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The neuropsychological significance of the "ACID" pattern on the WISC: A multivariate approach to subtyping learning disabled children.

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The Neuropsychological Significance of the "ACID" Pattern on the WISC: A Multivariate Approach to Subtyping Learning Disabled Children

by
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ABSTRACT

The ACID pattern on the WISC consists of depressed scores on the Arithmetic, Coding, Information, and Digit Span subtests relative to the remaining WISC subtests. This pattern tends to have associated with it a very poor prognosis with respect to academic achievement (Ackerman, Dykman, & Peters, 1976). Clinical experience and the available literature suggests that learning disabled (LD) children who exhibit the ACID pattern are a heterogeneous population with respect to their adaptive ability structures. The purpose of the present study was to determine whether this heterogeneity could be demonstrated objectively by an automatic multidimensional classification procedure.

A total of 362 children (181 LD children who exhibited the ACID pattern and 181 individually matched LD controls who did not exhibit the ACID pattern), divided into 2 age-based samples (6 – 8 years and 9 – 14 years) were selected for the present study. The subjects were screened for evidence of primary emotional disturbance, mental retardation, sensory acuity defects, and cultural, linguistic, or instructional deprivation. All subjects had received an extensive battery of neuropsychological tests designed to measure various sensory-perceptual, psychomotor, linguistic, and higher order cognitive abilities and were judged by at least two experienced clinical neuropsychologists to be experiencing a central information processing deficiency.

The following procedures were carried out separately for each of the two age-based samples. Test scores for each subject were converted to age norms. The data sets were reduced through principal components analysis with orthogonal rotation to varimax criterion. Data matrices consisting of (a) factor scores, (b) _T_ scores on variables with the highest factor loadings, and (c) a subset of the factor scores were created. Four learning disabled children with the ACID pattern (LD-ACID) in each age sample were considered to be outliers and were dropped, along with their matched controls, from further consideration. The factor score data matrices for the LD-ACID children were subjected to group average, centroid sorting, and iterative relocation cluster analyses in order to ensure that the derived subtypes were replicable across different clustering techniques. Centroid sorting with iterative relocation was considered to produce the best solutions and was therefore applied to the other data matrices to assess the stability of the derived classifications across different data sets. Finally, the factor score data matrices for the LD-ACID children and their matched controls were combined and subjected to centroid sorting analysis with iterative relocation to assess the stability of the LD-ACID classifications when more subjects were added to the data sets.

Four types of LD-ACID children were extracted from each of the two age-based samples. Significant differences were found between the LD-ACID and control groups on some of the subtests of the Wide Range Achievement Test. No significant intercluster differences in terms of level of performance, however, were found on the WRAT subtests. Visual intercomparisons of the mean factor score profiles for the four subtypes at each age level indicated that the clusters were qualitatively well-differentiated by their factor score patterns.

The derived subtypes are described and related to other subtypes or groups of LD-ACID children reported in the literature. Two subtypes at each level were found to be quite reliable; there were sufficient similarities between the reliable subtypes at the two age levels to suggest that the ability profiles of the young LD-ACID types may not change dramatically with age. One pair of younger/older subtypes were characterized by deficits in sequential processing. The other pair of reliable subtypes appeared to have difficulties on tasks involving facility with, and possibly "revisualization" of, numeric or language symbols. The implications of this study with respect to the significance of the ACID pattern and the subtyping of learning disabled children are presented.

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CHAPTER I

INTRODUCTION

A review of the recently burgeoning clinical and empirical literature concerned with subtypes of learning disabled (LD) children suggests strongly that LD children are a heterogeneous group with respect to their academic difficulties and their adaptive ability structures. LD subtypes have been defined on the basis of (1) etiology, (2) performance on neuropsychological and psychological measures, and (3) patterns and qualities of academic performance. A brief overview of this literature, followed by a review of the various profiles commonly obtained by LD children on the Wechsler Intelligence Scales, is presented in this chapter. First, however, definitions and a discussion of some basic assumptions are in order.

Definitions and assumptions. A multiplicity of factors can influence adversely, either separately or in an interactional way, a child's ability to master age-appropriate tasks within the academic and/or extra-academic spheres. These factors define the different general subgroups of the very heterogeneous group of all learning disordered children (i.e., children who are experiencing difficulties learning relative to 'normal' age peers). Each of these subgroups in turn is surely a composite of children with vastly different psychological and physiological characteristics.

An obvious subgroup includes those children whose learning is impaired as the result of a pronounced sensory defect, as in the case of extremely poor visual or auditory input organization or acuity (Seiderman, 1979; Cox & Edelin, 1978). Children with frank brain damage compose another subgroup of learning disordered children (Birch, 1964; Boll, 1974; Haywood, 1968; Reed, Reitan, & Klove, 1965; Reitan, 1966, 1974). A generalized inability to learn at a normal rate, as is characteristic of the mentally retarded, characterizes another readily identifiable subgroup of learning disordered children (Leland, 1978). Yet another subgroup is made up of those children with psychological or emotional 'blocks' to learning (Abrams; 1971; Blanchard, 1946; Faulkes & Abrams, 1979; Kessler, 1966; Pearson & English, 1952). Children who have not had either sufficient schooling or a high standard of education compose another subgroup of learning disordered children; children with physical illnesses which make regular school attendance impossible or children from poverty-stricken environments would be included here. Children who have been provided with adequate educational opportunities, but who do not learn because of cultural factors (e.g., inadequate preparation for school, linguistic/cultural deprivation, or role models who place a low priority on education) would form a further subgroup of learning disordered children.

The exclusion of the aforementioned factors as primary in the genesis of problems in learning is often used to define another heterogeneous subgroup of learning disordered children, viz., those children who are said to be exhibiting some form of learning disability (Critchley, 1970; Kirk & Bateman, 1962; McCarthy & McCarthy, 1969). There has been considerable criticism recently of "exclusionary definitions" of learning disabilities in general and of "dyslexia" in particular. These criticisms have focused on the circularity and the ambiguity of these definitions (Ross, 1976; Rutter, 1978) and the unproven meaningfulness of the concepts defined by exclusionary criteria (Satz & Morris, 1980). The definition utilized herein extends the above definition through the addition of an 'inclusionary' clause specifying the underlying primary etiology of the learning problem.

Rourke (1975, 1978a, 1981) has reviewed a research programme which supports the hypothesis that the functional integrity of the cerebral hemispheres is compromised in a subgroup of learning disordered children for whom the above factors have been judged to be either noncontributory or secondary to the learning problem. Other authors (e.g., see Benton, 1975; Johnson & Myklebust, 1967; Knights & Bakker, 1976; Rabinovitch, 1967; Reitan, 1966; Silver, 1976) have also described learning disordered children with centrally determined learning problems. As has been suggested repeatedly in the writings of Rourke and his associates (Rourke, 1975, 1976a, 1978a, 1980, 1981; Rourke & Gates, 1981; Rourke, Yanni, MacDonald, & Young, 1973), the exclusion of sensory deprivation, mental retardation, frank brain damage, emotional disturbance, and instructional or cultural factors is a necessary but not sufficient condition for defining a learning disability. The demonstration, through well validated inferential means (see Rourke, 1976b, 1980, for a description of a particularly heuristic and clinically useful approach to this problem), that a child is experiencing a marked difficulty in integrating, organizing, or synthesizing information as the result of some type of cerebral dysfunction, and the above exclusionary criteria, serve to define the term learning disability and LD children as used herein. Although this means of defining LD is, in part, exclusionary in that it is based on ruling out a number of factors which could result in impaired learning ability, it relies heavily on the demonstrated presence of central information processing deficiencies. As a result, this definition of learning disability is both unambiguous and noncircular.

The currently widening Zeitgeist which accepts the neurobehavioural basis of learning disabilities, as typified by the collection of theoretical, research, and clinical papers published by Knights and Bakker (1976, 1980), certainly contributes to the increasing tendency to consider subtypes or subgroup analyses in the research on learning disabilities. The very large number of variables which may contribute to cerebral impairment in LD children (consider, for example the many possible forms of prenatal, perinatal, or neonatal cerebral trauma, mechanical or otherwise, as one group of variables) and the differential behavioural effects of cerebral damage depending on the age of onset, the localization, and the nature of the neuropathological process (Luria, 1966; Hecaen & Albert, 1978; Reitan & Davison, 1974; Richmond & Herzog, 1979) logically leads to the hypothesis that LD children are a heterogeneous population. An overview of the literature which advances or supports this hypothesis is presented in the following section.

At this juncture, however, it is important to note that much of the literature reviewed below does not make adequate distinctions between LD children and some subgroups of learning disordered children. Many of the LD samples described in the literature appear to be quite heterogeneous across the dimensions of academic difficulty and information processing deficiency. The authors of many of these papers provide little of the data necessary to determine whether the sample discussed is either learning disabled or in any way equivalent to other samples in the literature. This must be kept in mind when evaluating this literature. For the purposes of this chapter, unless otherwise specified, the samples described in the literature cited below are considered to be roughly representative of LD children as defined herein.

Learning Disability Subtypes

Over the years a large number of classification schemes which attempt to categorize the underlying problems experienced by LD children have been proposed. Perceptual-motor classifications have been suggested by Ayres (1972), Barsch (1967), Frostig (1964), and Kephart (1960). Typologies that describe language disabilities can be found in Bateman (1968), Chalfant and Scheffelin (1969), and Kirk, McCarthy, and Kirk (1968). A more broadly based classification scheme has been presented by Johnson and Myklebust (1967). Although it would not be appropriate to conclude that these categories represent distinct subtypes of LD children, the diversity of the clinical categories proposed is certainly consistent with the notion of the heterogeneity of LD children.

It has been suggested repeatedly in recent review articles dealing with the neuropsychology of learning disabilities in children that LD children are a heterogeneous population with respect to their neuropsychological ability structures (Benton, 1975; Rourke, 1975, 1978a, 1978b, 1981; Rourke & Gates, 1981). Not only have workers in the field begun to consider separately LD children in terms of their major area of academic or extra-academic deficit, but effort currently is also being directed toward elucidating further subtypes within these more general classifications. For example, a number of investigators have been concerned with determining classifications of reading retarded LD children (Boder, 1973; Doehring & Hoshko, 1977; Doehring, Hoshko, & Bryans, 1979; Mattis, French & Rapin, 1975; Mattis, 1978; Petrauskas & Rourke, 1979). Others (Coderre, Sweeney, & Rourke, Note 1; Nelson & Warrington, 1974; Sweeney & Rourke, 1978; Sweeney, McCabe, & Rourke, Note 2) have described subtypes of LD children who are retarded in spelling. Rourke and Finlayson (1978) and Rourke and Strang (1978) have determined and studied two general types of arithmetic retarded LD children. Fisk and Rourke (1979) and Satz, Morris, and Darby (1979; described in Satz & Morris, 1980) have identified subtypes of 'uniformily' LD children.

Representative studies in the subtype literature have been comprehensively and critically reviewed by Satz and Morris (1980). These authors describe some methods by which the problem of exclusionary criteria in the selection of LD children can be avoided. They also provide some suggestions for circumventing some of the problems inherent in the statistical classification of LD children. No attempt will be made to review these points here.

What is quite clear upon review of the aforementioned literature is that LD children in general and LD children with circumscribed difficulties in reading, spelling, or arithmetic cannot be considered as homogeneous clinical entities. Heterogeneity with respect to brain-related abilities would seem to be the hallmark of LD children. On the basis of the research carried out to date, heterogeneity with respect to etiology, developmental course, response to remedial intervention, and psychological adjustment would seem likely, but this has not yet been demonstrated in a systematic fashion.

WISC and WISC-R Profiles of Learning Disabled Children

The Wechsler Intelligence Scales (Wechsler, 1949, 1974) have long been used in identifying and evaluating learning disabilities in children. Some school administrators require that a child obtain a certain pattern of performance on the Wechsler scales before she/he can be "diagnosed" as learning disabled and before remedial assistance can be provided. Administrative decisions such as this reflect the notion that there are specific Wechsler profiles which are reliably characteristic of LD children. A review of the clinical and empirical literature dealing with Wechsler profiles for LD children is presented in this section. What is immediately apparent when examining this literature is that there is no single Wechsler pattern characteristic of all LD children but rather that a number of different WISC/WISC-R profiles have been found for groups of LD children. This should come as no surprise in view of the overwhelming evidence for the heterogeneity of learning disabilities in children. Before reviewing this literature, however, it is necessary to address the issue of the comparability of the WISC and the WISC-R.

Comparability of the WISC and the WISC-R. An in-depth discussion of the clinical use of the WISC-R and its apparent advantages over the WISC can be found in Kaufman (1979). Comparisons of the two instruments have generally been consistent in showing that children obtain lower IQ scores on the revised instrument whether the children evaluated are mentally retarded (Berry & Sherrets, 1976), psychiatric patients (Klinge, Rodziewicz, & Schwartz, 1976), learning-disabled (Paal, Hesterly, & Wepfer, 1979), or "normal" (Tuma, Appelbaum, & Bee, 1978). Kaufman (1979) has reviewed factor analytic and correlational research which suggests that the WISC and WISC-R measure essentially the same abilities. Others (Davis, 1977; Hartlage & Steele, 1977), however, have suggested that the WISC and WISC-R are not directly comparable. Since the currently available evidence generally favors Kaufman's position, the literature reviewed below will not be discussed separately for the two instruments. For the purposes of this chapter, the two instruments will be considered comparable with respect to the abilities they measure.

The performance of LD children on the Wechsler Scales have been evaluated at several different levels: Verbal-Performance IQ differences, clinically or statistically derived factor profiles, and subtest scaled score patterns. The research in this area is roughly equally divided with respect to the use of within group comparisons (analysis of subtest scatter) or the use of comparison groups (WISC/WISC-R standardization samples or other control groups).

Verbal-Performance IQ differences. It is generally reported that LD children as a group obtain lower Verbal than Performance IQ values (Belmont & Birch, 1966; Clements & Peters, 1962; Heulsman, 1970; McLean, 1964; McManis, Figley, Richert, & Fabre, 1978; Milich & Loney, 1979; Neville, 1961; Zingale & Smith, 1978). A number of investigators, however, have noted that subgroups of LD children obtain lower Performance than Verbal IQs and have suggested subtypes of LD children based on Verbal-Performance differences (Ackerman, Peters, & Dykman, 1971; Graham, 1952; Paal, Hesterly, & Wepfer, 1979; Paterra, 1963; Rourke, Young, & Flewelling, 1971; Spache, 1957; Wells, 1970). Other investigators (Altus, 1956; Kallos, Grabow, & Guarino, 1961; Keogh, Wetter, McGinty, & Donlon, 1973; Sandstedt, 1964; Vance, Gaynor & Coleman, 1976) have not found Verbal-Performance IQ discrepancies in their samples of LD children. On the basis of these reports, it is clear that Verbal-Performance differences on the Wechsler Intelligence Scales can, in some instances, lead to meaningful subclassifications of LD children but that no unitary pattern of performance on the Wechsler summary scales is characteristic of all LD children.

Patterns on the Wechsler factors. Empirically or clinically derived Wechsler Intelligence Scale intertest combinations have been used to identify profiles of LD children. In a factor analytic study of the WISC standardization sample at ages 7½, 10½, and 13½, Cohen (1959) found five oblique factors: two "verbal" factors which he combined into a single verbal factor (Information, Comprehension, Similarities, Vocabulary), a "spatial" factor (Block Design, Object Assembly; Mazes was included at the two younger ages), a "distractibility" factor (Arithmetic, Digit Span; this factor was only evident for the oldest age group), and a "quasispecific" factor (Coding, Picture Arrangement; this factor was only evident for the two oldest groups). Kaufman's (1975) factor analysis of the WISC-R standardization sample identified three factors: Verbal Comprehension (Information, Similarities, Vocabulary, Comprehension), Perceptual Organization (Picture Completion, Block

Design, Picture Arrangement, Object Assembly, Mazes), and Freedom from Distractibility (Arithmetic, Digit Span, Coding). A widely used, clinically derived inferential classification of the WISC subtests by Bannatyne (1968) consists of the following three groupings: Spatial Ability (Picture Completion, Block Design, Object Assembly), Verbal Conceptualizing Ability (Comprehension, Similarities, Vocabulary), and Sequencing Ability (Digit Span, Coding, Picture Arrangement). He later modified his classification by creating a fourth grouping (Bannatyne, 1971) which he termed Acquired Knowledge (Information, Arithmetic, Vocabulary) and by replacing Picture Arrangement with Arithmetic in the Sequential category (Bannatyne, 1974).

Bannatyne (1971) states that "dyslexics" obtain their lowest Wechsler scores on his Sequential ability subtests. Studies of "reading-disabled" and LD children utilizing his categories provide some support for this assertion. For example, Rugel (1974) demonstrated to his satisfaction that reading-disabled children as a group score lowest on the Sequencing subtests. (See below for an elaboration of Rugel's findings). The majority of Ackerman, Dykman, and Peters' (1976, 1977) LD subjects evidenced below average Sequencing scores. Smith, Coleman, Dokecki, & Davis (1977) report that their samples of learning disabled children obtained their highest scores on the Spatial subtests, their next highest scores on the Verbal Conceptualizing subtests, and their lowest scores on the Sequencing and Acquired Knowledge subtests. The findings of Bannatyne (1971), Rugel (1974), Ackerman et al. (1976, 1977), and Smith et al. (1977) have been partially corroborated by a study conducted by Vance and Singer (1979).

Wechsler subtest scaled score patterns. As would be expected on the basis of the aforementioned studies dealing with subtypes of LD children and Wechsler Verbal-Performance IQ patterns, a number of different subtest profiles have been found with different samples of LD children. Some researchers have also reported different Wechsler profiles within one heterogeneous (although not always recognized as such) sample of children with learning disabilities.

Studies concerning WISC profiles and LD children ("disabled readers" in particular) published before 1972 have been reviewed by Huelsman (1970) and Rugel (1974). Huelsman concluded that disabled readers as a group tended to show low scores on the Arithmetic, Information, and Coding (AIC) subtests in 16, 20, and 19, respectively, of the 20 studies he reviewed; low scores on Digit Span were reported for 12 of the 20 studies. On the basis of rank ordering and regrouping of the Wechsler subtest scores from 25 studies, Rugel concluded that disabled readers as a group obtained consistently low scores on Arithmetic, Coding, and Digit Span (ACD). Rugel, possibly because of his attempt to analyze the WISC profiles in terms of Bannatyne's (1968) clinical categorization (which excludes Information), failed to note that the Information score was equal to or lower than the Sequencing subtests in 18 of the 25 studies he reviewed. It should also be noted that other patterns of low scores [e.g., Arithmetic, Coding, & Vocabulary (Graham, 1952), Arithmetic, Information, Object Assembly, and Vocabulary (Belmont & Birch, 1966), Arithmetic, Information, & Digit Span (Neville, 1961), Arithmetic, Coding, Digit Span, & Similarities (Ackerman, Peters & Dykman, 1971)] in addition to the AIC and ACD patterns were also evident in individual reports reviewed by Huelsman (1970) and Rugel (1974). More recent reports than those reviewed by these authors have also described a number of different WISC/WISC-R patterns for different samples of LD children.

Hale (1979) and Smith, Coleman, Dokecki, and Davis (1977) reported that their samples of "underachieving" and "disabled readers", respectively, obtained low WISC-R subtest scaled scores on Arithmetic and Coding. Low scores on the Coding and Digit Span subtests were reported by Tabachnick (1979) for a group of LD children. Zingale and Smith (1978) and Vance, Gaynor, and Coleman (1976) report that the LD subjects obtained depressed scores on the Arithmetic, Information, and Coding subtests of the WISC-R; these latter two studies did not utilize the Digit Span subtest.

A comparison of "retarded" and adequate readers on the WISC-R (McManis et al., 1978) showed that the retarded readers obtained significantly lower scores on Coding and all of the verbal subtests; a within group analysis of the retarded group showed significantly lower Arithmetic, Coding, and Digit Span scores. In a study designed to compare WISC and WISC-R profiles for the same sample of LD children (Paal et al., 1979) consistent patterns of low scores on the Arithmetic, Digit Span, and Coding subtests were obtained with both instruments. Depressed scores on Information, Arithmetic, and Digit Span characterized the "uniformly" LD subtypes generated by Fisk and Rourke (1979).

A number of investigators have reported that low scores on a cluster of four subtests — Arithmetic, Coding, Information, and Digit Span (the so-called ACID pattern) — characterize the Wechsler profiles of samples or subsamples of LD children. These studies will be reviewed next.

The Wechsler ACID pattern. According to Swartz (1974; cited in Ackerman et al., 1976; 1977; Dykman, Ackerman, & Oglesby, 1980; Petrauskas & Rourke, 1979) a pattern consisting of depressed scores on four WISC subtests, the ACID pattern (an acronym for Arithmetic, Coding, Information, and Digit Span) is characteristic of most LD samples. This view is also held by Lutey (1977). Overall, an analysis of the research reviewed above suggests that this assertion has some veracity, but that this pattern is certainly not characteristic of all samples or subsamples of learning disabled children.

The ACID pattern, although not recognized by the reviewers, was clearly evident upon reanalysis of the published data in five (Corwin, 1967; McDonald, 1964; Robeck, 1960, 1963, 1964) of the 20 studies reviewed by Huelsman (1970) and in 9 (Ackerman, Peters & Dykman, 1971; Burks & Bruce, 1955; Coleman & Rasof, 1963; DeBruler, 1967; Hunter & Johnson, 1971; McLean, 1964; Rice, 1970; Schiffman & Clemmens, 1966; Symmes & Rappaport, 1971) of the 25 studies reviewed by Rugel (1974). More recently, this pattern has been reported by Ackerman, Dykman, and Peters (1976; 1977) for a sample of LD boys, Dykman, Ackerman, and Oglesby (1980) for both a LD and hyperactive sample, Milich and Loney (1979) for a sample of "hyperactive/MBD" boys with academic deficits, and Petrauskas and Rourke (1979) for two subtypes of retarded readers. The ACID pattern was also evident upon inspection of the data available in a report by McManis et al. (1978).

The clinical experience of several in this field (including my own since 1976) with LD children suggests that (1) the ACID pattern is not individually characteristic of all LD children and that (2) LD children who exhibit the ACID pattern do not constitute a homogeneous population with respect to their neuropsychological ability structures. The literature reviewed in this and the previous section lends support to this first point. The findings reported by Ackerman et al. (1976, 1977), Dykman et al. (1980), and Petrauskas and Rourke (1979) are consistent with the second point and provide the impetus for further research on the ACID pattern. The relevant aspects of these latter studies will now be discussed in more detail.

