES, THE NAME OF THE DATASET CONTAINING */
/* THE PROTOTYPICAL (OR SEED) PROFILES, THE MINIMUM */
/* ACCEPTABLE LEVEL OF SIMILARITY FOR ASSIGNMENT TO OCCUR, */
/* THE NUMBER OF PROTOTYPES, THE NUMBER OF VARIABLES TO USE */
/* IN CALCULATING SIMILARITIES, AND A LIST OF THE VARIABLE */
/* NAMES, EACH SEPARATED BY A '+' . NOTE THAT, AS WRITTEN, */
/* THIS MACRO USES CORRELATION COEFFICIENTS AS THE */
/* SIMILARITY MEASURE; HOWEVER, THIS COULD BE EASILY CHANGED*/
/* TO ANY SUITABLE SIMILARITY/DISSIMILARITY MEASURE. */
/*-----------------------------------------------*/
%Macro PROFMAT(INSET, SEDSET, MINSIM, NSEED, NPVARS, PAVARS);
DATA PMTMP;
/*THE FOLLOWING VECTOR IS REALLY A NSEED×NPVARS MATRIX USED */
/*TO HOLD THE PROTOTYPICAL PROFILES - NO 2D ARRAYS IN CMS */
/*SAS! */
ARRAY X(\EVAL(&NSEED*&NPVARS)) X1-\EVAL(&NSEED*&NPVARS);
/*THE FOLLOWING VECTOR IS FOR TEMP STORAGE OF THE PVAR */
/*VALUES */
ARRAY Y(\NPVARS)
%DO I=1 %TO &NPVARS;
  %SCAN(&PVAR, &I, +)
%END;
; /*VECTOR CR HOLDS THE NSEED SIMILARITIES FOR AN */
/*OBSERVATION */
ARRAY CR(&NSEED) CR1-CR&NSEED;
PT=1;
SET &SEEDSET POINT=PT NOBS=NO;
IF _ERROR_=1 THEN ABORT;
DO I=1 TO NO;
PT=I;
SET &SEEDSET POINT=PT; /*Y() IS NOW LOADED WITH PROTO VALS */
IF _ERROR_ =1 THEN ABORT;
DO J=1 TO &NPVARS; /*COPY THEM TO SEMIPERM STORAGE IN */
   /*X()*/
   X{((I-1)*&NPVARS)+J}=Y(J);
END;
END;
PT=1;
SET &INSET POINT=PT NOBS=NO;
IF _ERROR_ =1 THEN ABORT;
DO I=1 TO NO; /*FOR EVERY SUBJECT... */
   PT=I;
   SET &INSET POINT=PT;
   IF _ERROR_ =1 THEN ABORT;
   SY=0; /*CALCULATE CORRS WITH PROTOTYPES */
   SYQ=0;
   DO K=1 TO &NPVARS; /*CALC THE Y VALUES ONLY ONCE */
      SY=SY+Y(K);
      SYQ=SYQ+(Y(K)**2);
   END;
   DO J=1 TO &NSEED;
      SX=0;
      SXQ=0;
      SXY=0;
   DO K=1 TO &NPVARS; /*CALC X AND XY VALUES */
      SX=SX+X{((J-1)*&NPVARS)+K};
      SXQ=SXQ+(X{((J-1)*&NPVARS)+K}**2);
      SXY=SYX+Y(K)*X{((J-1)*&NPVARS)+K};
   END; /*K*/
   CR(J)=((&NPVARS*SXY)-(SX*SY))/
   SQR(((&NPVARS*SXQ)-SX**2)*((&NPVARS*SYQ)-SY**2));
   END; /*J*/
   PROTO=0;
   MAXCORR=-2;
   DO J=1 TO &NSEED; /*GOT ALL CORRS SO DO THE ASSIGNMENT */
      IF (CR(J) >= &MINSIM) AND (CR(J) > MAXCORR) THEN DO;
         PROTO=J;
         MAXCORR=CR(J);
      END;
      END;
DROPCASEX1-X"%EVAL(&INSEED*>>&NPVARS) MAXCORR SX SY SXY SXQ SYQ;
OUTPUT;
END; /*I*/
STOP;
;
PROC DATASETS NO LIST;
DELETE &INSET;
;
PROC DATASETS NOLIST;
CHANGE PMTMP=&INSET;
%MEND;
VITA AUCTORIS

Darren Fuerst was born in Toronto, Ontario, on July 25, 1960. After escaping, relatively unscathed, from the Ontario public school system in 1979, he attended York University until June, 1983, when he received a Bachelor of Arts degree in Psychology. In September, 1983, he registered in the Human Clinical Neuropsychology program at the University of Windsor. He received a Master of Arts in Psychology from that institution in 1985.