Reports by Ackerman et al. (1976, 1977) present the results of a longitudinal laboratory study of 82 learning disabled boys and 34 matched normal achievers. Sixty-two subjects and 31 matched controls were available for study at 4-year follow-up. The combined group of 93 children were regrouped to form 8 achievement groups based on their WRAT (Wide Range Achievement

Test, Jastak & Jastak, 1965) performance at follow-up. These groups were classified according to the following criteria: "superior" reading (R), spelling (S), and arithmetic (A) scores; "superior" R but average A; average R, S, and A; "adequate" R and A but handicapped in S; "adequate" R and S but handicapped in A; "adequate" R but handicapped in "phoneme/grapheme correspondence"; and "deficient" R, S, and A. The characteristics of this latter group, the "generally disabled" students, are most pertinent to the present discussion. The generally disabled group, who had the poorest outcome at follow-up, evidenced the most severe early reading problems and a marked depression on the ACID subtests; this WISC pattern was especially evident during their initial evaluation (Ackerman et al., 1976; Ackerman, Peters, & Dykman, 1971). Although the LD sample as a group obtained lower ACID scores than did the controls (Ackerman et al., 1977), the LD children who overcame "(to varying degrees) some or all of their early learning problems... showed more strength on the Information subtest" (Ackerman et al., 1976, p. 609). These findings suggest that a subtype of LD children with poor prognosis for academic performance in reading, spelling, and arithmetic, as measured by the WRAT, may be defined by serious early reading problems and by depressed scores on the ACID subtests. Additional research, however, is necessary to cross-validate and to investigate further the characteristics of this possible subtype. In this regard, there is already some empirical evidence available.

Dykman et al. (1980) have shown that low scores on the ACID pattern are not always associated with deficient learning ability. Their "pure" LD and "pure" hyperactive subjects both obtained low ACID scores relative to a normal control group, yet only the former group demonstrated any learning problems. These findings are consistent with the notion that children with the ACID pattern constitute a heterogeneous group. The results of the Petrauskas and

Rourke (1979) study provide further support for this view. By utilizing the technique of Q type factor analysis, these authors extracted 5 subtypes of retarded readers. Three of these subtypes were considered to have been reliably classified in that they were duplicated in two random halves of the sample; one of these subtypes obtained their lowest WISC scores on the ACID subtests and exhibited uniformly deficient performances on the Reading, Spelling, and Arithmetic subtests of the WRAT. Another, albeit less reliable, subtype also demonstrated the ACID pattern. This subtype differed from the former in that depressed scores were obtained on the WRAT Reading and Spelling subtests relative to the Arithmetic score; in addition, this subtype did not exhibit any appreciable Verbal-Performance discrepancy or the finger agnosia characteristic of the former group. Ackerman et al. (1976) have also described a subgroup of generally disabled (ACID) subjects who were "less retarded" in arithmetic than the rest of the generally disabled group.

Support for the notion of the heterogeneity of LD-ACID children also comes from the clinical literature. For example, in a discussion of the ACID pattern, Rourke (1980) has described two subtypes of children exhibiting this pattern: "(a) one with particularly poor immediate memory for short bursts of non-redundant auditory-verbal information, and (b) another with particularly poor visual imaging capacity" (p. 15; mimeographed prepublication manuscript).

Summary, Caveats, and Conclusions

Literature has been cited which supports the notion that cerebral dysfunction is a valid explanatory model for learning disabilities and that a neuropsychological approach to the study of this group of children is heuristic. A definition of learning disabilities was presented which reflects this view. Evidence which suggests that learning disabilities are a heterogeneous group of clinical disorders was reviewed. On the basis of the review of the literature concerned with the Wechsler Intelligence Scale profiles of LD children, it is evident that LD children as a group generally obtain depressed subtest scores on Information, Arithmetic, Digit Span, and Coding, or on some subset thereof. Studies were reviewed which indicate that children who exhibit the ACID pattern on the Wechsler scales are a heterogeneous group but that meaningful subtypes of LD children might be partially defined by the ACID pattern.

A number of caveats must be raised concerning any generalizations made on the basis of the literature dealing with Wechsler profiles. The research in this area is often flawed by methodological problems which make the replication and generalization of results problematical. For example, many samples differ or are not described with respect to the developmental level, the demographic characteristics, the source (e.g., clinic vs. school), and the criteria employed to select LD subjects. Small sample sizes plague many studies. The use of different statistical treatments and the use of research designs which vary greatly in quality also affect the generalizability of many studies in this area. Nonetheless, the consistency of the findings reported would seem to indicate that certain Wechsler profiles are characteristic of groups of LD children. Herein, however, lies a major weakness of this literature. It is self-evident that mean group profiles may mask two or more profiles of LD subtypes. The failure to recognize this, in a large part, has contributed to the confusion and ambiguity in the literature concerned with the Wechsler profiles of LD children.

The differential score (pattern analysis) approach as a method of analysis in the study of LD children has been described by Rourke (1975, 1978, 1980). A number of patterns have already been investigated in neuropsychological research with LD children, viz. (a) patterns of performance on the Trail Making

Test (Rourke & Finlayson, 1975); (b) patterns of performance on the Wide Range Achievement Test (Rourke & Finlayson, 1978; Rourke & Strang, 1978); and, (c) differential patterns of performance on the WISC Verbal and Performance scales (Rourke, Dietrich, & Young, 1973; Rourke & Telegdy, 1971; Rourke, Young & Flewelling, 1971). The research proposed in the next chapter further exploits the differential score approach in an attempt to demonstrate the neuropsychological heterogeneity of LD children with a particular Wechsler profile, viz. the ACID pattern.

CHAPTER II

STATEMENT OF THE PROBLEM

The Wechsler ACID pattern represents a profile sometimes found in heterogeneous groups of LD children, as well as in some circumscribed LD subgroups. Although it is a clinically meaningful pattern (Rourke, 1980), there have been no published attempts to study LD children who individually demonstrate depressed scores on the ACID subtests. Previous research which has described relatively homogeneous groups of LD children exhibiting this pattern has been limited by the use of small samples. The present study attempts to determine the neuropsychological significance of the ACID pattern for a large group of LD children who individually demonstrate this pattern. The relationship of the ACID pattern to academic performance is also investigated. These goals are accomplished by: (1) statistically generating homogeneous subtypes of LD-ACID children through cluster analytic techniques, (2) interpreting the associated neuropsychological and academic ability profiles of each of the subtypes, and (3) comparing by MANOVA the academic performance of the ACID subtypes to matched groups of LD children who do not exhibit the ACID pattern.

Expectations

Because of the exploratory nature of the present study and the paucity of research involving the ACID pattern, it is difficult to propose well specified hypotheses. However, the literature reviewed above (Ackerman et al.,1976, 1977; Dykman et al., 1980; Petrauskas and Rourke, 1979; Rourke, 1980) suggests that LD-ACID children are not a homogeneous group and that subtypes can be identified. Thus, on the basis of clinical experience and these reports, it seemed reasonable to expect that:

(1) A number of subtypes of LD-ACID children would emerge and that some of them would be similar to those suggested by the literature, viz.,:

(a) a younger group with outstandingly poor reading scores and low average WISC Verbal and Performance IQs (see Ackerman et al., 1977, for reference to this potential subtype);

(b) a group with uniformly depressed reading, spelling, and arithmetic scores, low average WISC FSIQ, and a greater Performance than Verbal IQ (see Ackerman et al., 1976, and Petrauskas and Rourke, 1979, for reference to this potential subtype);

(c) a group with low reading and spelling scores relative to arithmetic, average WISC FSIQ, and no appreciable Verbal-Performance discrepancy (see Ackerman et al., 1976, and Petrauskas and Rourke, 1979 for reference to this potential subtype).

(2) At least one LD-ACID subtype would be characterized by poorer reading, spelling, and arithmetic performance than a matched group of LD children who do not evidence the ACID pattern (see Ackerman et al., 1976, 1977 regarding support for this hypothesis).

(3) Some subtypes would replicate across different age levels (see Fisk and Rourke, 1979, regarding support for this hypothesis).

(4) A subtype composed of younger children with pronounced distractibility, attentional difficulties, and pervasive neuropsychological defects would not replicate at older age levels because of changing ability profiles due to neurodevelopmental factors (e.g., subsided "psychic edema" Rourke, 1981).

CHAPTER III

METHOD

Data Collection

The data reported in this study were culled from a data base exceeding 3200 cases which represents the clinical files of a neuropsychology service in a large, urban children's mental health clinic. The Clinic serves a catchment area consisting of three counties and provides a wide range of multidisciplinary assessment and treatment services to the referred children, adolescents, and families.

Children and adolescents who were referred for neuropsychological assessment because of academic difficulties or other adaptive problems suspected to be largely due to some form of cerebral impairment constitute the subject population for this investigation. Each subject had received a standarized, comprehensive battery of neuropsychological measures, administered in a standardized manner by highly trained psychometrists. See Rourke (1976a, 1976b, 1980) for a description of the assessment procedure and a discussion of the rationale underlying the test selection and this approach to the assessment of LD children.

Because the administration and scoring of the test battery takes approximately 8 hours per subject and due to the relative rarity of LD-ACID children/ adolescents, it was decided to use this well documented and carefully collected data base. It was felt that the advantages of any other approach to data collection would be outweighed substantially by the savings in time and money engendered by the use of this extensive data base.

Subjects

One hundred and eighty-one LD-ACID subjects and an individually matched control group (LD-C) consisting of LD subjects who did not evidence the ACID pattern were selected from the data base. The two groups were divided into two age ranges: 6 – 0 to 8 – 11 and 9 – 0 to 14 – 11. This resulted in the creation of four groups of subjects: Young LD-ACID, Young LD-C, Old LD-ACID, and Old LD-C. The LD-C subjects were matched to the LD-ACID subjects on age, WISC Full Scale IQ, sex, and handedness. The adequacy of the matching of the LD-ACID and the LD-C groups is demonstrated in Table 1. No subject in any of these groups had missing data on more than four of the variables described in the next section.

The clinical files of the subjects (N = 362) were carefully reviewed; each subject selected for the study met the necessary criteria to be classified as learning disabled according to the definition presented above. That is, each subject:

(1) obtained a WISC FSIQ of 80 or greater;

(2) obtained at least one WRAT centile score of 30 or below;

(3) did not evidence any hearing or visual acuity defects (determined from the results of a puretone sweep hearing test, a questionnaire completed by the parents, and visual and auditory screening information, when available, in the child's clinical file);

(4) did not have a history of medically documented cerebral trauma or neurological dysfunction;

(5) spoke English as the primary language in their home (determined from the parent questionnaire);

(6) was not believed to be "culturally, environmentally, or educationally deprived" (determined from the history documented in the child's clinical file);

TABLE 1

Characteristics of the Young and Old LD-ACID and LD-C Groups on the Matched Variables

	Young LD-ACID		Young LD-C		Old LD-ACID		Old LD-C		
SUBJECT COMPOSITION									
Males	54		54		117		117		
Females	5		5		5		5		
Total	59	+	59	+	122	+	122	=	362
HANDEDNESS									
Right	54		54		103		103		
Left	5		5		19		19		
Total	59	+	59	+	122	+	122	=	362
AGE									
Mean	8.24		8.21		10.91		10.88		
S.D.	.55		.57		1.44		1.47		
Range	6.63 - 8.98		6.66 - 8.96		9.07 - 14.88		9.04 - 14.97		
WISC FULL SCALE IQ[a]									
Mean	49.64		49.20		49.20		49.03		
S.D.	5.65		5.41		6.70		6.62		
Range	38.67 - 60.00		38.00 - 61.33		36.67 - 66.00		36.67 - 70.00		

[a] T Scores.

(7) did not evidence any "primary" emotional/behavioural disturbances (determined from the results of a neuropsychological evaluation and the history available in the child's clinical file);

and

(8) was judged by at least two experienced clinical neuropsychologists to be experiencing a central information processing deficiency.

The LD-ACID group met the following additional criteria which were necessary to define a clinically meaningful ACID pattern:

(1a) the subtest scaled scores on Arithmetic, Information, Digit Span less than Comprehension, Similarities, Vocabulary <u>or</u>

(1b) at least two of Arithmetic, Information, and Digit Span less than Comprehension, Similarities, and Vocabulary and the third AID subtest scaled score equal to the lowest of the remaining verbal subtests,

and

(2a) Coding the lowest Performance subtest scaled score <u>or</u>

(2b) Coding the lowest and equal to one other Performance scaled score.

Choice of Variables

One hundred and ten neuropsychological measures (listed in Table 2 and described in Appendix A) were available for children aged 6 — 0 to 8 — 11 (Data Set Young). One hundred and three neuropsychological measures (listed in Table 3 and described in Appendix A) were available for subjects aged 9 — 0 to 14 — 11 (Data Set Old). As specified in Appendix A, some of the measures administered to the younger group were quite different than similar measures administered to the older group, although both sets of measures are thought to tap the same abilities. These differences must be kept in mind when comparing the results obtained for the two groups.

TABLE 2

Neuropsychological Measures - Younger Group

Number	Measure
1.	WISC Full Scale IQ (FSIQ)
2.	WISC Verbal IQ (VIQ)
3.	WISC Performance IQ (PIQ)
4.	WISC Information (INFO)
5.	WISC Comprehension (COMP)*
6.	WISC Arithmetic (ARITH)
7.	WISC Similarities (SIM)*
8.	WISC Vocabulary (VOCB)*
9.	WISC Digit Span: Total (DSPAN)
10.	WISC Digit Span: Forward (DSFOR)
11.	WISC Digit Span: Backward (DSBKWD)
12.	WISC Picture Completion (PICCOM)*
13.	WISC Picture Arrangement (PICARR)*
14.	WISC Block Design (BLKDES)*
15.	WISC Object Assembly (OBASS)*
16.	WISC Coding (DSYM)
17.	Peabody Picture Vocabulary Test Form A: Oral IQ (PPVTIQ)*
18.	Peabody Picture Vocabulary Test Form A: Mental Age (PPVTMA)
19.	WRAT Reading: Standard Score (READSTS)
20.	WRAT Reading: Grade Score (READGRD)
21.	WRAT Reading: Centile Score (READPER)
22.	WRAT Spelling: Standard Score (SPELSTS)
23.	WRAT Spelling: Grade Score (SPELGRD)
24.	WRAT Spelling: Centile Score (SPELPER)
25.	WRAT Arithmetic: Standard Score (ARITHSS)
26.	WRAT Arithmetic: Grade Score (ARITHGD)
27.	WRAT Arithmetic: Centile Score (ARITHPR)
28.	Tactile Perception - Right Hand (TACR)*
29.	Tactile Perception - Left Hand (TACL)*
30.	Auditory Perception - Right (AUDR)*
31.	Auditory Perception - Left (AUDL)*
32.	Visual Perception - Right (VISR)*
33.	Visual Perception - Left (VISL)*
34.	Finger Agnosia - Right (FAGR)*
35.	Finger Agnosia - Left (FAGL)*
36.	Finger-Tip Symbol Writing - Right Hand (FTWRR)*
37.	Finger-Tip Symbol Writing - Left Hand (FTWRL)*

TABLE 2 cont'd

Number	Measure
38.	Tactile Form Recognition - Right Hand (ASTR)*
39.	Tactile Form Recognition - Left Hand (ASTL)*
40.	Target Test (TARGET)*
41.	Sweep Hearing Test - Right Ear (SWEEPR)
42.	Sweep Hearing Test - Left Ear (SWEEPL)
43.	Auditory Closure (AUDCLO)*
44.	Sentence Memory (SENMEM)*
45.	Speech-Sounds Perception Test (SSPER)
46.	Verbal Fluency (FLUENCY)*
47.	Halstead-Wepman Aphasia Screening Test(HWAST): Dysnomia (AST1
48.	HWAST: Dysgraphia (AST3)
49.	HWAST: Dyslexia (AST5)
50.	HWAST: Constructional Dyspraxia (AST6)
51.	HWAST: Dyscalculia (AST7)
52.	HWAST: Body Orientation (AST9)
53.	HWAST: Right-Left Discrimination (AST10)
54.	HWAST: Total Errors (APHASIA)*
55.	Seashore Rhythm Test (SEASHR)
56.	Halstead Category Test: Subtest 1 (CAT1)
57.	Halstead Category Test: Subtest 2 (CAT2)
58.	Halstead Category Test: Subtest 3 (CAT3)
59.	Halstead Category Test: Subtest 4 (CAT4)
60.	Halstead Category Test: Subtest 5 (CAT5)
61.	Halstead Category Test: Total Errors (CATTOT)*
62.	Color Form Test: Time (COLFRMT)*
63.	Color Form Test: Errors (COLFRME)*
64.	Progressive Figures Test: Time (PROFIGT)*
65.	Progressive Figures Test: Errors (PROFIGE)*
66.	Matching Pictures (MATPXT)*
67.	Matching Figures: Time (MFIGT)*
68.	Matching Figures: Errors (MFIGE)*
69.	Matching Vs: Time (MATVT)*
70.	Matching Vs: Errors (MATVE)*
71.	Drawing Star: Time (START)*
72.	Drawing Star: Errors (STARE)
73.	Drawing Concentric Squares: Time (CONSQT)*
74.	Drawing Concentric Squares: Errors (CONSQE)*
75.	Hand Preference - Right (HANDR)
76.	Hand Preference - Left (HANDL)
77.	Foot Preference - Right (FOOTR)
78.	Foot Preference - Left (FOOTL)

TABLE 2 cont'd

Number	Measure
79.	Strength of Grip - Right Hand (DYNR)*
80.	Strength of Grip - Left Hand (DYNL)*
81.	Writing Speed - Right Hand (NAMER)*
82.	Writing Speed - Left Hand (NAMEL)*
83.	Finger Tapping - Right Hand (TAPRH)*
84.	Finger Tapping - Left Hand (TAPLH)*
85.	Maze Test: Time - Right Hand (MAZERT)*
86.	Maze Test: Counter - Right Hand (MAZERC)*
87.	Maze Test: Speed - Right Hand (MAZERS)*
88.	Graduated Holes Test: Time - Right Hand (HOLESRT)*
89.	Graduated Holes Test: Counter - Right Hand (HOLESRC)*
90.	Grooved Pegboard Test: Time - Right Hand (PEGSRT)*
91.	Grooved Pegboard Test: Dropped - Right Hand (PEGSRD)
92.	Maze Test: Time - Left Hand (MAZELT)*
93.	Maze Test: Counter - Left Hand (MAZELC)*
94.	Maze Test: Speed - Left Hand (MAZELS)*
95.	Graduated Holes Test: Time - Left Hand (HOLESLT)*
96.	Graduated Holes Test: Counter - Left Hand (HOLESLC)*
97.	Grooved Pegboard Test: Time - Left Hand (PEGSLT)*
98.	Grooved Pegboard Test: Dropped - Left Hand (PEGSLD)
99.	Tactual Performance Test: Time - Dominant (TPTDT)*
100.	Tactual Performance Test: Blocks - Dominant (TPTDBLK)
101.	Tactual Performance Test: Time - Nondominant (TPTNDT)*
102.	Tactual Performance Test: Blocks - Nondominant (TPTNDBK)
103.	Tactual Performance Test: Time - Both (TPTBT)*
104.	Tactual Performance Test: Blocks - Both (TPTBBLK)
105.	Tactual Performance Test: Memory (TPTMEM)*
106.	Tactual Performance Test: Location (TPTLOC)*
107.	Eye Preference - Right (ABCR)
108.	Eye Preference - Left (ABCL)
109.	Foot Tapping - Right (TAPRF)*
110.	Foot Tapping - Left (TAPLF)*

* Indicates variables used in the principal components and cluster analyses.

TABLE 3

Neuropsychological Measures - Older Group

Number	Measure
1.	WISC Full Scale IQ (FSIQ)
2.	WISC Verbal IQ (VIQ)
3.	WISC Performance IQ (PIQ)
4.	WISC Information (INFO)
5.	WISC Comprehension (COMP)*
6.	WISC Arithmetic (ARITH)
7.	WISC Similarities (SIM)*
8.	WISC Vocabulary (VOCB)*
9.	WISC Digit Span: Total (DSPAN)
10.	WISC Digit Span: Forward (DSFOR)
11.	WISC Digit Span: Backward (DSBKWD)
12.	WISC Picture Completion (PICCOM)*
13.	WISC Picture Arrangement (PICARR)*
14.	WISC Block Design (BLKDES)*
15.	WISC Object Assembly (OBASS)*
16.	WISC Coding (DSYM)
17.	Peabody Picture Vocabulary Test Form A: Oral IQ (PPVTIQ)*
18.	Peabody Picture Vocabulary Test Form A: Mental Age (PPVTMA)
19.	WRAT Reading: Standard Score (READSTS)
20.	WRAT Reading: Grade Score (READGRD)
21.	WRAT Reading: Centile Score (READPER)
22.	WRAT Spelling: Standard Score (SPELSTS)
23.	WRAT Spelling: Grade Score (SPELGRD)
24.	WRAT Spelling: Centile Score (SPELPER)
25.	WRAT Arithmetic: Standard Score (ARITHSS)
26.	WRAT Arithmetic: Grade Score (ARITHGD)
27.	WRAT Arithmetic: Centile Score (ARITHPR)
28.	Tactile Perception - Right Hand (TACR)*
29.	Tactile Perception - Left Hand (TACL)*
30.	Auditory Perception - Right (AUDR)
31.	Auditory Perception - Left (AUDL)
32.	Visual Perception - Right (VISR)*
33.	Visual Perception - Left (VISL)*
34.	Finger Agnosia - Right Hand (FAGR)*
35.	Finger Agnosia - Left Hand (FAGL)*
36.	Finger-Tip Number Writing Perception - Right Hand (FTWRR)*
37.	Finger-Tip Number Writing Perception - Left Hand (FTWRL)*

TABLE 3 cont'd

Number	Measure
38.	Coin Recognition - Right Hand (ASTR)*
39.	Coin Recognition - Left Hand (ASTL)*
40.	Target Test (TARGET)*
41.	Trail Making Test A: Time (TRAILAT)*
42.	Trail Making Test A: Errors (TRAILAE)*
43.	Trail Making Test B: Time (TRAILBT)*
44.	Trail Making Test B: Errors (TRAILBE)*
45.	Sweep Hearing Test - Right Ear (SWEEPR)
46.	Sweep Hearing Test - Left Ear (SWEEPL)
47.	Auditory Closure (AUDCLO)*
48.	Sentence Memory (SENMEM)*
49.	Speech-Sounds Perception Test (SSPER)*
50.	Verbal Fluency (FLUENCY)*
51.	Halstead-Wepman Aphasia Screening Test(HWAST): Dysnomia (AST1)
52.	HWAST: Spelling Dyspraxia (AST2)
53.	HWAST: Dysgraphia (AST3)
54.	HWAST: Dysarthria (AST4)
55.	HWAST: Dyslexia (AST5)
56.	HWAST: Constructional Dyspraxia (AST6)
57.	HWAST: Dyscalculia (AST7)
58.	HWAST: Auditory-Verbal Agrosia (AST8)
59.	HWAST: Total Errors (APHASIA)*
60.	Seashore Rhythm Test (SEASHR)
61.	Halstead Category Test: Subtest 1 (CAT1)
62.	Halstead Category Test: Subtest 2 (CAT2)
63.	Halstead Category Test: Subtest 3 (CAT3)
64.	Halstead Category Test: Subtest 4 (CAT4)
65.	Halstead Category Test: Subtest 5 (CAT5)
66.	Halstead Category Test: Subtest 6 (CAT6)
67.	Halstead Category Test: Total Errors (CATTOT)*
68.	Hand Preference - Right (HANDR)
69.	Hand Preference - Left (HANDL)
70.	Eye Preference - Right (ABCR)
71.	Eye Preference - Left (ABCL)
72.	Foot Preference - Right (FOOTR)
73.	Foot Preference - Left (FOOTL)
74.	Strength of Grip - Right Hand (DYNR)*
75.	Strength of Grip - Left Hand (DYNL)*
76.	Writing Speed - Right Hand (NAMER)*
77.	Writing Speed - Left Hand (NAMEL)*
78.	Finger Tapping - Right Hand (TAPRH)*
79.	Finger Tapping - Left Hand (TAPLH)*

TABLE 3 cont'd

Number	Measure
80.	Maze Test: Time - Right Hand (MAZERT)*
81.	Maze Test: Counter - Right Hand (MAZERC)*
82.	Maze Test: Speed - Right Hand (MAZERS)*
83.	Maze Test: Time - Left Hane (MAZELT)*
84.	Maze Test: Counter - Left Hand (MAZELC)*
85.	Maze Test: Speed - Left Hand (MAZELS)*
86.	Graduated Holes Test: Time - Right Hand (HOLESRT)*
87.	Graduated Holes Test: Counter - Right Hand (HOLESRC)*
88.	Graduated Holes Test: Time - Left Hand (HOLESLT)*
89.	Graduated Holes Test: Counter - Left Hand (HOLESLC)*
90.	Grooved Pegboard Test: Time - Right Hand (PEGSRT)*
91.	Grooved Pegboard Test: Dropped - Right Hand (PEGSRD)
92.	Grooved Pegboard Test: Time - Left Hand (PEGSLT)*
93.	Grooved Pegboard Test: Dropped - Left Hand (PEGSLD)
94.	Tactual Performance Test: Time - Dominant (TPTDT)*
95.	Tactual Performance Test: Blocks - Dominant (TPTDBLK)
96.	Tactual Performance Test: Time - Nondominant (TPTNDT)*
97.	Tactual Performance Test: Blocks - Nondominant (TPTNDBK)
98.	Tactual Performance Test: Time - Both Hands (TPTBT)*
99.	Tactual Performance Test: Blocks - Both Hands (TPTBBLK)
100.	Tactual Performance Test: Memory (TPTMEM)*
101.	Tactual Performance Test: Location (TPTLOC)*
102.	Foot Tapping - Right (TAPRF)*
103.	Foot Tapping - Left (TAPLF)*

* Indicates variables used in the principal components and cluster analyses.

The following measures were not used in the principal components and cluster analyses described below because they were either composites of other measures used (i.e.,summary scores), components of composite measures used (i.e., subtest scores), measures used to validate the subtypes obtained, measures used directly in the selection of the LD-ACID group, or measures for which there were not complete normative data available: WISC FSIQ, VIQ, and PIQ; WRAT Reading, Spelling, and Arithmetic standard, grade, and centile scores; WISC Arithmetic, Coding, Information, and Digit Span subtest scores; Halstead-Wepman Aphasia Screening Test and Halstead Category Test subtest scores (note: total error scores for these two tests were used); Peabody Picture Vocabulary Test — Mental Age; Sweep Hearing Test; Seashore Rhythm Test; Tactual Performance Test — Number of Blocks; Hand, Foot, and Eye Preference.

Data Analyses

Data management. The measures utilized in the present study have already been described. The data were recorded directly onto computer coding sheets from the child's clinical file. The data source was organized, well documented, and completely legible. In some cases the child's file was not entirely complete; in those instances, incomplete information was simply recorded as missing data.

Numerous precautions were taken to ensure the accuracy of the original coding of the data and their transformation into machine readable form. A detailed "code book" was utilized throughout the coding and analyses stages of the present research. Considerable effort was expended to ensure objective, mutually exclusive, and exhaustive coding categories. The excellent reliability of the original coding was demonstrated by the recoding of randomly selected cases. The completed coding sheets were submitted for professional keypunching and verifying. The punched data were then recorded directly onto magnetic tape.

The Statistical Package for Social Sciences (SPSS for OS/360, version H, Release 8.1; Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975) was used to build, edit, document, and analyse the data files utilized in this research and to generate data sets for input into other statistical packages. Extensive editing of the SPSS data files ensured that undefined or spurious codes were not present during the data analyses. Randomly selected cases from the data files were compared to the original coding sheets and were found to be identical for all untransformed variables. Hand calculations from the coding sheets provided results identical to the computer generated transformations. Throughout the present research, transformations to the system files (e.g., the creation of new variables, the deletion of subjects, or the creation of new subfiles) were consistently checked for accuracy before the results of any statistical procedures were accepted as valid.

Data transformation and data reduction. Test scores on each of the measures for which the necessary data were available were converted to *T* scores based on the normative data provided by Jastak and Jastak (1965), Klonoff and Low (1974), Knights (1970), Knights and Moule (1967), and Wechsler (1949). This metric was chosen to avoid artificially high correlations between variables because of positive correlations with age and to express the many different variables in comparable units for ease of comparison between tests. In order to (1) enhance the reliability and interpretability of the subtypes determined in later analyses, (2) reduce redundancy in the variables utilized, and (3) conserve computing resources, the initial analyses involved the reduction of the two age-based data sets (Data Set Young and Data Set Old) through principal components analyses. In addition to the measures listed above, the following measures were omitted from the principal components analyses because of a high frequency of missing values (greater than 10%): Speech-Sounds Perception Test (deleted from Data Set Young only) and Grooved Peg Board Test — number of pegs dropped. The variables utilized in the principal components analyses have been denoted by an asterisk in Tables 2 and 3.

Separate principal components analyses were performed on Data Set Young and Data Set Old; 63 and 54 variables, respectively, were intercorrelated and utilized in these two analyses. The principal components that had associated eigenvalues greater than or equal to 1.0 were retained and rotated orthogonally to varimax criterion (SPSS program FACTOR; Nie et al., 1975). Factor scores based on factor loadings of all variables on a given principal component were generated for each subject in the Young LD-ACID, Old LD-ACID, Young LD-C, and Old LD-C groups; this resulted in the creation of four data matrices consisting of factor scores (matrix Young LD-ACID Factor Scores, matrix Old LD-ACID FS, matrix Young LD-C FS, and matrix Old LD-C FS) which were later subjected to a series of cluster analyses. A conservative method of substituting the population mean was used to determine the factor score whenever a subject had missing data on a variable. In this regard, the number of missing values for the variables utilized in these analyses ranged from 0 to 5.08% for the Young LD-ACID group and from 0 to 3.28% for the Old LD-ACID group.

In addition to the factor score data matrices, four data matrices consisting of T scores on the neuropsychological measures with the two highest loadings on each principal component ("factor representative" variables) were generated (matrix Young LD-ACID T Score, matrix Old LD-ACID TS, matrix Young LD-C TS, and matrix Old LD-C TS). The measures comprising the T score matrices were used to represent the principal components in a number of further analyses.

Figure 1 outlines the creation and composition of the eight data matrices

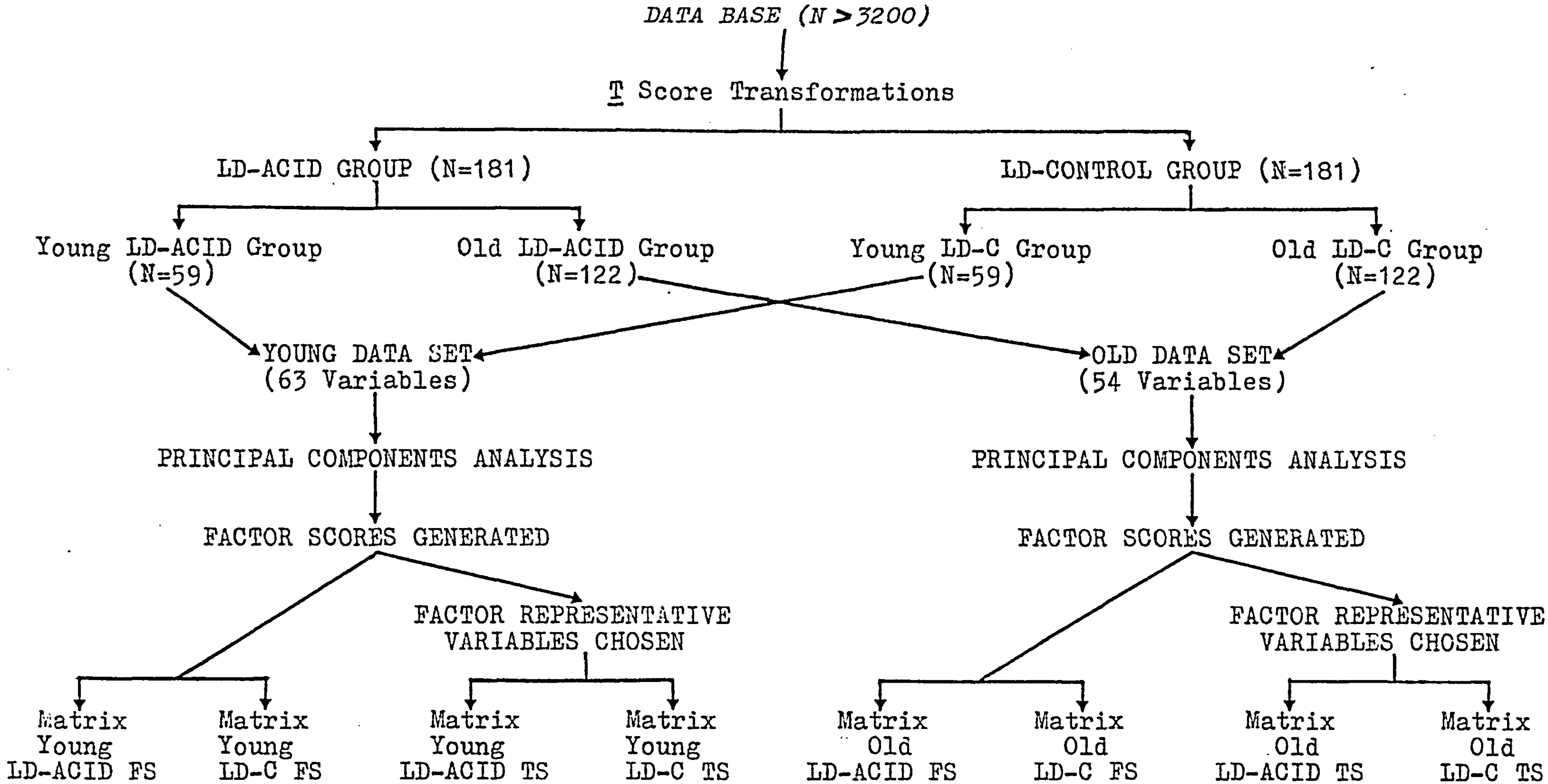


Figure 1. The creation and composition of the factor score and T score matrices.

described thus far.

Removal of 'outliers'. Outliers representing unique individuals or resulting from measurement error are known to affect most clustering procedures (Edelbrock, 1979; Everitt, 1974; Milligan, 1979). Therefore, the frequency distributions for the retained principal components and the two-dimensional mappings of the LD-ACID groups in the space of the first few principal components were inspected for extreme scores. The LD-ACID subjects judged to be outliers and their matched controls were dropped from the eight data matrices described above.

Choice of similarity measure. Since different similarity measures can produce discrepant results even when the same data and clustering algorithms are used (Edelbrock, 1979; Mezzich, 1978), the choice of the similarity measure used in a cluster analysis demands careful consideration. It is generally agreed (Everitt, 1974; Fleiss & Zubin, 1969; Skinner, 1978) that the correlation coefficient, as a measure of similarity, is differentially sensitive to profile shape (pattern) and is inappropriate when profile elevation (level of performance) needs to be emphasized. On the other hand, distance measures are more sensitive to profile elevation.

Because it was felt that the relative patterning of the scores was more important in the search for LD-ACID subtypes, the product-moment correlation coefficient was chosen as the similarity measure for the primary analyses in this research. Some empirical support for this choice can be found in two recent investigations which suggest that the correlation coefficient is a useful similarity measure for discriminating between clinical subtypes and that correlation performs as well if not better (Mezzich, 1978) or better (Edelbrock, 1979) than distance measures when recovering known groupings from artificial data sets. A distance measure, squared Euclidean distance, was used in a series of secondary analyses in an attempt to determine whether the groupings derived from the use of the correlation coefficient could be further subdivided on the basis of profile elevation. This involved clustering (using squared Euclidean distance as the measure of dissimilarity) each of the groupings generated on the basis of profile shape.

Choice of clustering algorithms. As suggested by Everitt (1974) and Mezzich (1978), a two-dimensional mapping of the data distributions was carried out in an attempt to estimate the shape and the number of clusters present in the data. This procedure was thought to be important because different clustering algorithms tend to find clusters of a particular shape (Everitt, 1974). The information gleaned from the plotting of the data matrices Young LD-ACID FS and Old LD-ACID FS (with outliers removed) in the space of the pairs of the first few principal components, however, was equivocal. Therefore, the clustering algorithms utilized in this research were chosen on other grounds.

It is generally accepted that no one clustering technique is "better" than other techniques in all research applications. Different methods of clustering can generate different groupings when applied to the same data set (Blashfield, 1976; Edelbrock, 1979; Everitt, 1974; Hetler, 1977; Mezzich, 1978; Milligan, 1978; Doehring, Hoshko, & Bryans, 1979; Wolfe, 1978). Well structured data, however, could be expected to produce clusters which replicate well across different clustering methods applicable to a particular research problem (Everitt, 1974). Therefore, a decision was made to subject the data to a number of different clustering techniques, including two of the popular hierarchical agglomerative algorithms and an iterative relocation method, in order to ensure that the derived groupings were replicable across different clustering techniques. Because homogeneous groups of subjects were expected, algorithms subject to "chaining" (Everitt, 1974) were excluded as possible clustering procedures.

The following two hierarchical agglomerative methods were chosen on the basis of previous research which has assessed the accuracy of different clustering algorithms (Edelbrock, 1979; Mezzich, 1978) and because of their sensitivity to group structure: the unweighted pair-group method using arithmetic averages of Sokal and Michner (1958) (CLUSTAN, version 1C2, procedure HIERARCHY, method GROUP AVERAGE; Wishart, 1975) and the unweighted pair-group centroid method of Sokal and Michner (1958) (CLUSTAN, version 1C2, procedure CENTROID; Wishart, 1975). These two methods are commonly referred to as group average (or average linkage) and centroid sorting, respectively.

In an attempt to increase the homogeneity, to decrease cluster overlap, and to assess further the stability of the clusters derived by the hierarchical agglomerative analyses, it was decided to apply an iterative relocation procedure (CLUSTAN, version 1C2, procedure RELOCATE; Wishart, 1975) to the part-optimum solutions generated by the group average and centroid sorting methods. In order to assess further the replicability of the generated groupings, the iterative relocation method was also used to cluster a random initial classification of the data matrices.

The CLUSTAN (version 1C2) (Wishart, 1975) computer software package was chosen because of its versatility, reasonably detailed documentation, and increasing familiarity to researchers in the behavioural sciences.

The sequence of cluster analyses. (Step 1.) Similarity matrices utilizing the product-moment correlation coefficient as the similarity criterion were calculated for data matrices Young LD-ACID FS and Old LD-ACID FS. The two similarity matrices were each subjected to group average (AL) and centroid sorting (CS) analyses. The resultant cluster solutions (YOUNG FS-AL, OLD FS-AL, YOUNG FS-CS, & OLD FS-CS) were each subjected to iterative relocation analyses (IR) in order to optimize the solutions derived from the two hierarchical analyses. This resulted in four more cluster solutions, YOUNG FS-AL-IR, OLD FS-AL-IR, YOUNG FS-CS-IR, and OLD FS-CS-IR. Finally, random initial classifications of data matrices Young LD-ACID FS and Old LD-ACID FS into six groups were clustered by the iterative relocation technique [IR(RANDOM)] producing solutions YOUNG FS-IR(RANDOM) and OLD FS-IR(RANDOM). The sequence of cluster analyses described in this section is outlined in Figure 2.

A problem common to all hierarchical clustering methods is in deciding at what stage in the procedure the clustering algorithm should stop generating more clusters, i.e., in deciding how many clusters represent the most appropriate solution (Everitt, 1974). There does not yet appear to be any universally accepted, objective solution to this problem. It has generally been suggested (Everitt, 1974; Wishart, 1975) that a significant "drop" or discontinuity in the clustering coefficient indicates that two dissimilar clusters have been combined to create a relatively heterogeneous cluster. Therefore, for each age group, it was decided to plot the clustering coefficients generated by two different clustering algorithms against the number of clusters. The stopping point in the cluster analyses was then determined by a visual inspection of these plots and an evaluation of the cluster solutions at different levels in the hierarchy.

On the basis of the comparison of the above five clustering methods [AL, CS, AL-IR, CS-IR, & IR(RANDOM)], centroid sorting with iterative relocation (CS-IR) was chosen as the "best" procedure and was used in all of the remaining analyses. From this point, the adequacy of different cluster solutions was always interpreted with reference to the classifications generated by the FS-CS-IR solutions.

(Step 2.) In order to assess the replicability of the clusters in the

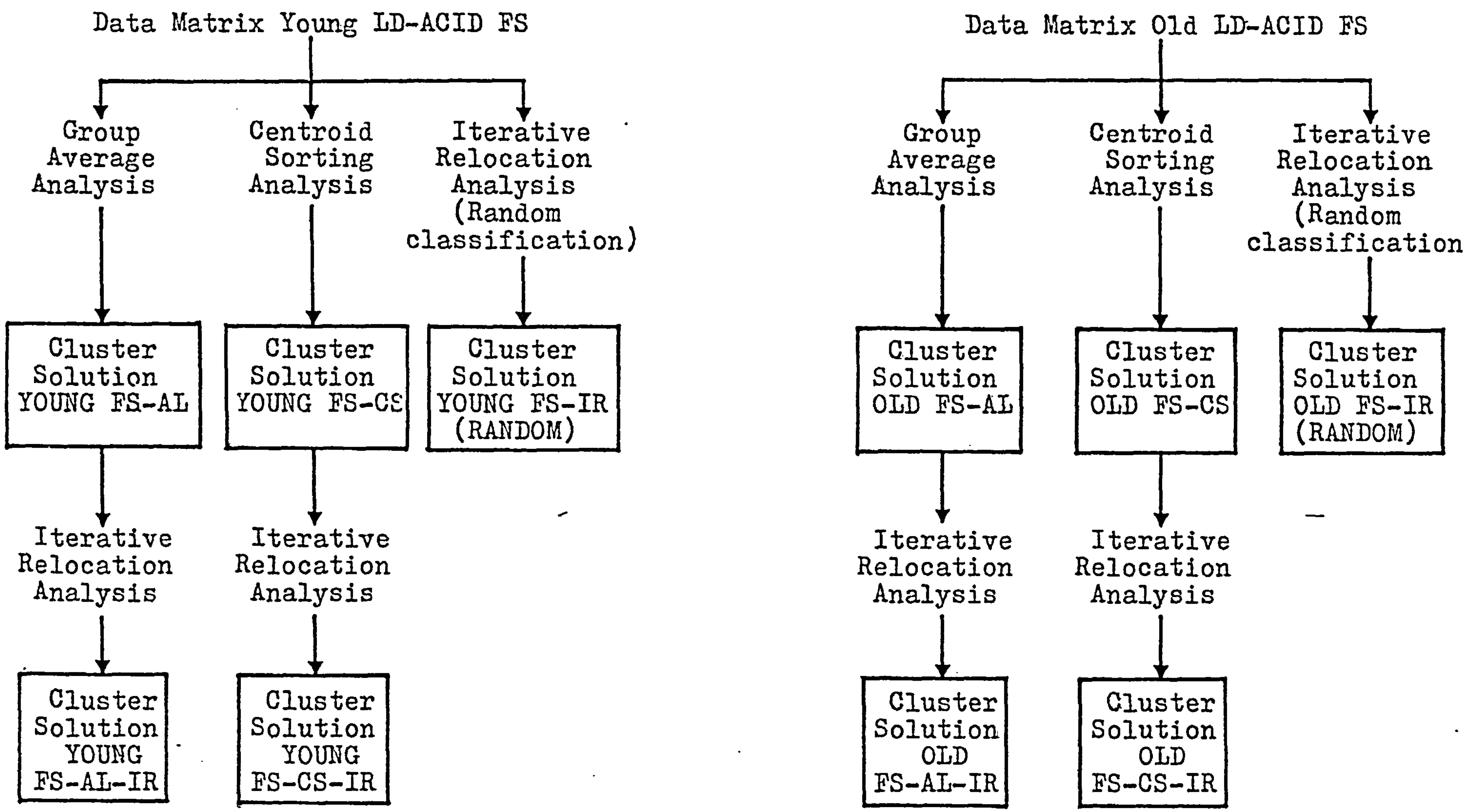


Figure 2. Sequence of cluster analyses: Step 1.

face of changes to the input data set, product-moment similarity matrices were calculated for data matrices Young LD-ACID TS and Old LD-ACID TS and were then each subjected to CS and CS-IR analyses. This produced terminal cluster solutions YOUNG TS-CS-IR and OLD TS-CS-IR. Inspection of the means and standard deviations of the "factor representative" variables in matrices Young LD-ACID TS and Old LD-ACID TS, however, revealed variances of quite different magnitudes (see Tables 12 and 14, Results section). Because similarity measures are biased towards variables which have large variances (Wishart, 1975), the validity of using solutions derived from matrices Young LD-ACID TS and Old LD-ACID TS as indices of cluster stability was considered to be problematical. Therefore, an additional approach was devised to evaluate the stability of the classifications generated in Step 1 in response to changes in the clustering variables.

Factor scores representing principal components which, in the opinion of the author, had little clinical utility were deleted from matrices Young LD-ACID FS and Old LD-ACID FS. This resulted in the creation of two new data matrices, Young LD-ACID FS^- and Old LD-ACID FS^-. These matrices were subjected to CS-IR clustering producing cluster solutions YOUNG FS^--CS-IR and OLD FS^--CS-IR. The sequence of cluster analyses described in this section is outlined in Figure 3.

(Step 3.) In an attempt to generate further clusters on the basis of profile elevation, distance matrices utilizing squared Euclidean distance as the dissimilarity measure were calculated for each of the cluster solutions produced by CS-IR analysis in Step 1.

Cluster replicability and subtype validation. No universal, objective criterion yet exists to evaluate the accuracy and stability of the subtype structure generated by automatic multidimensional classification procedures such as cluster analysis. However, well structured data could be expected to stand

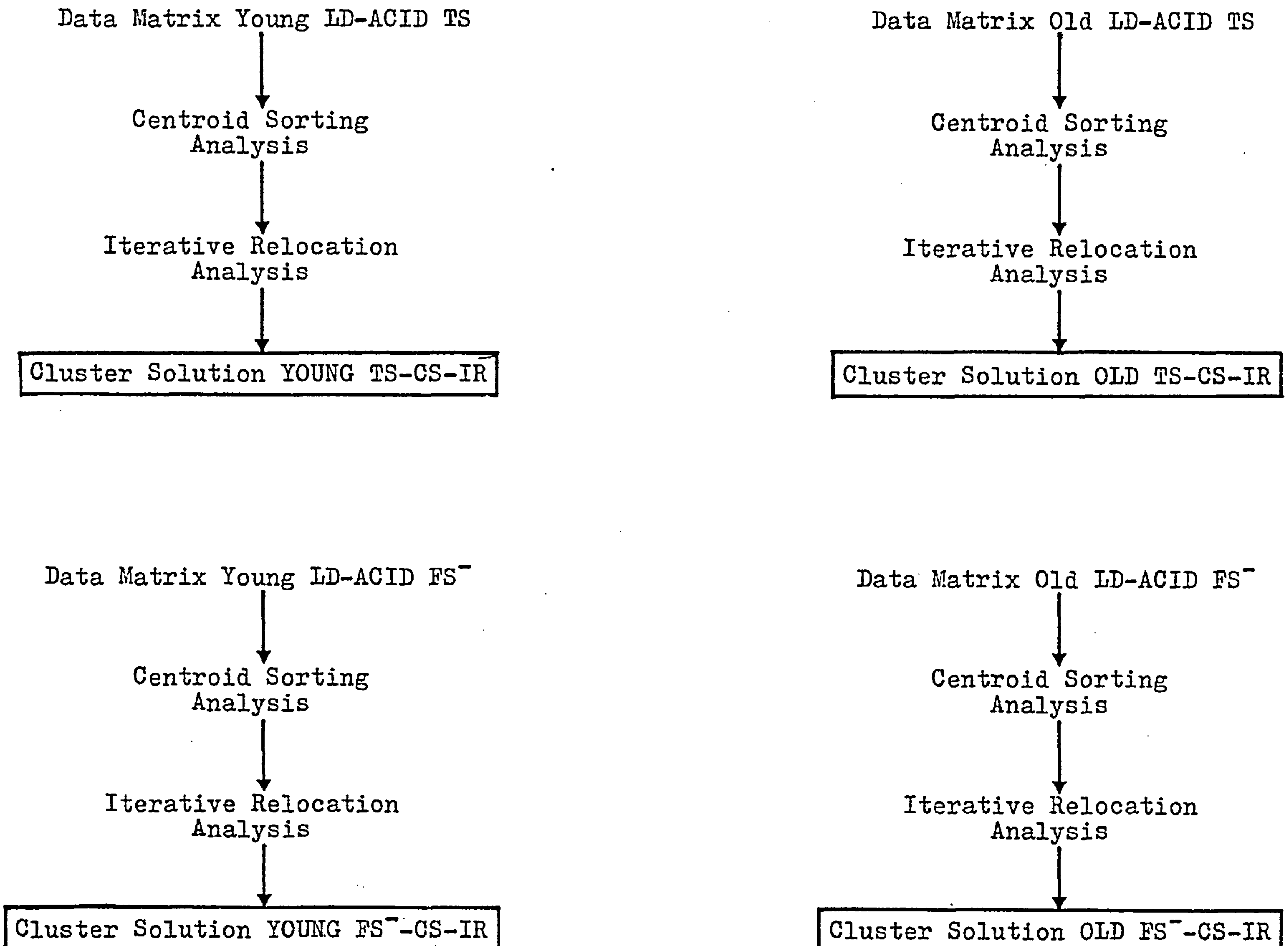


Figure 3. Sequence of cluster analyses: Step 2.

up well to different clustering methods and to manipulations of the input data set (e.g., changes in the subjects or variables clustered), while unstructured data or data containing only poorly defined groups could be expected to show great variability in response to these treatments.

In light of these considerations, the stability of the clusters generated by solutions YOUNG FS-CS-IR and OLD FS-CS-IR was assessed by determining the replicability of these groupings across the clustering methods and the data matrices described above. That is, the replicability of the classification generated by cluster solution YOUNG FS-CS-IR was assessed across cluster solutions YOUNG FS-AL, YOUNG FS-CS, YOUNG FS-AL-IR, YOUNG FS-IR(RANDOM), YOUNG TS-CS-IR, and YOUNG FS^{-}-CS-IR, while the replicability of the classification generated by cluster solution OLD FS-CS-IR was assessed across cluster solutions OLD FS-AL, OLD FS-CS, OLD FS-AL-IR, OLD FS-IR(RANDOM), OLD TS-CS-IR, and OLD FS^{-}-CS-IR. Although Wishart (1975) recommends the clustering of a random classification of the data as a check on the acceptability of a classification obtained by an iterative relocation procedure, it is debatable whether this represents a true replication of a cluster solution.

The next step was to further establish the consensual validity of the LD-ACID clusters by determining if these clusters would remain well-defined when data from the LD-ACID subjects were pooled with the data from the LD-C sample. Therefore, combined data sets consisting of the factor scores of all the LD-ACID subjects and their matched controls (i.e., matrices Young LD-ACID FS + Young LD-C FS and matrices Old LD-ACID FS + Old LD-C FS) were subjected to CS-IR clustering. It was thought that clinically meaningful LD-ACID subtypes should be distinguished by cluster analysis from subtypes of LD-C children.

A number of authors (Blashfield, 1980; Fleiss et al., 1971; Satz & Morris, 1980) have stressed that the validity of a cluster solution should be assessed in terms of variables independent of those used in the cluster analysis. That is, groups determined from a cluster analysis should differ with respect to variables not used in the actual classification. In this regard, multivariate analysis of variance, ANOVAs (SAS, program GLM; Helwig & Council, 1974), and Newman-Keuls tests (SPSS, program ONEWAY; Nie et al., 1975) were used to assess the validity of the subtypes generated in this research by comparing the LD-ACID clusters to their matched controls and by evaluating intercluster differences on the subtests of the WRAT.

Finally, in order to visually display the differences between the derived clusters, mean factor score profiles were plotted graphically for each of the clusters generated by cluster solutions YOUNG FS-CS-IR and OLD FS-CS-IR. Neuropsychological interpretation of the mean _T_ score test profiles of these clusters and comparisons to the groups of LD-ACID subjects described in the literature were also used to assess the meaningfulness of the LD-ACID clusters generated in this study.

CHAPTER IV

RESULTS

The results are discussed as follows: (1) data reduction; (2) the different data matrices subjected to cluster analyses; (3) cluster analysis solutions; (4) subtype validation.

Data Reduction

Data Set Young. The means, standard deviations, and number of nonmissing cases for the 63 variables comprising Data Set Young (groups Young LD-ACID + Young LD-Control) are presented in Table 4. Nineteen factors with eigenvalues greater than or equal to one were extracted when principal components analysis with varimax rotation was applied to this data set. These factors accounted for 76.3% of the common variance. The eigenvalues, proportion of total variance, and cumulative proportion of total variance for the 19 factors are presented in Table 5. The variables with loadings greater than |.55| on the retained factors are presented in Table 6; the only exceptions to this are the two highest loadings on factor 19 which did not reach this level. The varimax rotated factor matrix (terminal solution) for Data Set Young is contained in Appendix B.

Data Set Old. The means, standard deviations, and number of nonmissing cases for the 54 variables comprising Data Set Old (groups Old LD-ACID + Old LD-C) are presented in Table 7. Sixteen factors with eigenvalues greater than or equal to one were extracted by principal components analysis with varimax rotation. These factors accounted for 68.1% of the common variance in Data Set Old. Table 8 contains the eigenvalues, proportion of total variance, and cumulative proportion of total variance for the 16 retained factors. The variables

TABLE 4

T Score Means and Standard Deviations for Variables Comprising Data Set Young

VARIABLE	MEAN	STANDARD DEV	CASES
CATTOT	47.4781	11.1768	118
APHASIA	42.1116	12.1232	117
TACR	51.0954	11.9582	117
TACL	50.6683	13.5496	117
AUDR	48.1613	14.2991	118
AUDL	50.0985	12.5069	118
VISR	47.9990	15.4272	117
VISL	48.0760	15.5258	117
FAGR	44.3305	18.9217	118
FAGL	44.0718	16.3431	118
FTWRR	46.3651	16.6357	118
FTWRL	48.6956	12.5765	118
ASTR	50.5180	9.0340	118
ASTL	51.0834	6.0631	118
NAMER	48.3333	11.2727	118
NAMEL	45.5971	11.0322	118
MAZERT	46.0426	12.4082	118
MAZERC	46.5164	13.6758	118
MAZERS	39.1389	18.5552	118
MAZELT	40.4660	13.7264	118
MAZELC	40.2793	15.4050	118
MAZELS	41.3954	14.9511	118
HOLESRT	43.5053	14.7249	118
HOLESRC	41.7276	18.9032	118
HOLESLT	38.9590	19.5037	118
HOLESLC	37.8509	19.6227	118
PEGSRT	49.8379	10.8333	118
PEGSLT	49.0577	10.3365	118
TPTDT	49.7468	6.2833	118
TPTNDT	48.0718	22.9615	118
TPTBT	45.8230	12.5865	118
MFIGT	54.4802	6.0403	118
MFIGE	48.0968	10.8686	118
START	47.1309	12.0124	118
MATVT	51.1544	8.7371	118
MATVE	41.6162	13.7534	118
CONSQT	49.0612	10.5120	118
CONSQE	32.7531	13.9235	118
PROFIGT	45.9670	13.4044	117
PROFIGE	58.1828	17.0782	117
COLFRMT	39.9608	19.6184	116
COLFRME	43.7210	23.7771	116
MATPXT	46.0942	14.2078	118
COMP	51.8554	8.6215	118
SIM	54.1634	9.6108	118
VOCB	52.0487	8.5922	118
PICCOM	53.1521	9.9734	118
PICARR	51.7707	9.9903	118
BLKDES	52.4459	8.6857	118
OBASS	51.6576	8.7656	118
PPVTIQ	50.0135	9.7492	118
AUDCLO	47.8983	11.5015	115
SENMEM	33.0058	13.9496	117
FLUENCY	29.5513	11.1562	117
TAPRH	52.7912	15.1692	118
TAPLH	52.5163	15.2689	118
TAPRF	39.6275	8.6496	118
TAPLF	37.5048	9.0073	118
DYNR	60.8765	9.5403	118
DYNL	61.3455	10.1021	118
TPTMEM	47.2403	9.7213	118
TPTLOC	43.7582	9.0094	118
TARGET	38.5727	13.4175	116

TABLE 5

Principal Components Analysis Solution for Data Set Young

Factor	Eigenvalue	Percent of Variance	Cumulative Percent
1	12.29037	19.5	19.5
2	5.76551	9.2	28.7
3	3.60126	5.7	34.4
4	3.00967	4.8	39.2
5	2.53773	4.0	43.2
6	2.19657	3.5	46.7
7	2.03189	3.2	49.9
8	1.85266	2.9	52.8
9	1.76912	2.8	55.6
10	1.71416	2.7	58.4
11	1.56594	2.5	60.8
12	1.48983	2.4	63.2
13	1.34984	2.1	65.4
14	1.30364	2.1	67.4
15	1.20635	1.9	69.3
16	1.18736	1.9	71.2
17	1.12852	1.8	73.0
18	1.05687	1.7	74.7
19	1.01370	1.6	76.3

TABLE 6

Retained Factors with Variable Loadings:
Data Set Young

Factor 1	
.60001	Maze Test: Time - Right Hand
.64639	Maze Test: Counter - Right Hand
.62874	Maze Test: Time - Left Hand
.70088	Maze Test: Counter - Left Hand
.86824	Graduated Holes Test: Time - Right Hand
.90206	Graduated Holes Test: Counter - Right Hand*
.88337	Graduated Holes Test: Time - Left Hand
.88907	Graduated Holes Test: Counter - Left Hand*
Factor 2	
.69119	WISC Comprehension
.75919	WISC Similarities*
.72829	WISC Vocabulary*
Factor 3	
.56066	Tactile Perception - Left Hand
.73273	Auditory Perception - Left
.87855	Visual Perception - Right*
.70290	Visual Perception - Left*
Factor 4	
.84327	Grooved Pegboard Test: Time - Right Hand*
.76037	Grooved Pegboard Test: Time - Left Hand*
Factor 5	
-0.77479	Maze Test: Speed - Right Hand*
-0.83100	Maze Test: Speed - Left Hand*
.55255	Matching Figures - Time
Factor 6	
.80370	Progressive Figures Test: Time*
.59060	Progressive Figures Test: Errors
.62699	Matching Pictures*
Factor 7	
.64992	Tactual Performance Test: Memory*
.83349	Tactual Performance Test: Location*
Factor 8	
.78694	Finger Tapping - Right Hand*
.82784	Finger Tapping - Left Hand*

TABLE 6 cont'd

Factor 9	
.88384	Strength of Grip - Right Hand*
.87204	Strength of Grip - Left Hand*
Factor 10	
.55440	Halstead Category Test: Total Errors
.74546	WISC Block Design*
.69201	WISC Object Assembly*
Factor 11	
.81306	Finger-Tip Symbol Writing - Right Hand*
.74727	Finger-Tip Symbol Writing - Left Hand*
Factor 12	
.78424	Finger Agnosia - Right*
.71428	Finger Agnosia - Left*
Factor 13	
.90662	Color Form Test - Time*
.82196	Color Form Test - Errors*
Factor 14	
.84736	Writing Speed - Right Hand*
.89035	Writing Speed - Left Hand*
Factor 15	
.76350	Foot Tapping - Right*
.78684	Foot Tapping - Left*
Factor 16	
.83898	Drawing Concentric Squares: Time*
-0.60723	Drawing Concentric Squares: Errors*
Factor 17	
.59561	Auditory Perception - Right*
.52707	WISC Picture Completion*
Factor 18	
.56929	Matching Vs: Time*
Factor 19	
.47367	Tactile Perception - Right
-0.42988	Drawing Star: Time

* Indicates "factor representative" variables.

TABLE 7

T Score Means and Standard Deviations for Variables Comprising Data Set Old

VARIABLE	MEAN	STANDARD DEV	CASES
CATTOT	48.5230	13.8175	243
APHASIA	27.0115	15.2860	244
TACR	43.8834	14.7065	244
TACL	52.6569	11.1721	244
VISR	48.1637	26.7289	243
VISL	40.4715	40.3658	243
FAGR	35.5402	32.3120	244
FAGL	39.2808	24.8838	244
FTWRR	37.3190	31.6096	243
FTWRL	35.4285	35.9377	243
ASTP	43.1195	13.6274	243
ASTL	43.5668	13.9788	243
NAMER	46.4687	13.0149	243
NAMEL	45.4937	10.5702	243
MAZERT	43.3967	19.6169	244
MAZERC	50.8232	13.1005	244
MAZERS	36.7131	15.3292	243
MAZELT	37.7791	42.0232	244
MAZELC	43.8409	15.4301	244
MAZELS	38.3505	13.2766	243
HOLESRT	45.0546	14.1260	243
HOLESRC	52.5560	9.9280	243
HOLESLT	40.6024	15.0323	242
HOLESLC	52.5874	9.2854	243
PEGSRT	43.3547	15.6880	243
PEGSLT	41.7409	19.3991	243
TPTDT	50.6879	10.0779	243
TPTNDT	47.8580	14.4154	243
TPTBT	44.9929	19.4592	243
SSPER	32.4895	19.7681	242
TRAILAT	42.2311	13.0694	243
TRAILAE	46.0992	17.1009	243
TRAILBT	36.1798	20.2708	242
TRAILBE	43.8294	17.4116	234
COMP	50.0810	8.3526	244
SIM	52.8542	7.4195	244
VOCB	50.4226	7.3361	244
PICCOM	54.3023	10.4456	244
PICARR	52.1166	9.0381	244
BLKDES	52.8679	9.0702	244
OBASS	54.4526	10.4020	244
PPVTIQ	53.1425	39.4235	243
AUDCLU	43.5129	11.0867	235
SENMEM	36.7336	11.8794	236
FLUENCY	26.0003	12.9880	236
TAPRH	48.6791	11.5648	244
TAPLH	48.3885	10.6358	244
TAPRF	42.8281	9.5734	242
TAPLF	41.7206	10.5890	242
DYNR	68.0219	12.3806	242
DYNL	66.5169	11.7414	242
TPTMEM	50.9306	10.0991	242
TPTLOC	47.6952	12.6356	242
TARGET	41.9344	12.4199	243

TABLE 8

Principal Components Analysis Solution for Data Set Old

Factor	Eigenvalue	Percent of Variance	Cumulative Percent
1	7.95204	14.7	14.7
2	4.01239	7.4	22.2
3	2.94804	5.5	27.6
4	2.49988	4.6	32.2
5	2.41252	4.5	36.7
6	2.12669	3.9	40.7
7	1.93536	3.6	44.2
8	1.85234	3.4	47.7
9	1.79289	3.3	51.0
10	1.55826	2.9	53.9
11	1.50325	2.8	56.7
12	1.43517	2.7	59.3
13	1.30789	2.4	61.7
14	1.20742	2.2	64.0
15	1.17303	2.2	66.1
16	1.08270	2.0	68.1

with loadings greater than |.55| on the 16 factors are presented in Table 9. Appendix C contains the varimax rotated factor matrix (terminal solution) for Data Set Old.

Data Matrices

The factor score means and standard deviations for data matrices Young LD-ACID FS and Old LD-ACID FS are presented in Tables 10 and 11, respectively. Inspection of these tables reveals standard deviations of approximately the same magnitude for all variables.

With a few exceptions, the neuropsychological measures with the two highest loadings on each factor were chosen to be "factor representative" variables (denoted by an asterisk in Tables 6 and 9); the values of these variables became the columns of data matrices Young LD-ACID TS, Young LD-C TS, Old LD-ACID TS, and Old LD-C TS. The exceptions to the use of the measures with the two highest loadings occurred when both measures represented performance with the same extremity. In these cases, two equivalent measures representing the right and left extremities were chosen to reflect performance on the two sides of the body; it was thought that these data would be more meaningful in the search for LD-ACID subtypes. The T score means and standard deviations of the variables comprising data matrices Young LD-ACID TS and Old LD-ACID TS are presented in Tables 12 and 13, respectively.

As indicated in Tables 12 and 13, the standard deviations and hence the variances of the factor representative variables were of quite different magnitudes. Since this could create potential problems for a cluster analysis (Wishart, 1975), it was decided not to rely on the use of the T score matrices as the sole variable manipulation procedure.

Therefore, data matrices Young LD-ACID FS and Old LD-ACID FS were altered

TABLE 9

Retained Factors with Variable Loadings:
Data Set Old

Factor 1	
.77909	Maze Test: Time - Right Hand
.78210	Maze Test: Counter - Right Hand*
.65716	Maze Test: Counter - Left Hand*
.58139	Grooved Pegboard Test: Time - Right Hand
.60966	Grooved Pegboard Test: Time - Left Hand
Factor 2	
.78714	Graduated Holes Test: Time - Right Hand
.86284	Graduated Holes Test: Counter - Right Hand*
.77343	Graduated Holes Test: Time - Left Hand
.84914	Graduated Holes Test: Counter - Left Hand*
Factor 3	
.66337	Halstead-Wepman Aphasia Screening Test: Total Errors
.60800	WISC Similarities*
.75507	WISC Vocabulary*
.60607	Sentence Memory
Factor 4	
.55116	Tactual Performance Test: Time - Both Hands
.77278	Tactual Performance Test: Memory*
.78188	Tactual Performance Test: Location*
Factor 5	
.57039	WISC Block Design*
.73334	WISC Object Assembly*
Factor 6	
.91801	Strength of Grip - Right Hand*
.91328	Strength of Grip - Left Hand*
Factor 7	
.75795	Foot Tapping - Right*
.73374	Foot Tapping - Left*
Factor 8	
.83588	Finger-Tip Number Writing Perception - Right Hand*
.83898	Finger-Tip Number Writing Perception - Left Hand*

TABLE 9 cont'd

Factor 9	
.78149	Trail Making Test B: Time*
.89032	Trail Making Test B: Errors*
Factor 10	
.79712	Finger Tapping - Right*
.79556	Finger Tapping - Left*
Factor 11	
.86045	Writing Speed - Right Hand*
.82287	Writing Speed - Left Hand*
Factor 12	
.66157	Finger Agnosia - Right*
.81876	Finger Agnosia - Left*
Factor 13	
.87218	Maze Test: Speed - Right Hand*
.87005	Maze Test: Speed - Left Hand*
Factor 14	
.55140	Tactile Perception - Right
.63841	Visual Perception - Right*
.67108	Visual Perception - Left*
Factor 15	
.82998	Coin Recognition - Right Hand*
.84151	Coin Recognition - Left Hand
Factor 16	
.66460	Trail Making Test A: Time*
.71499	Trail Making Test A: Errors*

* Indicates "factor representative" variables

TABLE 10

Factor Score Means and Standard Deviations
for Data Matrix Young LD-ACID FS

Factor	Mean	Standard Deviation
1	0.0188	0.8131
2	0.1881	0.8428
3*	-0.0092	0.8991
4	-0.0196	0.7923
5	0.0593	0.9296
6	0.0954	0.7431
7	0.0895	0.9788
8	-0.1153	1.0697
9	-0.1771	0.6876
10	0.2777	0.9906
11	-0.1275	1.0559
12	-0.0457	1.1536
13	-0.0437	0.8708
14*	-0.1051	1.1116
15	-0.1730	1.0623
16	-0.0075	1.0498
17	-0.0321	1.0205
18*	-0.1335	0.8684
19*	-0.2463	1.0561

* Indicates factors deleted to form matrix Young LD-ACID FS$^-$.

TABLE 11

Factor Score Means and Standard Deviations
for Data Matrix Old LD-ACID FS

Factor	Mean	Standard Deviation
1	-0.0830	0.7938
2	-0.0550	0.9292
3	0.0800	0.8907
4	-0.0243	0.9714
5	0.4365	0.8512
6	-0.0794	0.9687
7*	0.0003	0.9618
8	-0.1152	1.1067
9	-0.0343	0.9107
10	0.1103	0.8457
11*	-0.1989	0.9744
12	-0.0289	0.8424
13	-0.0871	1.0669
14*	-0.0018	0.9819
15	0.1555	0.9929
16	-0.1444	0.9176

* Indicates factors deleted to form matrix Old LD-ACID FS7.

TABLE 12

T Score Means and Standard Deviations for Data Matrix Young LD-ACID TS: "Factor Representative" Variables

Factor	Variable[a]	Mean	Standard Deviation
1	HOLESRT	41.8797	15.7015
	HOLESLT	35.8247	17.5972
2	SIM	55.6362	7.5596
	VOCB	54.6665	6.9859
3	VISR	47.4163	14.8457
	VISL	47.9847	12.5046
4	PEGSRT	49.9907	8.5342
	PEGSLT	49.1325	9.4552
5	MAZERS	38.2517	17.0013
	MAZELS	40.1872	14.5593
6	PROFIGT	46.3325	10.3995
	MATPXT	46.4266	11.5059
7	TPTMEM	48.7876	6.3139
	TPTLOC	44.4728	8.6625
8	TAPRH	52.3720	16.1593
	TAPLH	50.5228	15.1447
9	DYNR	59.9192	6.0471
	DYNL	59.8784	6.5614
10	BLKDES	54.4847	8.4916
	OBASS	53.7575	7.7787
11	FTWRR	43.7879	19.4171
	FTWRL	47.6211	12.5914
12	FAGR	43.2000	20.1489
	FAGL	42.0909	18.4011

TABLE 12 cont'd

Factor	Variable[a]	Mean	Standard Deviation
13	COLFRMT	40.1744	16.8812
	COLFRME	42.6335	20.8867
14	NAMER	46.9128	12.3643
	NAMEL	44.5701	11.4559
15	TAPRF	38.0207	8.5609
	TAPLF	36.0097	8.5044
16	CONSQE	33.0453	13,4126
	CONSQT	47.7004	11.7342
17	AUDR	47.7814	16.6502
	PICCOM	53.9392	8.6324
18	MATVT	49.9904	8.0703

[a] Abbreviations as listed in Table 2. These variables have also been indicated in Table 7.

TABLE 13

T Score Means and Standard Deviations for Data Matrix Old LD-ACID TS: "Factor Representative" Variables

Factor	Variable[a]	Mean	Standard Deviation
1	MAZERC	50.0548	12.8115
	MAZELC	43.1282	15.5373
2	HOLESRC	52.0687	9.2640
	HOLESLC	51.7967	8.5698
3	SIM	54.2367	6.4772
	VOC	51.9204	6.3688
4	TPTMEM	51.5224	10.2202
	TPTLOC	48.6602	13.0598
5	BLKDES	53.9826	9.0731
	OBASS	56.4967	9.9768
6	DYNR	67.5502	12.7128
	DYNL	66.1009	11.4076
7	TAPRF	42.8935	9.4362
	TAPLF	41.2887	10.2186
8	FTWRR	39.5811	25.6718
	FTWRL	35.9876	26.4411
9	TRAILBT	34.5852	21.2198
	TRAILBE	44.3292	15.4599
10	TAPRH	49.5479	11.1772
	TAPLH	48.1966	8.8995
11	NAMER	44.5299	13.8939
	NAMEL	43.9571	10.9183
12	FAGR	35.8255	17.0091
	FAGL	37.4079	15.2003

TABLE 13 cont'd

Factor	Variable[a]	Mean	Standard Deviation
13	MAZERS	35.5593	32.7374
	MAZELS	39.7909	22.8605
14	VISR	51.0952	18.6310
	VISL	41.7015	31.5936
15	ASTR	44.6781	13.6089
	ASTL	44.6145	14.6079
16	TRAILAT	46.1778	16.6354
	TRAILAE	41.2994	13.6184

[a] Abbreviations as listed in Table 3. These variables have also been indicated in Table 10.

by reducing the number of factors they contained. Factors 3, 14, 18, and 19 were chosen to be deleted from matrix Young LD-ACID FS because, in the opinion of the author, the variables which had high loadings on these factors (see Table 6) were of relatively little clinical utility; likewise factors 7, 11, and 14 were deleted from matrix Old LD-ACID FS. The factor score means and standard deviations of the resultant matrices (Young LD-ACID FS^- and Old LD-ACID FS^-) can be determined from Tables 10 and 11, respectively.

Four subjects in each of the two LD-ACID groups were considered to be outliers; these subjects and their matched controls were dropped from the data matrices described above. The composition of the LD-ACID and LD-C groups and revised statistics relating to sex, handedness, age, and WISC Full Scale IQ are presented in Table 14.

The scatter plots of matrices Young LD-ACID FS and Old LD-ACID FS in the space of the pairs of the first three principal components are presented in Appendix D. Inspection of these scatter plots does not provide any clear indications of the shapes or the number of clusters in the data. Therefore, as described in the previous chapter, the clustering methods utilized in this research were chosen on the basis of other considerations.

Cluster Analysis Solutions

The hierarchical trees (dendrograms) summarizing cluster solutions YOUNG FS-AL, YOUNG FS-CS, OLD FS-AL, and OLD FS-CS are presented in Figures 4, 5, 6, and 7, respectively; these figures demonstrate clearly that the data is structured. The corresponding plots of the clustering coefficients against the number of clusters are presented in Figures 8, 9, 10, and 11, respectively. Inspection of the dendrograms and the latter figures led to a decision to utilize the four-cluster groupings at each of the two age levels as the terminal

TABLE 14

Characteristics of the Young and Old LD-ACID and LD-C Groups
with Outliers Removed

	Young LD-ACID		Young LD-C		Old LD-ACID		Old LD-C		
SUBJECT COMPOSITION									
Males	51		51		113		113		
Females	4		4		5		5		
Total	55	+	55	+	118	+	118	=	346
HANDEDNESS									
Right	51		51		101		101		
Left	4		4		17		17		
Total	55	+	55	+	118	+	118	=	346
AGE									
Mean	8.26		8.23		10.94		10.92		
S.D.	.52		.54		1.44		1.47		
Range	6.73 - 8.98		6.84 - 8.96		9.07 - 14.88		9.04 - 14.97		
WISC FULL SCALE IQ[a]									
Mean	49.37		49.01		49.25		49.10		
S.D.	5.67		5.51		6.74		6.64		
Range	38.67 - 60.00		38.00 - 61.33		36.67 - 66.00		36.67 - 70.00		

[a] T Scores.

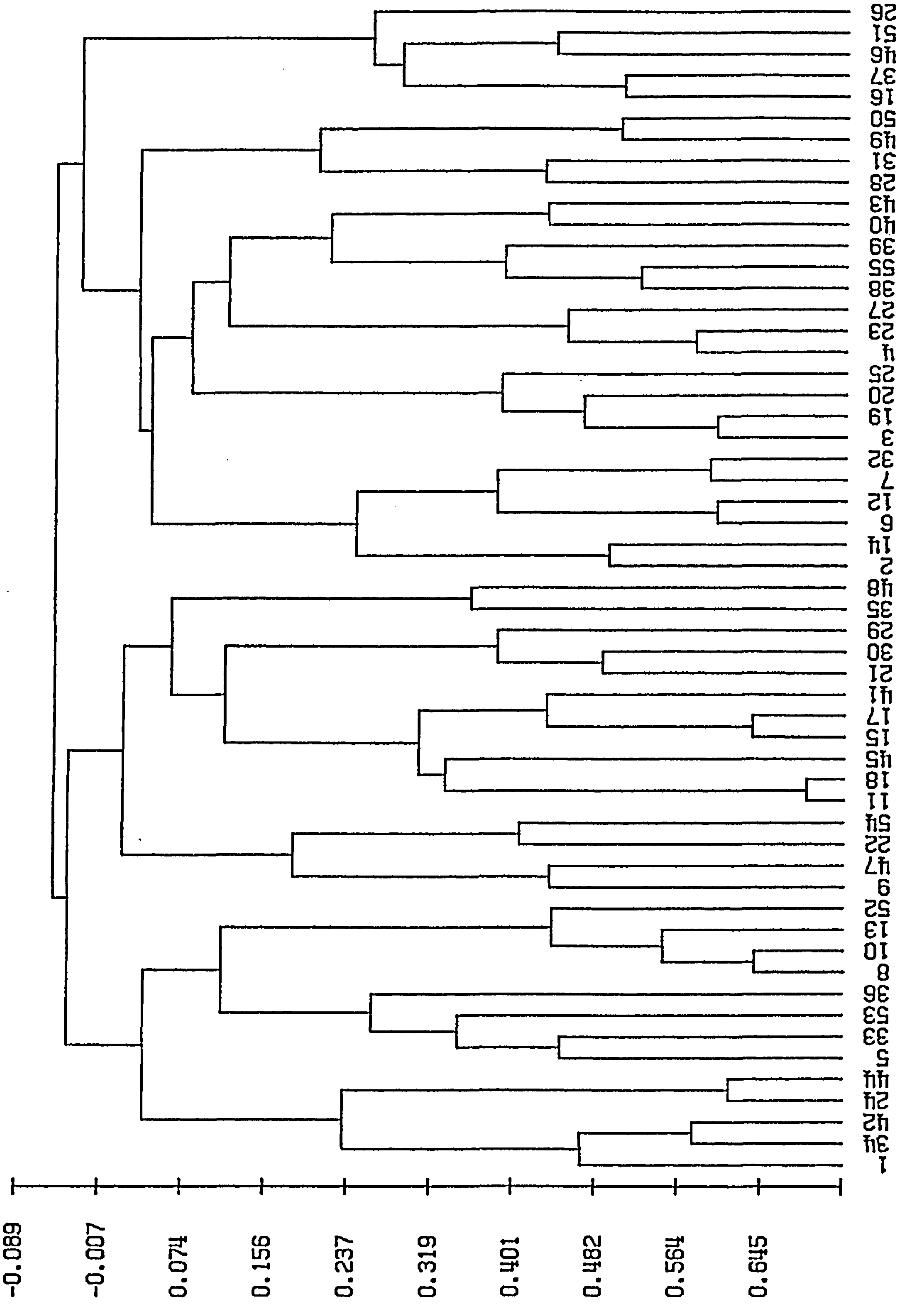


FIGURE 4. GROUP AVERAGE ANALYSIS OF YOUNG LD-ACID SUBJECTS.

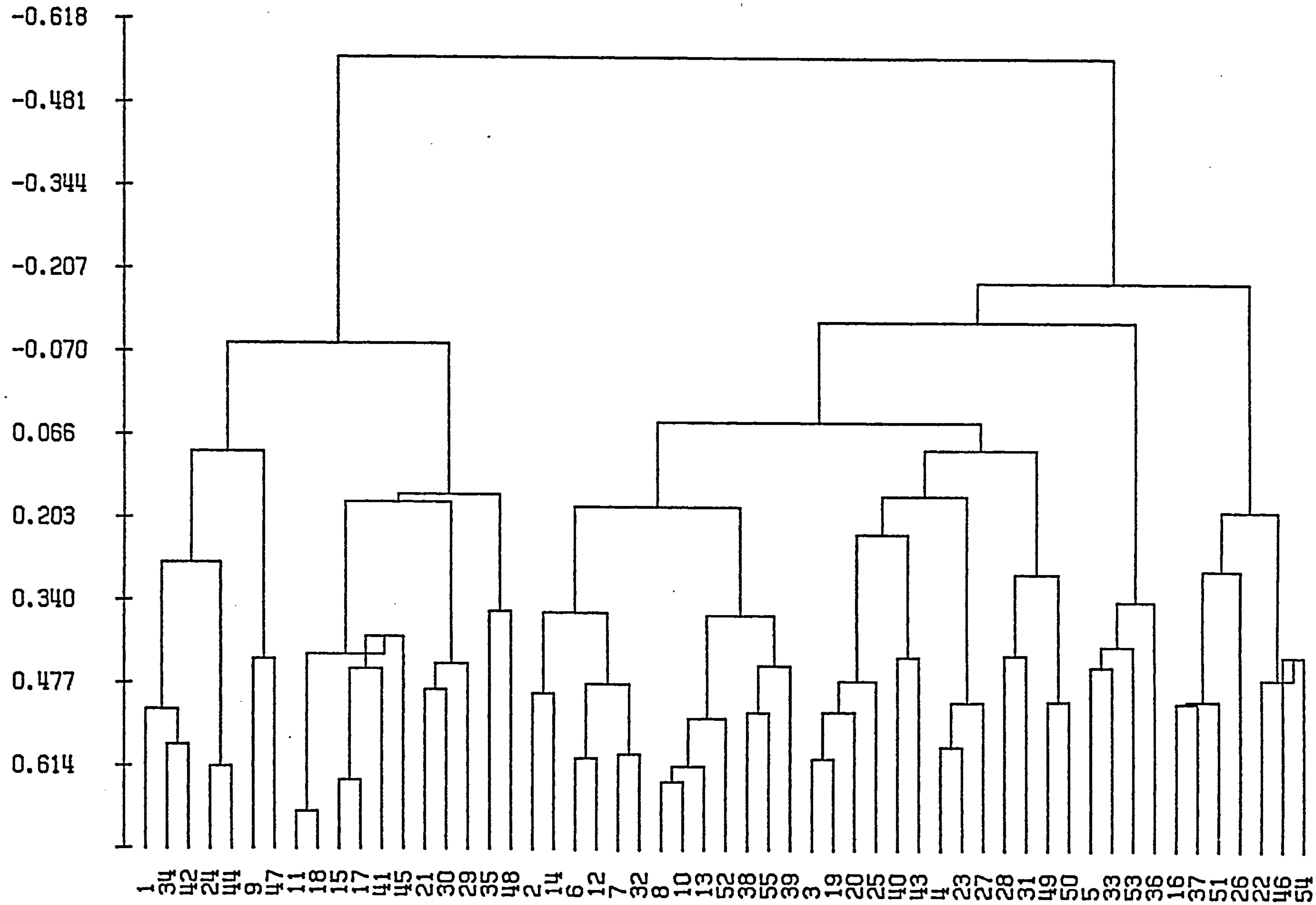


FIGURE 5. CENTROID SORTING ANALYSIS OF YOUNG LD-ACID SUBJECTS.

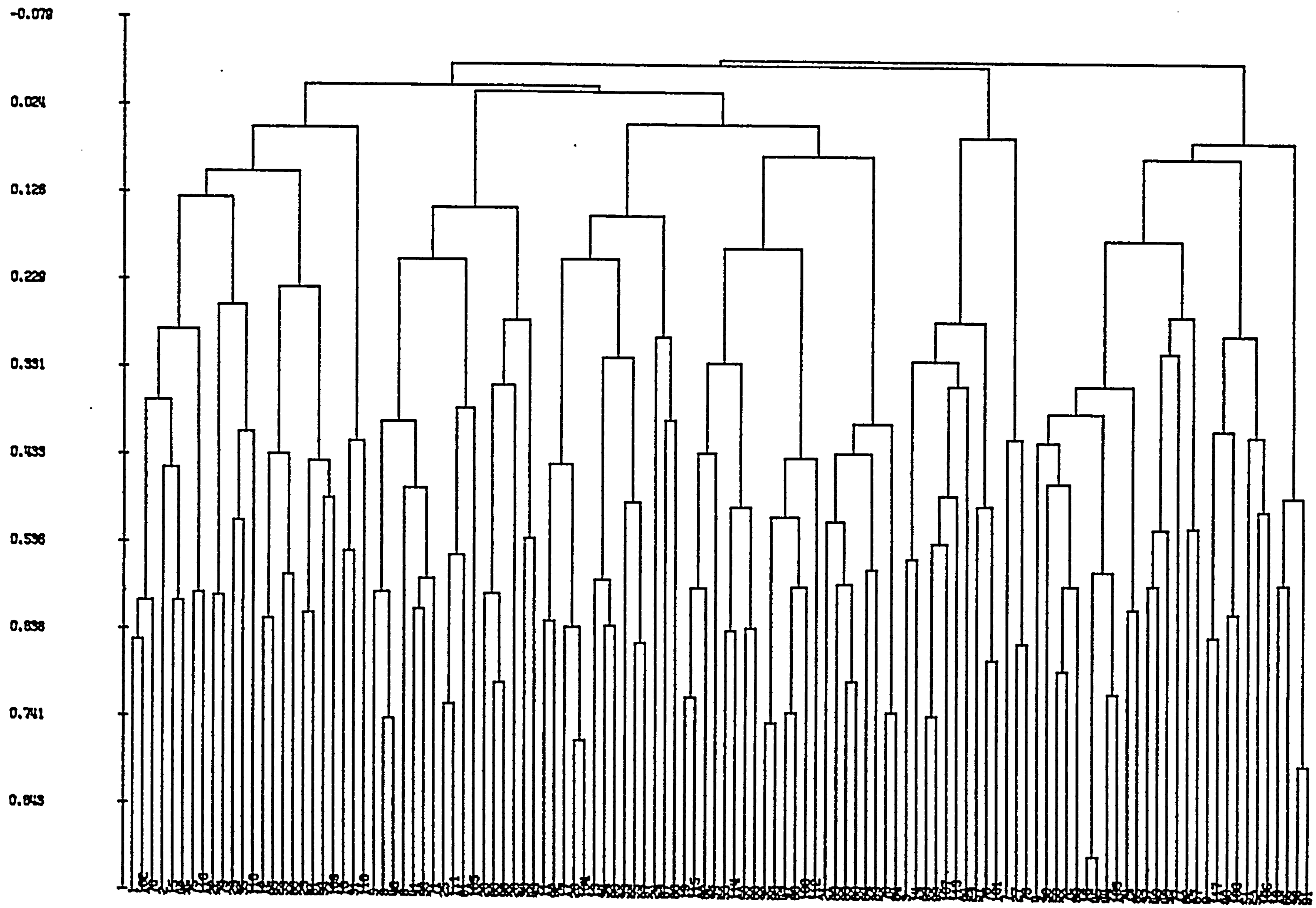


FIGURE 6. GROUP AVERAGE ANALYSIS OF OLD LD-ACID SUBJECTS.

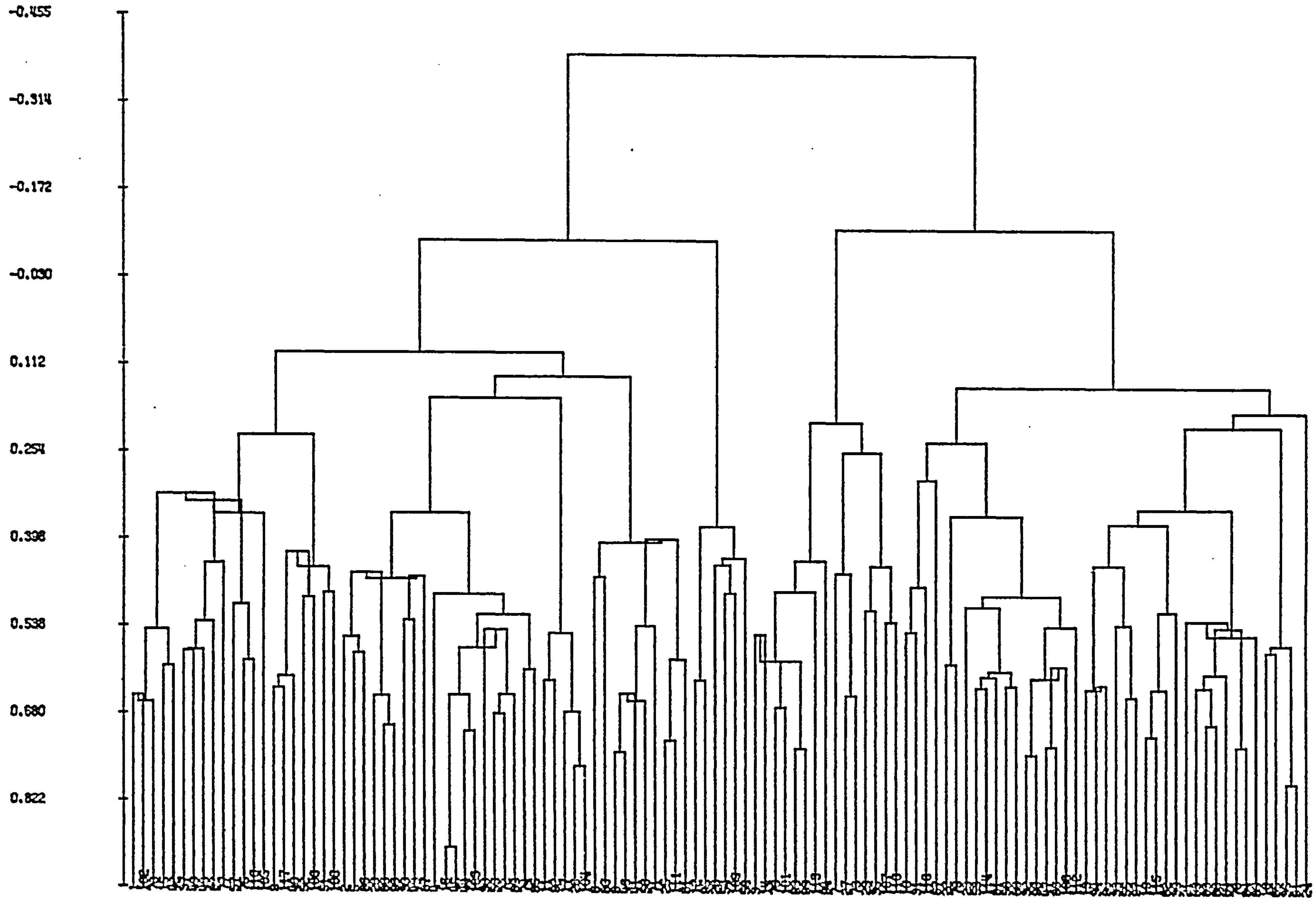


FIGURE 7. CENTROID SORTING ANALYSIS OF OLD LD-ACID SUBJECTS.

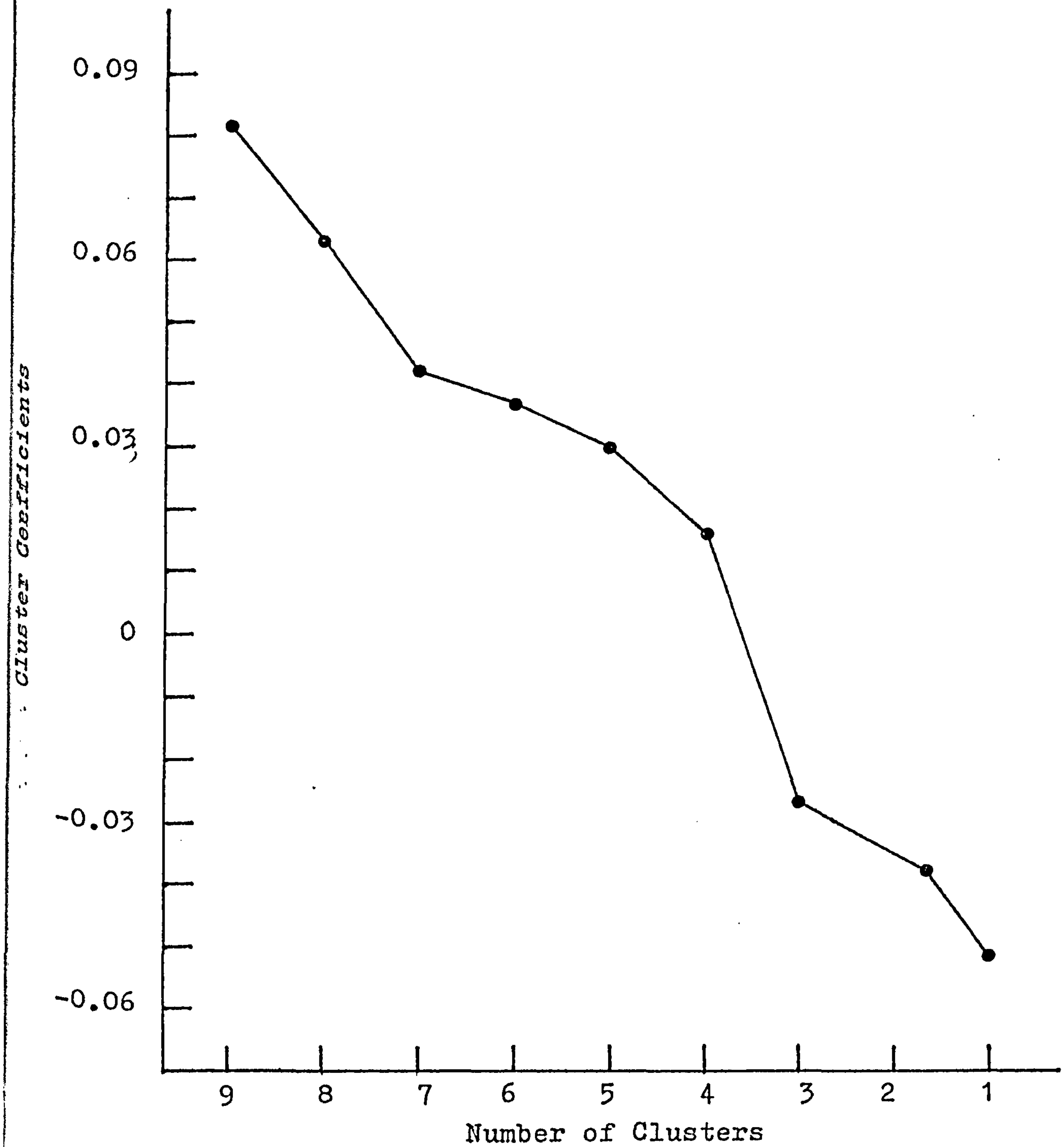


Figure 8. Group average analysis applied to matrix Young LD-ACID FS: Cluster coefficients plotted against number of clusters.

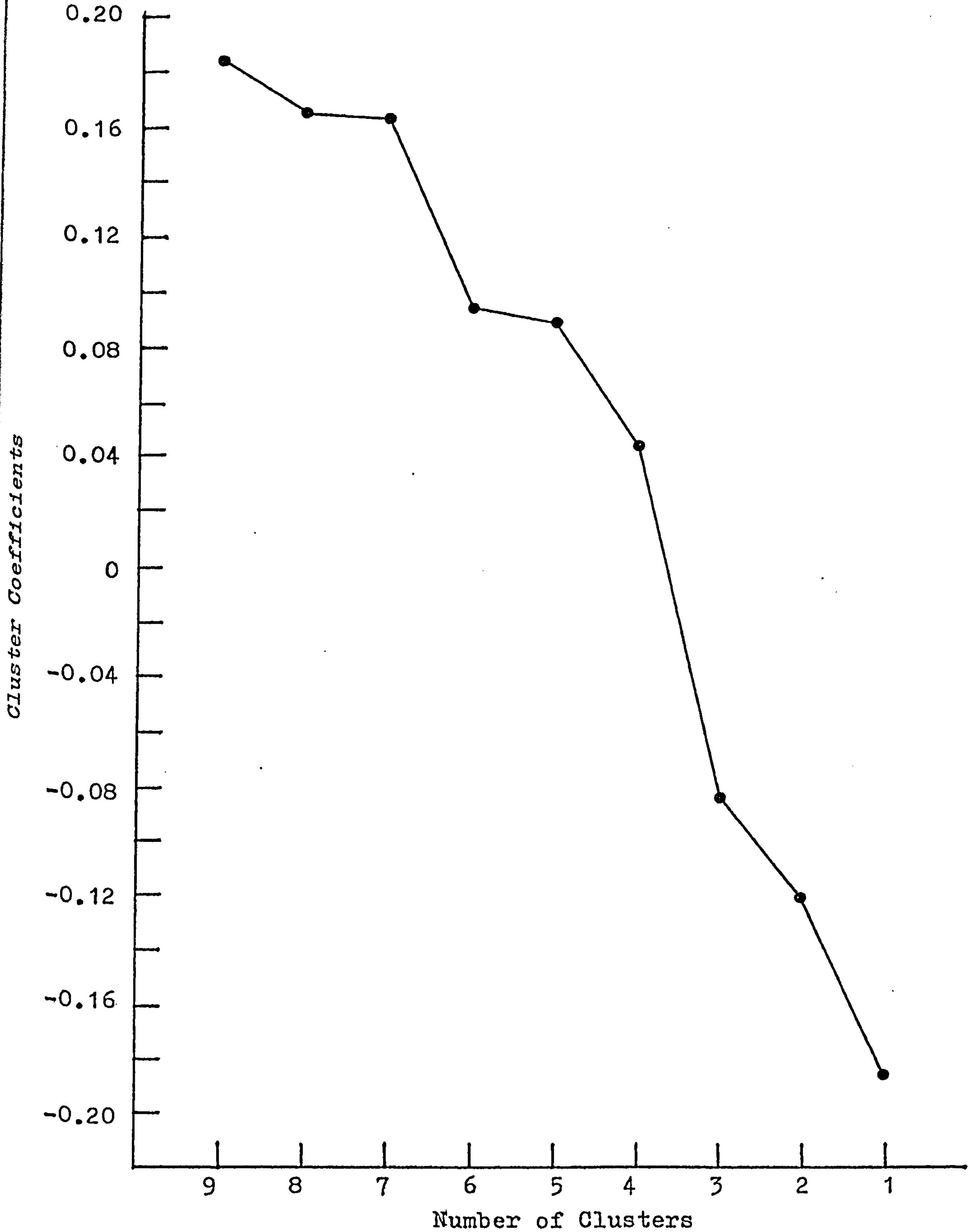


Figure 9. Centroid sorting analysis applied to matrix Young LD-ACID FS: Cluster coefficients plotted against number of clusters.

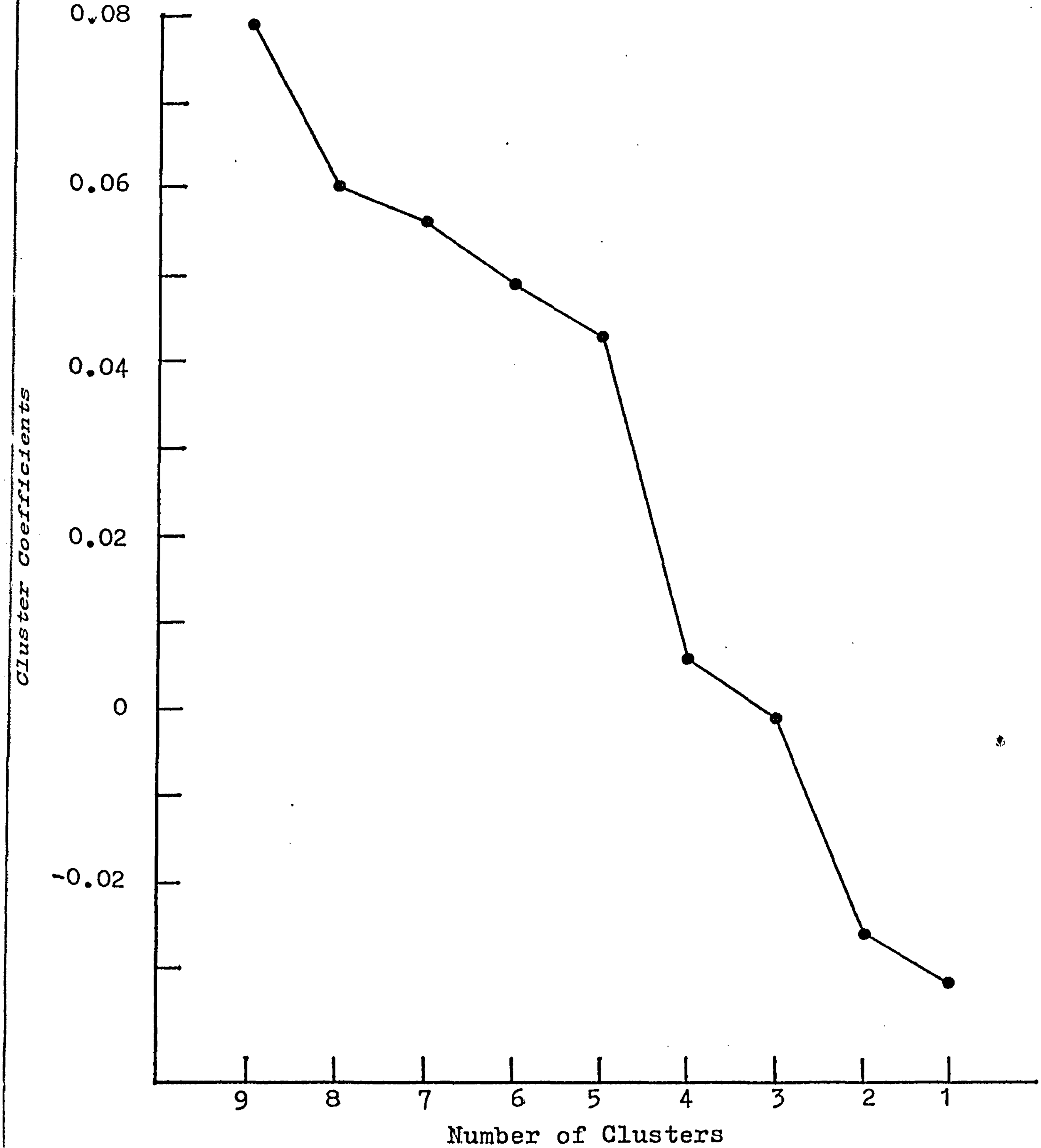


Figure 10. Group average analysis applied to matrix Old LD-ACID FS: Cluster coefficients plotted against number of clusters.

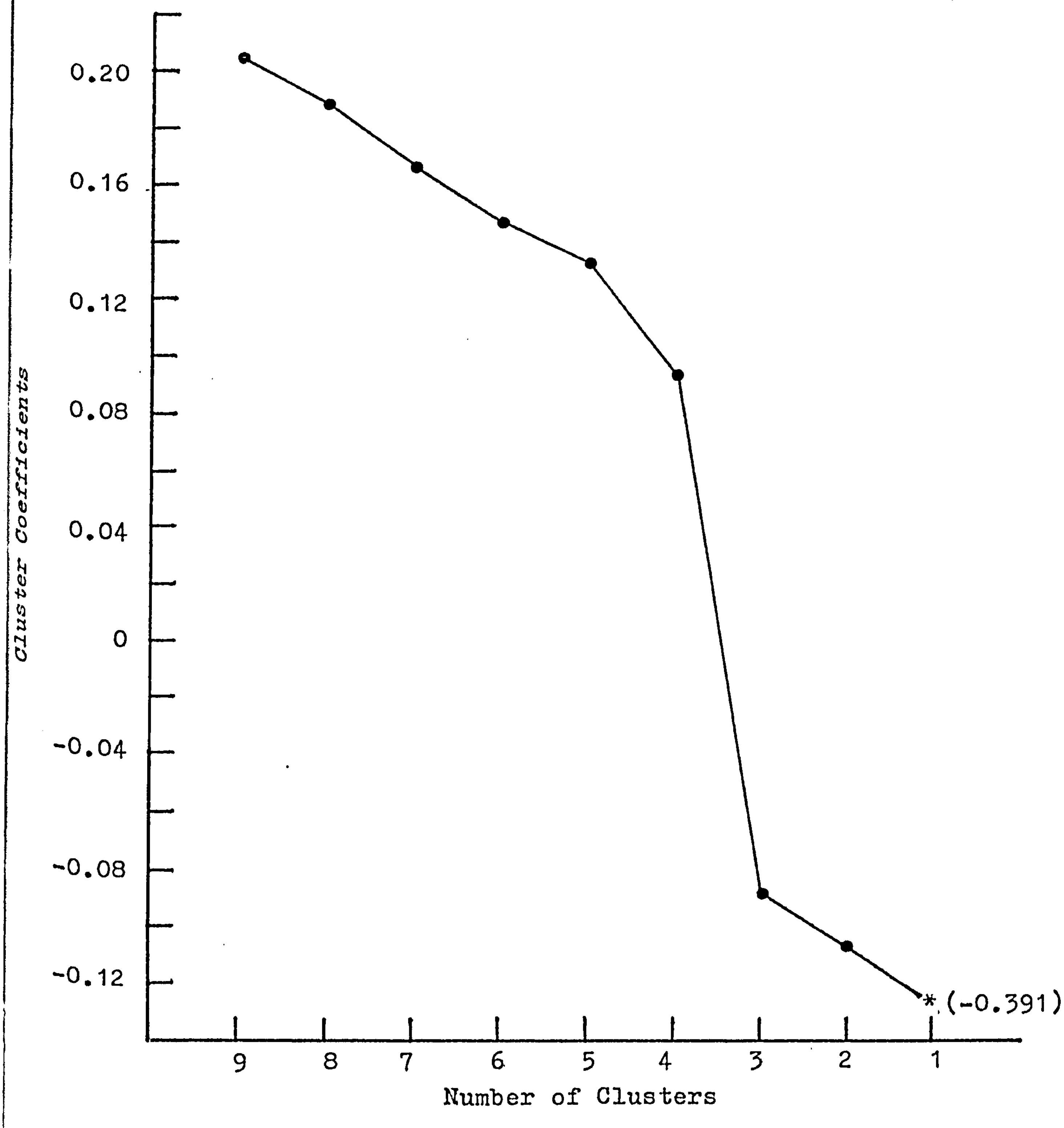


Figure 11. Centroid sorting analysis applied to matrix Old LD-ACID FS: Cluster coefficients plotted against number of clusters.

solutions.

The four-cluster classification arrays for the cluster solutions YOUNG FS-AL, YOUNG FS-CS, YOUNG FS-AL-IR, YOUNG FS-CS-IR, YOUNG FS-IR(RANDOM) are presented in Appendix E. Comparisons of the classification arrays YOUNG FS-AL-IR, YOUNG FS-CS-IR, YOUNG FS-IR(RANDOM) indicated that the closest agreement occurred between the latter two cluster solutions (85% of the subjects were classified into the same clusters by both methods). Since essentially the same solution was obtained from quite different starting points, this was taken as an indication that an acceptable solution had been reached (Wishart, 1975). On the basis of these results, cluster solution YOUNG FS-CS-IR was chosen to represent the underlying structure of the Young LD-ACID group; the four clusters were arbitrarily named YAC1, YAC2, YAC3, and YAC4.

The four-cluster classification arrays for cluster solutions OLD FS-AL, OLD FS-CS, OLD FS-AL-IR, OLD FS-CS-IR, OLD FS-IR(RANDOM) are presented in Appendix F. Identical groupings were produced by cluster solutions OLD FS-AL-IR and OLD FS-CS-IR indicating that an acceptable solution had been reached. Only 57% of the subjects, however, were placed into the same grouping by cluster solution OLD FS-IR(RANDOM); evidence reviewed below indicates that this relatively low concordance maybe due to the effect of one particularly unreliable grouping. In order to maintain consistency with the Young LD-ACID solution, CS-IR clustering was arbitrarily considered to produce the best solution for the Old LD-ACID group. The clusters were named OAC1, OAC2, OAC3, and OAC4.

The four-cluster classification arrays produced by cluster solutions YOUNG TS-CS-IR, YOUNG FS^{-}-CS-IR, and cluster solutions OLD TS-CS-IR, OLD FS^{-}-CS-IR are presented in Appendices G and H respectively. Solutions YOUNG FS^{-}-CS-IR and OLD FS^{-}-CS-IR were considerably more accurate in replicating the corresponding FS-CS-IR cluster solutions than were cluster solutions YOUNG TS-CS-IR and OLD TS-CS-IR (this is discussed further in the next section).

The dendrograms produced by CS analyses of the distance matrices (squared Euclidean distance) for each of the four groupings generated by cluster solutions YOUNG FS-CS-IR and OLD FS-CS-IR are presented in Figures 12 through 19. Inspection of these hierarchical trees suggests that "chaining" has occurred and that clusters do not contain further groupings which can be defined on the basis of profile elevation.

Subtype Validation

Concordance over clustering procedures (input matrices: Young LD-ACID FS and Old LD-ACID FS). The agreement between the four-cluster solutions generated by the five different cluster analyses, AL, CS, AL-IR, CS-IR, and IR(RANDOM), is summarized in Table 15 for the Young LD-ACID group. The "hits" (number of subjects correctly classified) and percentage hits were calculated with the four-cluster solution produced by CS-IR analysis as reference. Inspection of Table 15 reveals different concordance rates across the Young LD-ACID clusters. Clusters YAC2 and YAC4 were well-preserved over the CS, AL, AL-IR, and IR(RANDOM) cluster analyses with mean percentage hits of 88.16 and 89.58, respectively. These clusters would appear to constitute reliable subtypes. Clusters YAC1 and YAC3, on the other hand, were considerably less stable (mean percentage hits of 52.78 and 58.33, respectively, over the four cluster analyses) suggesting that these clusters may represent artificial groupings forced on the data.

Further evidence of the stability of clusters YAC2 and YAC4 was obtained from the inspection of the five- and three-cluster CS-IR solutions. The five-cluster solution grouped together all 19 YAC2 subjects in one cluster and 11 (91.67%) of the YAC4 subjects in another cluster. Eighteen (94.73%) of the

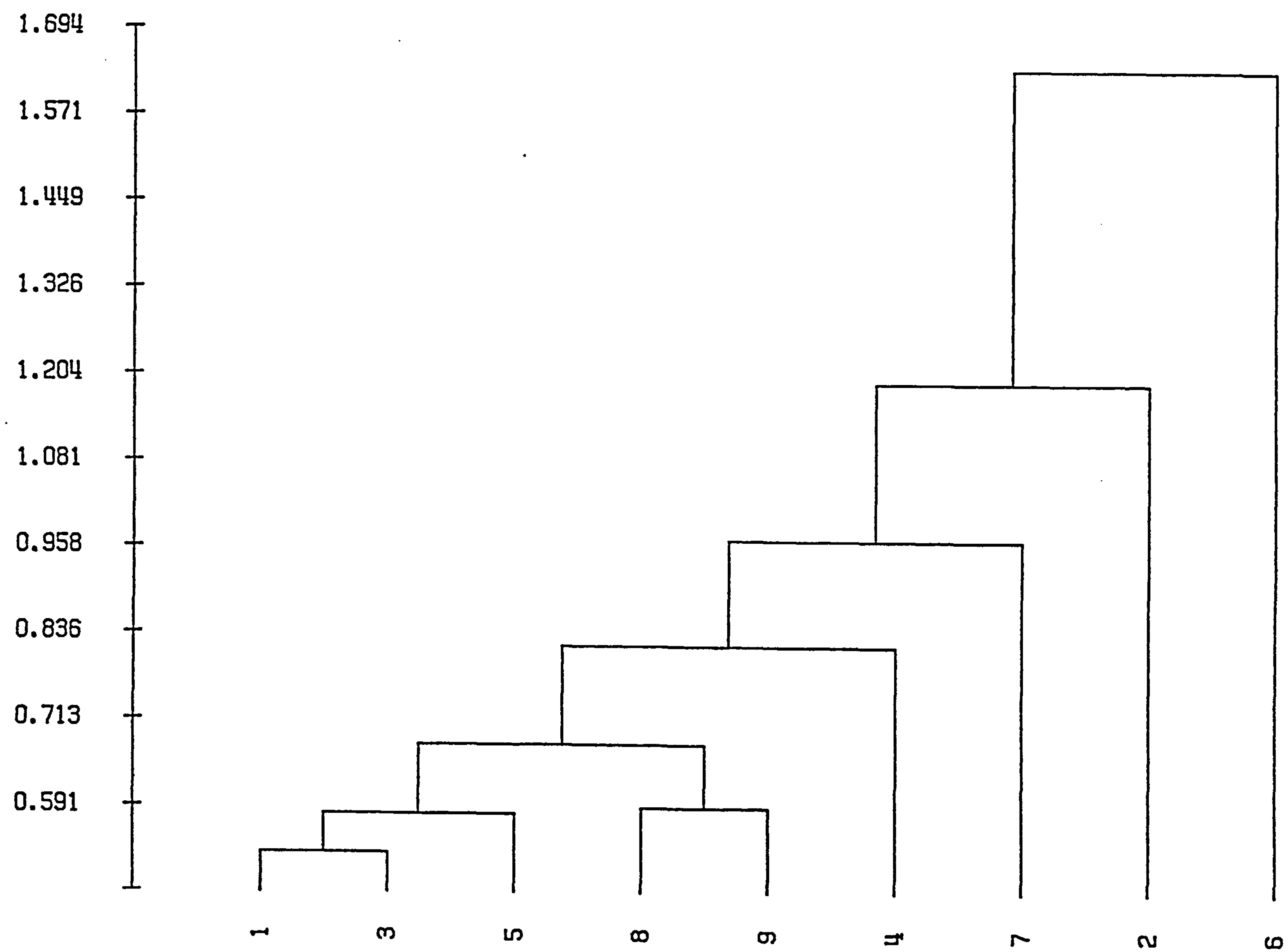


FIGURE 12. CENTROID SORTING ANALYSIS OF CLUSTER YAC1: EUCLIDEAN DISTANCE.

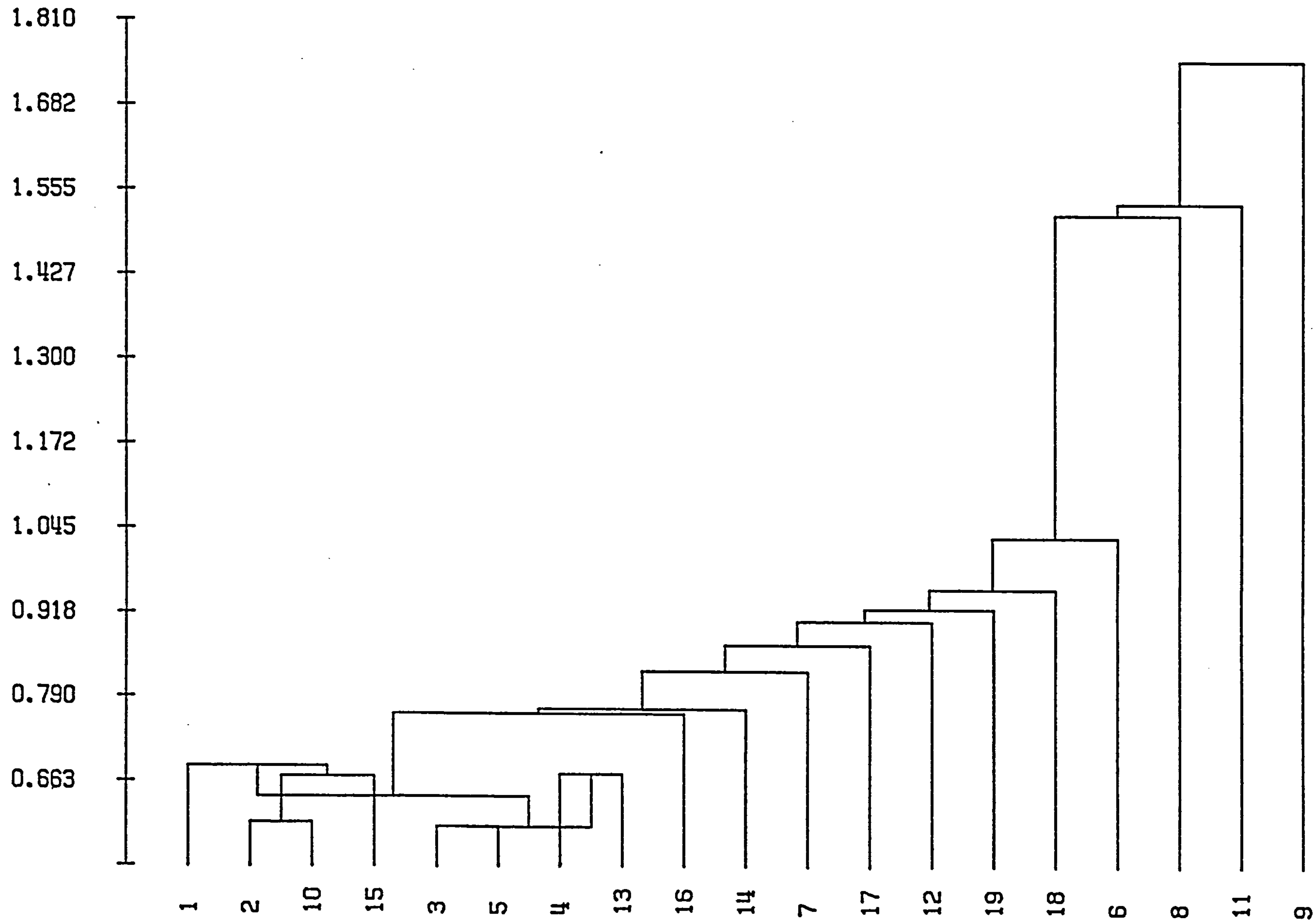


FIGURE 13. CENTROID SORTING ANALYSIS OF CLUSTER YAC2: EUCLIDEAN DISTANCE.

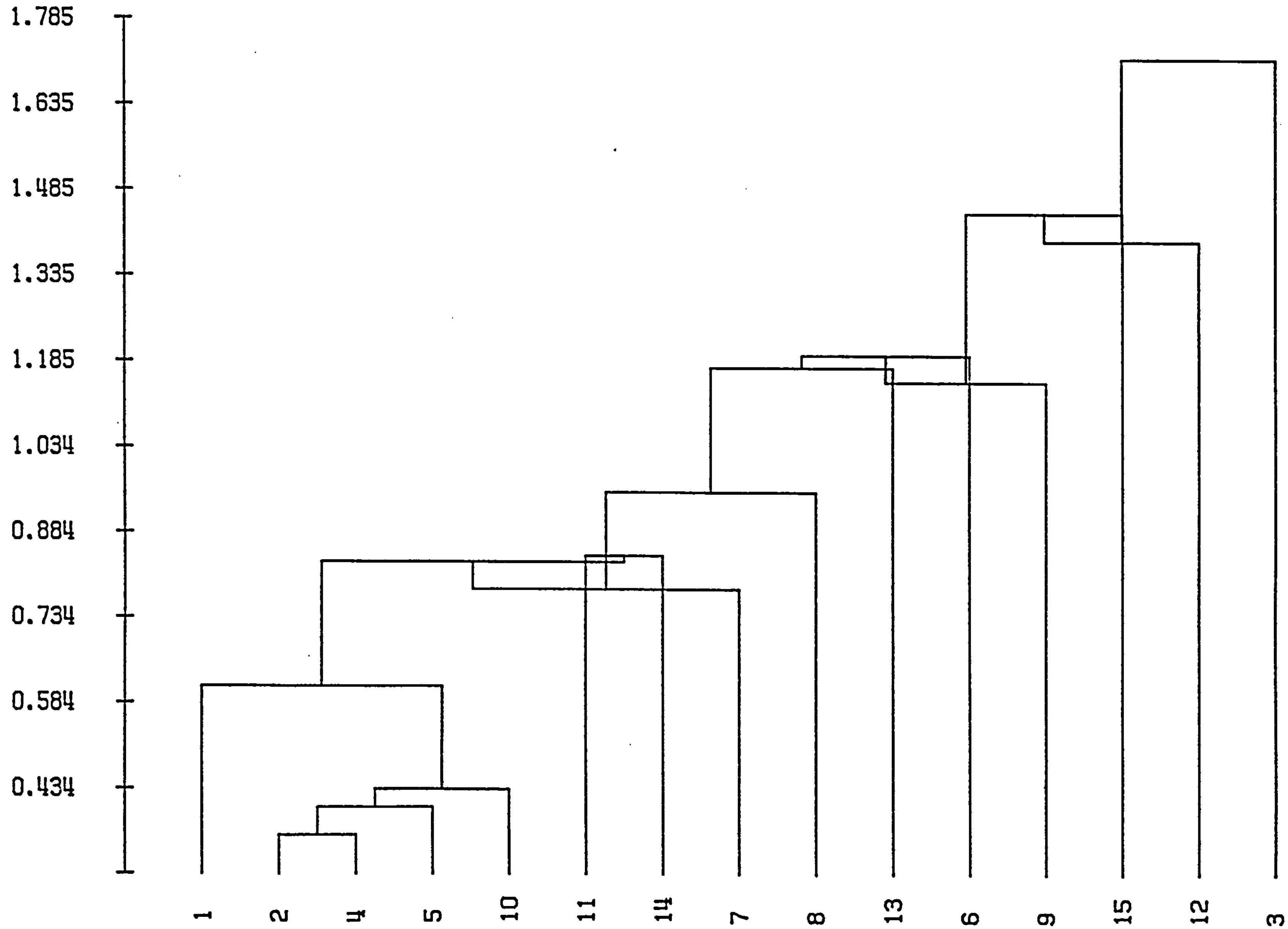


FIGURE 14. CENTROID SORTING ANALYSIS OF CLUSTER YAC3: EUCLIDEAN DISTANCE.

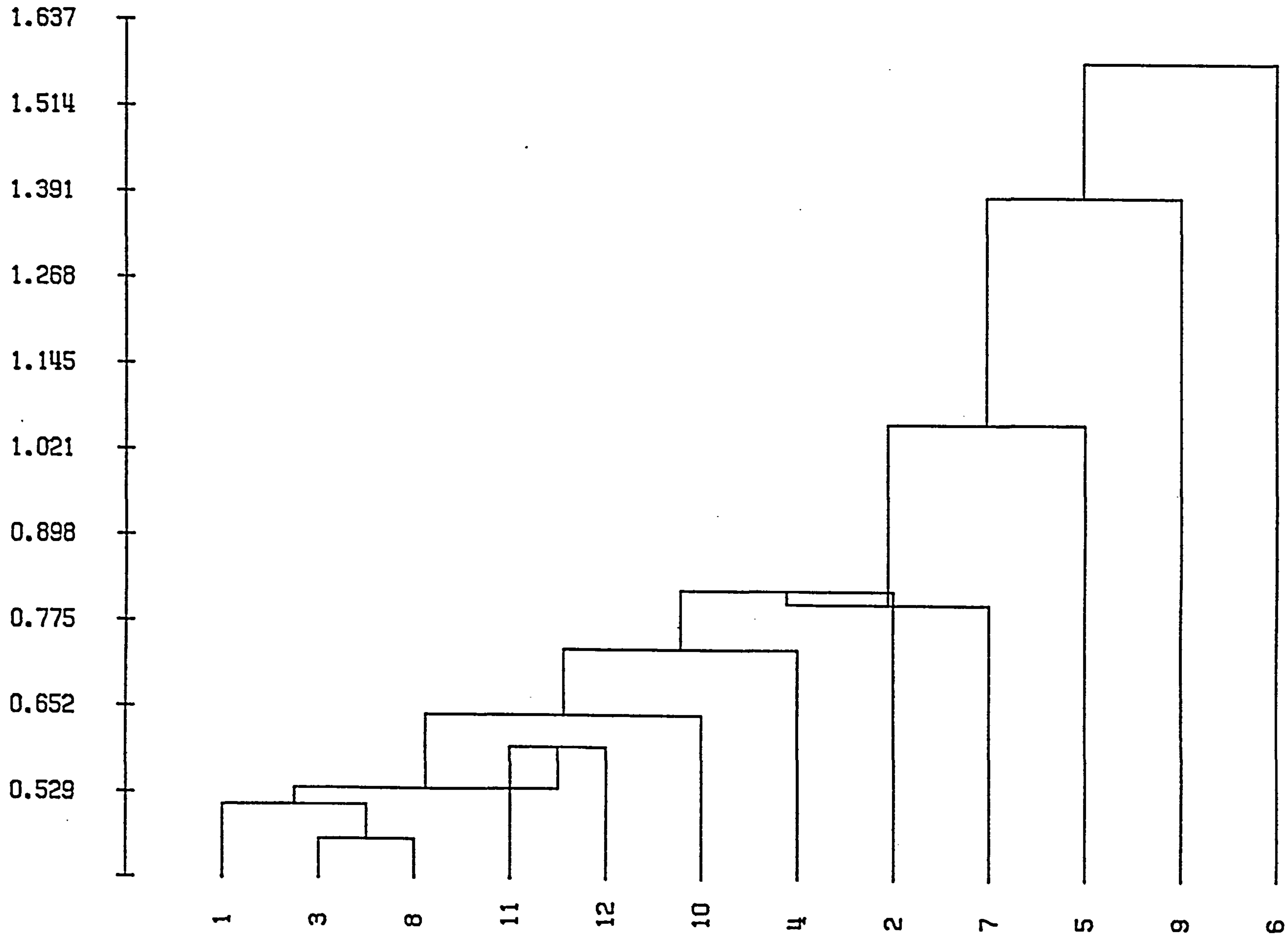


FIGURE 15. CENTROID SORTING ANALYSIS OF CLUSTER YAC4: EUCLIDEAN DISTANCE.

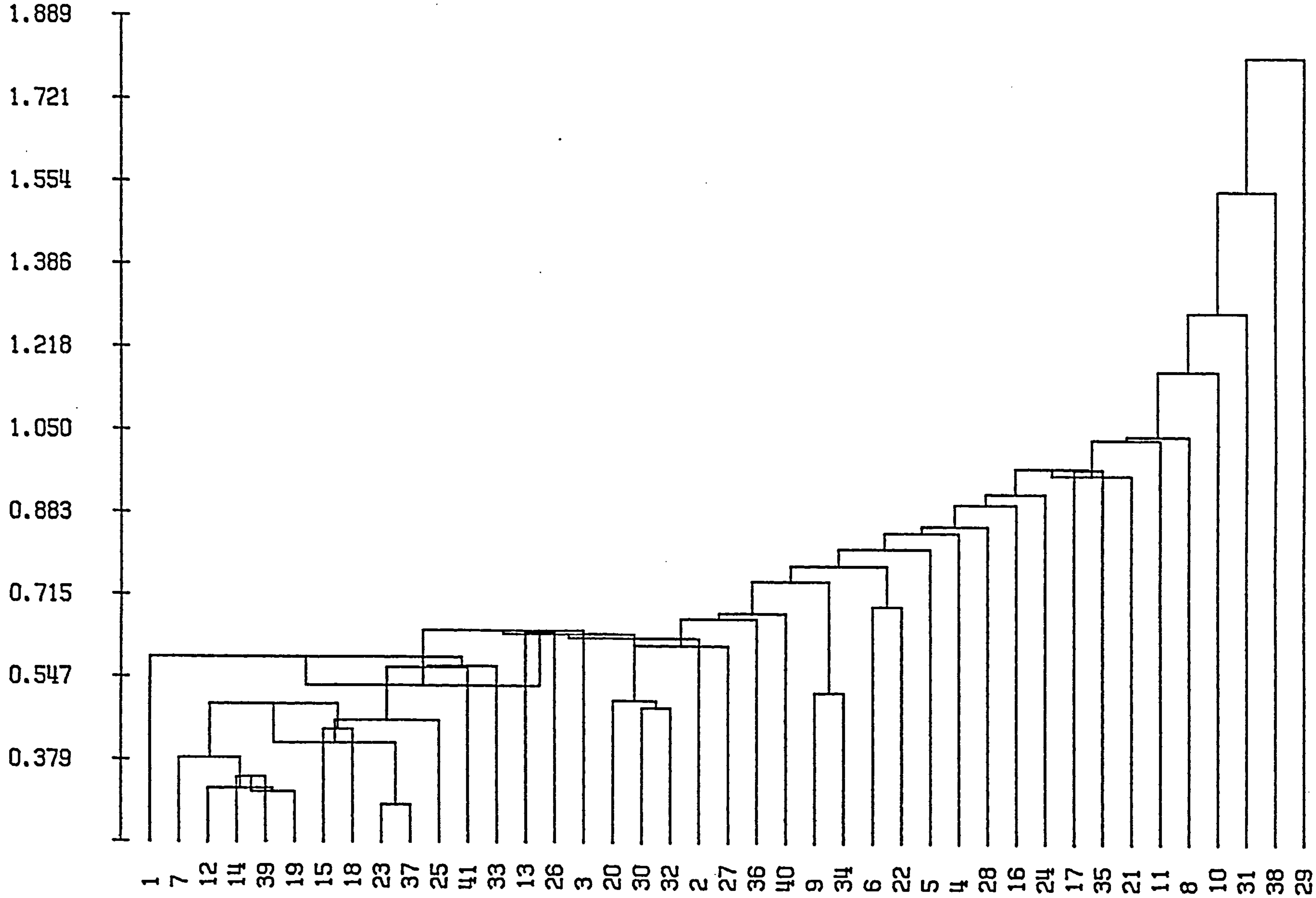


FIGURE 16. CENTROID SORTING ANALYSIS OF CLUSTER OAC1: EUCLIDEAN DISTANCE.

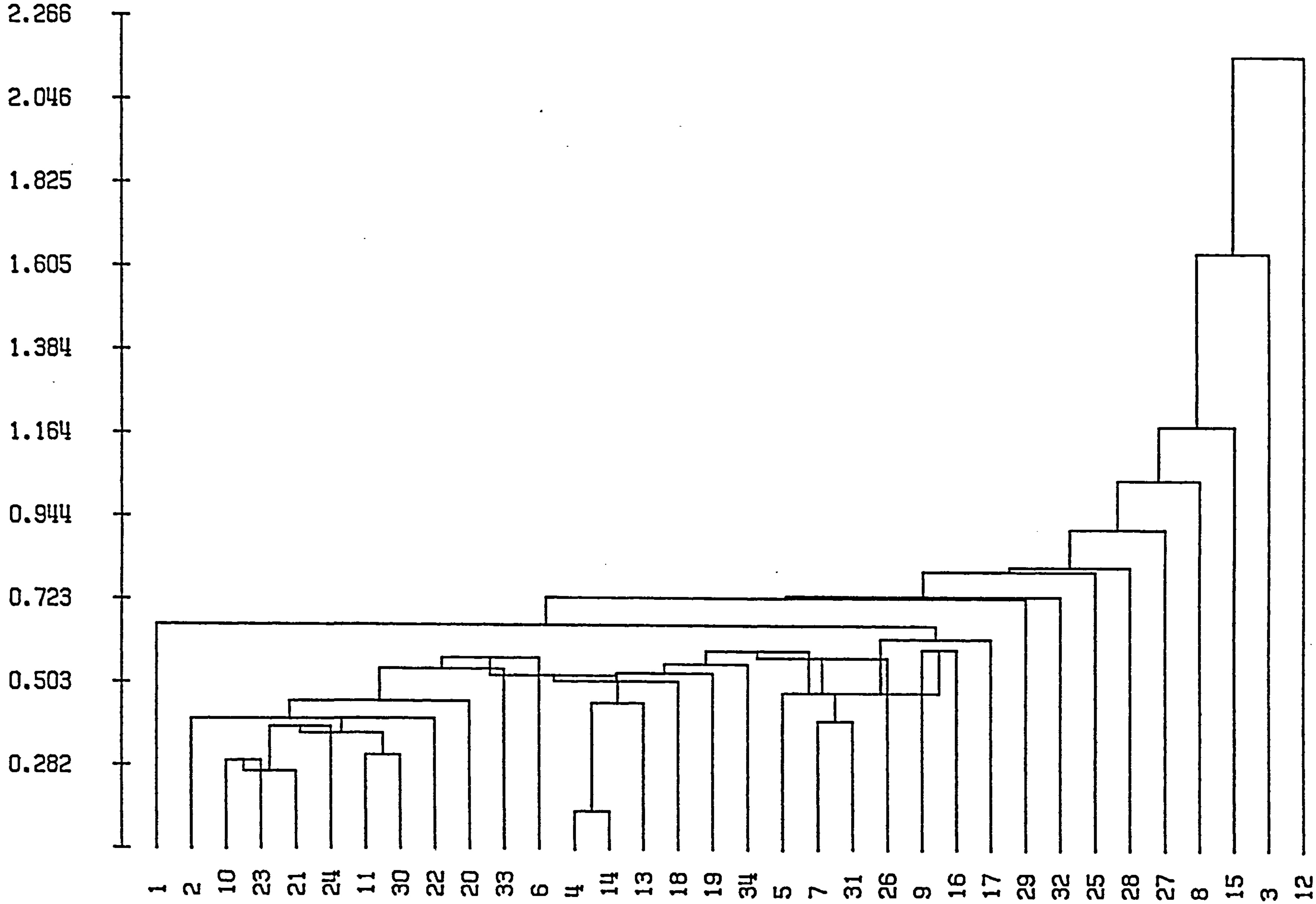


FIGURE 17. CENTROID SORTING ANALYSIS OF CLUSTER OAC2: EUCLIDEAN DISTANCE.

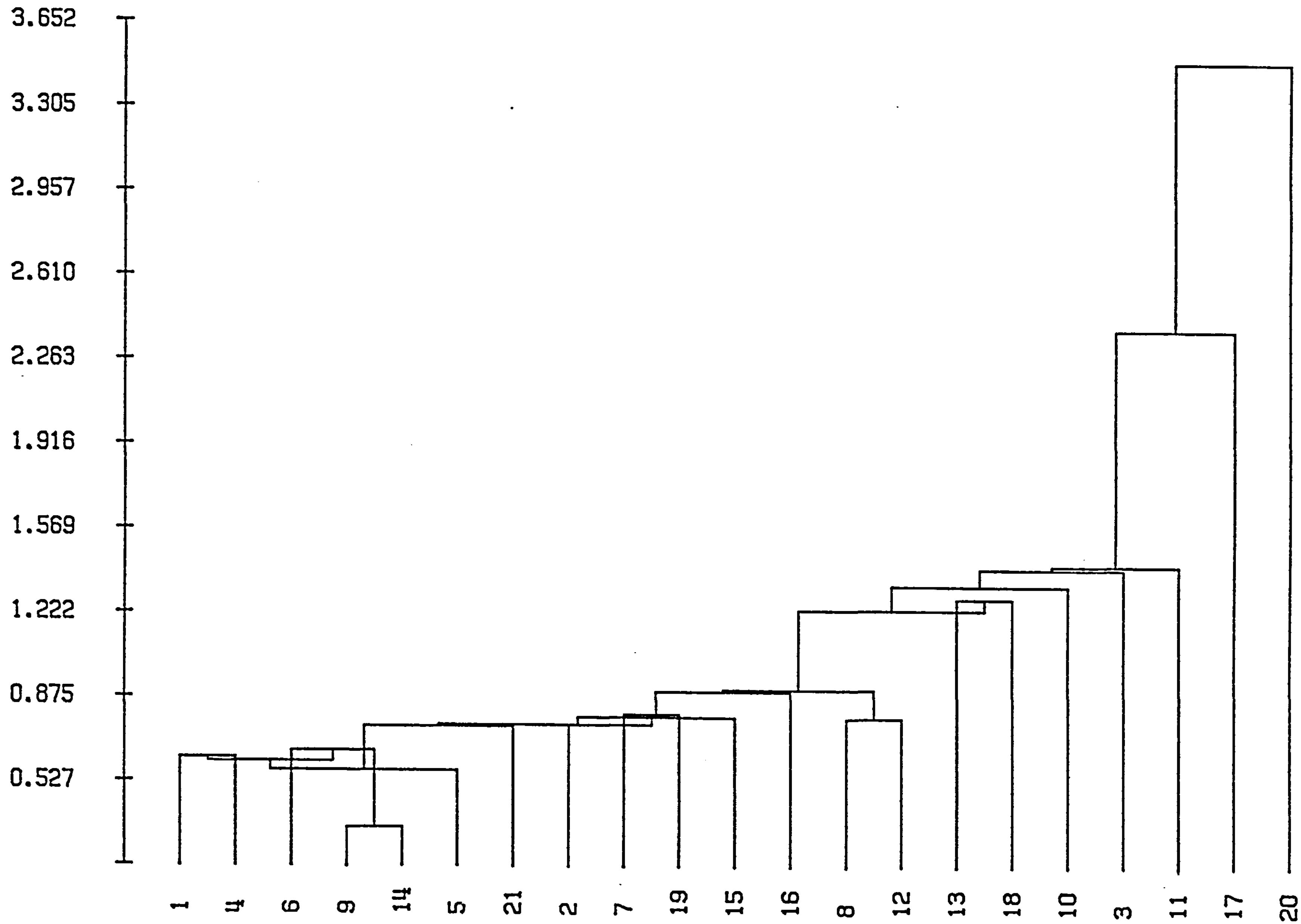


FIGURE 18. CENTROID SORTING ANALYSIS OF CLUSTER OAC3: EUCLIDEAN DISTANCE.

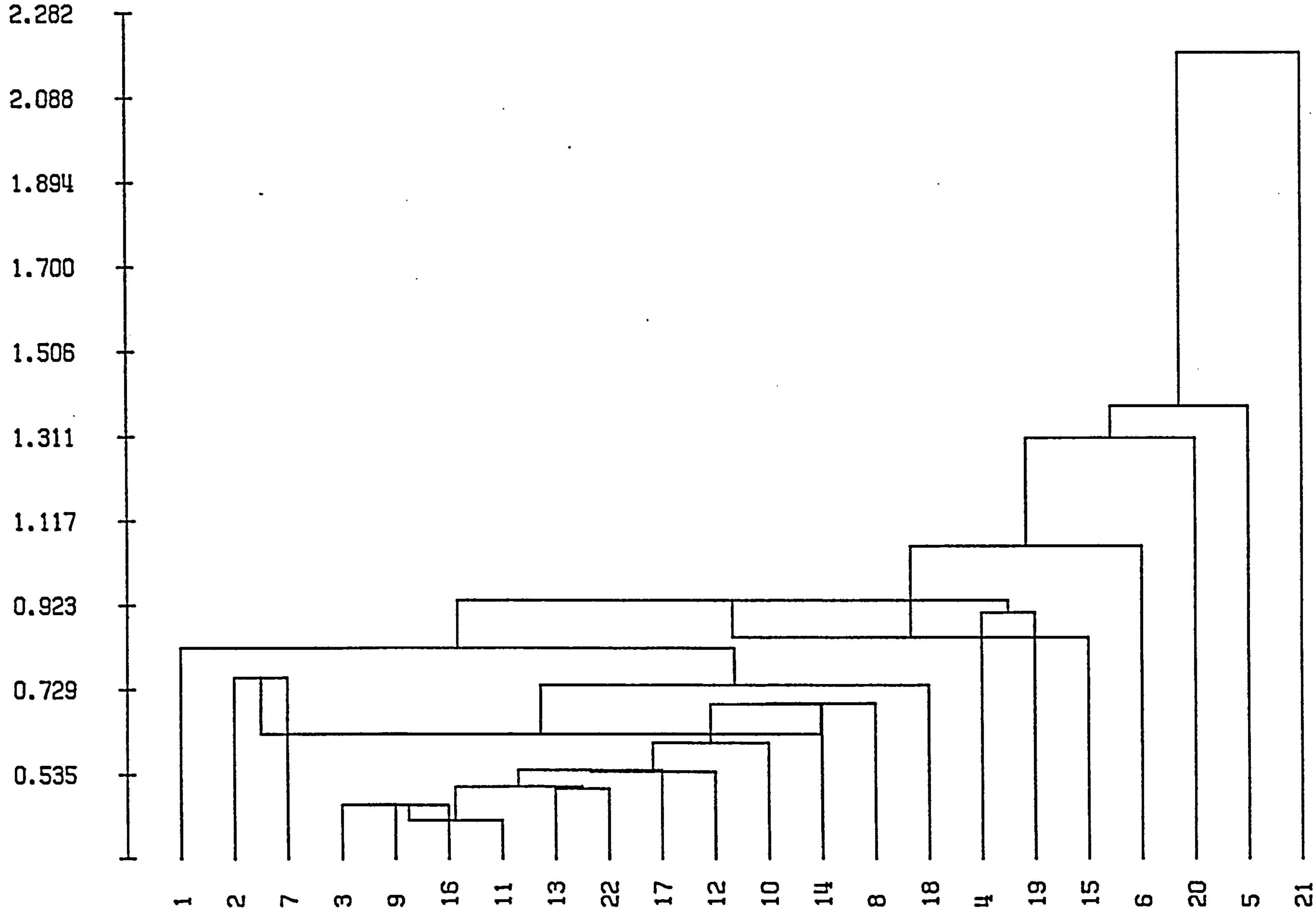


FIGURE 19. CENTROID SORTING ANALYSIS OF CLUSTER ØAC4: EUCLIDEAN DISTANCE.

TABLE 15

Concordance Across Different Clustering Procedures for the Young LD-ACID Subtypes with Cluster Solution YOUNG FS-CS-IR as Reference

Cluster Analysis Procedure[a]	YAC1 Hits	YAC1 (%)	YAC2 Hits	YAC2 (%)	YAC3 Hits	YAC3 (%)	YAC4 Hits	YAC4 (%)
CS-IR	9	(100)	19	(100)	15	(100)	12	(100)
AL-IR	6	(66.67)	16	(84.21)	15	(100)	11	(91.67)
IR(RANDOM)	8	(88.89)	16	(84.21)	8	(53.33)	11	(91.67)
CS	4	(44.44)	18	(94.74)	6	(40.00)	11	(91.67)
AL	1	(11.11)	17	(89.47)	6	(40.00)	10	(83.33)
Mean Percentage Hits[b]	52.78		88.16		58.33		89.58	

Young LD-ACID Clusters: YAC1–YAC4.

[a] CS-IR = Centroid sorting analysis with iterative relocation.
AL-IR = Group average analysis with iterative relocation.
IR(RANDOM) = Iterative relocation from an initial random classification.
CS = Centroid sorting analysis.
AL = Group average analysis.

[b] Mean percentage hits over methods AL-IR, IR(RANDOM), CS, and AL.

YAC2 subjects were grouped together with one other subject by the three-cluster solution. Ten (83.33%) of the YAC4 subjects were grouped together with six other subjects by the three-cluster solution.

The results for the Old LD-ACID group are summarized in Table 16, which shows different concordance rates across the four groupings. Clusters OAC1, OAC2, and OAC3 remained fairly well-preserved over the CS, AL, AL-IR, and IR (RANDOM) cluster analyses. The mean percentage hit rates for the three clusters were 83.54, 80.88, and 69.04, respectively. These clusters would appear to constitute fairly reliable subtypes. As shown in Table 16, cluster OAC4 was not reliably reproduced by the four clustering methods indicating that this cluster may represent an artificial grouping forced on the data.

Inspection of the five-cluster CS-IR solution provides another indication of the stability of the Old LD-ACID clusters. Twenty-nine (70.73%) of the OAC1 subjects were grouped together with one other subject to form a cluster. Twenty-seven (79.41%) of the OAC2 subjects constituted a second cluster, while 15 (71.43%) of the OAC3 subjects and one other subject constituted a third cluster. A fourth cluster consisted of 20 (90.90%) OAC4 subjects and one other subject. Clusters OAC1 and OAC2 were well-preserved by the three-cluster solution: 26 OAC1 subjects were grouped together in a 38 member cluster while 34 OAC2 subjects were grouped together in a 40 member cluster. Cluster OAC4 formed the majority of the third cluster (16 of the 36 members). The subjects in cluster OAC3 were interspersed among the three clusters.

Alterations in the input data sets. The results of CS-IR clustering applied to the factor score, T score, and reduced factor score matrices are summarized in Tables 17 and 18 for the Young LD-ACID and Old LD-ACID groups, respectively. Inspection of Table 17 indicates that the Young LD-ACID clusters were best replicated by the YOUNG FS$^-$-CS-IR cluster solution. A 54.54% concordance rate

TABLE 16

Concordance Across Different Clustering Procedures for the Old LD-ACID Subtypes with Cluster Solution OLD FS-CS-IR as Reference

Cluster Analysis Procedure[a]	Old LD-ACID Clusters							
	OAC1		OAC2		OAC3		OAC4	
	Hits	(%)	Hits	(%)	Hits	(%)	Hits	(%)
CS-IR	41	(100)	34	(100)	21	(100)	22	(100)
AL-IR	41	(100)	34	(100)	21	(100)	22	(100)
IR(RANDOM)	32	(78.05)	21	(61.76)	13	(61.90)	3	(13.64)
CS	31	(75.61)	33	(97.06)	12	(57.14)	6	(27.27)
AL	33	(80.49)	22	(64.71)	12	(57.14)	17	(77.27)
Mean Percentage Hits[b]	83.54		80.88		69.04		54.54	

[a] CS-IR = Centroid sorting analysis with iterative relocation.
AL-IR = Group average analysis with iterative relocation.
IR(RANDOM) = Iterative relocation from a initial random classification.
CS = Centroid sorting analysis.
AL = Group average analysis.

[b] Mean percentage hits over methods AL-IR, IR(RANDOM), CS, and AL.

TABLE 17

Concordance Across Different Data Matrices for Centroid Sorting Analysis with Iterative Relocation of the YOUNG LD-ACID Group (Solution for Data Matrix Young LD-ACID FS as Reference)

	Young LD-ACID Clusters							
	YAC1		YAC2		YAC3		YAC4	
Data Matrix[a]	Hits	(%)	Hits	(%)	Hits	(%)	Hits	(%)
Young LD-ACID FS	9	(100)	19	(100)	15	(100)	12	(100)
Young LD-ACID FS$^-$	1	(11.11)	14	(73.68)	7	(46.67)	8	(66.67)
Young LD-ACID TS	2	(22.22)	8	(42.10)	0	(0.00)	6	(50.00)

[a] Young LD-ACID FS = Factor score data matrix (19 factors).
Young LD-ACID FS$^-$ = Modified factor score data matrix (15 factors).
Young LD-ACID TS = T score data matrix (35 variables).

TABLE 18

Concordance Across Different Data Matrices for Centroid Sorting Analysis with Iterative Relocation of the Old LD-ACID Group (Solution for Data Matrix Old LD-ACID FS as Reference)

	Old LD-ACID Clusters							
	OAC1		OAC2		OAC3		OAC4	
Data Matrix[a]	Hits	(%)	Hits	(%)	Hits	(%)	Hits	(%)
Old LD-ACID FS	41	(100)	34	(100)	21	(100)	22	(100)
Old LD-ACID FS^{-}	22	(53.66)	27	(79.41)	5	(23.81)	13	(59.09)
Old LD-ACID TS	14	(34.15)	18	(52.94)	6	(28.57)	5	(22.73)

[a] Old LD-ACID FS = Factor score data matrix (16 factors).
Old LD-ACID FS^{-} = Modified factor score data matrix (13 factors).
Old LD-ACID TS = T score data matrix (32 variables).

was obtained from the YOUNG FS^{-}-CS-IR classification, while the YOUNG TS-CS-IR classification produced only a 29.09% concordance rate. Further inspection of Table 17 reveals that subtypes YAC2 and YAC4 were relatively well-preserved by both the YOUNG FS^{-}-CS-IR and YOUNG TS-CS-IR cluster solutions. Inspection of Table 18 also indicates that the FS^{-}-CS-IR solution was more accurate than the TS-CS-IR solution for the Old LD-ACID subjects; a 56.78% concordance rate was obtained for the OLD FS^{-}-CS-IR cluster solution, while the OLD TS-CS-IR solution produced only a 36.4% concordance rate. Subtypes OAC1 and OAC2 were best preserved by both cluster solutions.

Concordance over the various cluster solutions. In total, seven different cluster solutions were generated for the Young LD-ACID group. The number of subjects classified together by different combinations of these cluster solutions is presented in Table 19. These data provide another indication of the stability of the YOUNG FS-CS-IR cluster solutions; 80% of the subjects were classified together by at least four of the seven cluster solutions. Further evidence of the reliability of subtypes YAC2 and YAC4 vis-à-vis the other clusters can also be gleaned from this table; 89.47%, 100%, 11.11%, and 40.00% of the YAC2, YAC4, YAC1, and YAC3 subjects, respectively were classified together by at least five of the seven cluster solutions.

Table 20 presents similar data for the Old LD-ACID group. A substantial number (89.83%) of the subjects were classified together by at least four of the seven cluster solutions, while 75.61%, 85.29%, 57.14%, and 50.00% of the OAC1, OAC2, OAC3, and OAC4 subjects, respectively, were classified together by at least five of the seven cluster solutions.

Inspection of the fifteen- to three-cluster solutions obtained for the Young LD-ACID and Young LD-C samples combined revealed that the nine-cluster solution produced a closest agreement with cluster solution YOUNG FS-CS-IR.

TABLE 19

Number of Young LD-ACID Subjects Classified Together by Different Combinations of Cluster Solutions

Number of Cluster Solutions	Young LD-ACID Clusters				Total n=55
	YAC1 n=9	YAC2 n=19	YAC3 n=15	YAC4 n=12	
7 of 7	0	9	0	5	14
At least 6 of 7	0	14	4	8	26
At least 5 of 7	1	17	6	12	36
At least 4 of 7	4	18	10	12	44
At least 3 of 7	7	19	14	12	52

TABLE 20

Number of Old LD-ACID Subjects Classified Together by Different Combinations of Cluster Solutions

Number of Cluster Solutions	Old LD-ACID Clusters				
	OAC1 n=41	OAC2 n=34	OAC3 n=21	OAC4 n=22	Total n=118
7 of 7	9	13	1	0	23
At least 6 of 7	19	22	11	5	57
At least 5 of 7	31	29	12	11	83
At least 4 of 7	41	33	15	17	106
At least 3 of 7	41	34	17	22	114

Appendix I contains the nine-cluster classification array for the combined sample. The number of Young LD-ACID subjects correctly classified together for clusters YAC1, YAC2, YAC3, and YAC4 were as follows: 4, 9, 6, and 9, respectively. The corresponding percentage hit rates were 44.44, 47.37, 40.00, and 75.00, respectively. The number of LD-C subjects classified together with the LD-ACID subjects were, for the most part, quite small (6, 2, 4, and 3, for clusters YAC1, YAC2, YAC3, and YAC4, respectively) indicating that the neuropsychological ability profiles for at least the latter three LD-ACID clusters differed from those of the LD-C sample.

The eleven-cluster solution obtained from the Old LD-ACID and Old LD-C samples combined provided the closest agreement with cluster solution OLD FS-CS-IR. Appendix J contains the eleven-cluster classification array for the combined sample. The number of Old LD-ACID subjects correctly classified together for clusters OAC1, OAC2, OAC3, and OAC4 were as follows: 19, 11, 10, and 8, respectively. The corresponding percentage hit rates were 46.34, 32.35, 47.61, and 36.36, respectively. The number of LD-C subjects grouped together with the LD-ACID subjects were 5, 6, 3, and 20 for the OAC1, OAC2, OAC3, and OAC4 clusters, respectively. This provides some evidence that the neuropsychological profiles of clusters OAC1, OAC3, and, to a lesser extent, OAC2 differed from those of the LD-C subjects.

<u>External criterion procedures for cluster solution YOUNG FS-CS-IR</u>. LD-C subjects matched to LD-ACID subjects in clusters YAC1, YAC2, YAC3, and YAC4 were grouped into corresponding "clusters" (YCC1, YCC2, YCC3, and YCC4, respectively). Multivariate analysis of variance (MANOVA) with group (LD-ACID vs. LD-C) and cluster membership as independent variables and performance on the Reading, Spelling, and Arithmetic subtests of the WRAT as dependent variables revealed a significant main effect of group; see Table 21. The univari-

TABLE 21

Multivariate Analysis of Variance of the WRAT Subtests by Group and Cluster: Young Age Group

Global Test	Wilk's lambda	p	Largest root criterion
Group	0.9234	0.0405	0.0829
Cluster	0.9006	0.2791	0.0913

TABLE 22

Univariate Analysis of Variance of the WRAT Subtests by Group and Cluster: Young Age Group

	Mean T Score										
	LD-ACID Clusters[a]				LD-C "Clusters"[b]					$p \leq$	
WRAT Subtest	1	2	3	4	5	6	7	8	MSe	Group	Cluster
Reading	36.96	40.03	40.75	37.94	38.22	42.63	44.73	40.83	40.998	.023	.039
Spelling	37.48	38.91	40.18	38.67	37.85	41.05	42.67	39.55	32.923	.129	.160
Arithmetic	40.81	41.44	43.15	41.33	42.37	45.12	46.82	42.05	29.615	.011	.091

Newman-Keuls Tests $p < .05$

Reading	1	4	5	2	3	8	6	7
Spelling	1	5	4	2	8	3	6	7
Arithmetic	1	4	2	8	5	3	6	7

[a] Cluster 1 = YAC1, Cluster 2 = YAC2, Cluster 3 = YAC3, Cluster 4 = YAC4,

[b] Cluster 5 = YCC1, Cluster 6 = YCC2, Cluster 7 = YCC3, Cluster 8 = YCC4.

ate tests, shown in Table 22, indicated a significant difference in favour of the LD-C group on the Reading and Arithmetic subtests of the WRAT.

The results of the post hoc Newman-Keuls tests are also included in Table 22. Clusters not connected by a line indicate a significant difference at the .05 level; clusters are listed in order of increasing magnitude of the corresponding WRAT subtest scores. The post hoc analyses suggest that the Young LD-ACID and LD-C clusters did not differ significantly from one another on any of the WRAT subtests.

External criterion procedures for cluster solution OLD FS-CS-IR. Table 23 contains the results of the multivariate analysis of variance for the Old LD-ACID and LD-C subjects with group (LD-ACID vs. LD-C) and cluster membership as independent variables and performance on the WRAT subtests as dependent variables; a significant main effect for group was indicated. The univariate tests indicated a significant difference in favour of the LD-C group on the Arithmetic subtest of the WRAT; see Table 24. The results of the post hoc Newman-Keuls tests, included in Table 24, indicate that the Old LD-ACID and LD-C clusters did not differ significantly from one another on any of the WRAT subtests.

Cluster descriptions. The mean factor score profiles for clusters YAC1, YAC2, YAC3, and YAC4 are presented in Figures 20 through 23; the profiles for clusters OAC1, OAC2, OAC3, and OAC4 are presented in Figures 24 through 27. Visual intercomparisons of these profiles for each age level indicated that the clusters were qualitatively well differentiated by their factor score profiles.

The *T* score means and standard deviations of the 110 neuropsychological measures available for the Young LD-ACID group were calculated for the four Young LD-ACID clusters; the majority of these summary scores are presented in Appendix K. Similar data were compiled for the 103 measures available for the

TABLE 23

Multivariate Analysis of Variance of the WRAT Subtests by Group and Cluster: Old Age Group

Global Test	Wilk's lambda	*p*	Largest root criterion
Group	0.9605	0.0269	0.0411
Cluster	0.9470	0.1891	0.0374

TABLE 24

Univariate Analysis of Variance of the WRAT Subtests by Group and Cluster: Old Age Group

	Mean T Score										
	LD-ACID Clusters[a]				LD-C "Clusters"[b]					p ≤	
WRAT Subtest	9	10	11	12	13	14	15	16	MSe	Group	Cluster
Reading	41.02	39.80	42.97	38.48	41.75	41.08	42.97	40.76	59.248	.329	.250
Spelling	36.39	36.59	37.77	35.85	38.13	37.74	37.68	38.12	31.580	.067	.943
Arithmetic	39.20	38.76	37.53	38.45	40.77	40.98	39.36	39.73	20.329	.003	.266

Newman-Keuls Tests $p < .05$

Reading	12	10	16	9	14	13	15	11
Spelling	12	9	10	15	14	11	16	13
Arithmetic	11	12	10	9	15	16	13	14

[a] Cluster 9 = OAC1, Cluster 10 = OAC2, Cluster 11 = OAC3, Cluster 12 = OAC4,

[b] Cluster 13 = OCC1, Cluster 14 = OCC2, Cluster 15 = OCC3, Cluster 16 = OCC4.

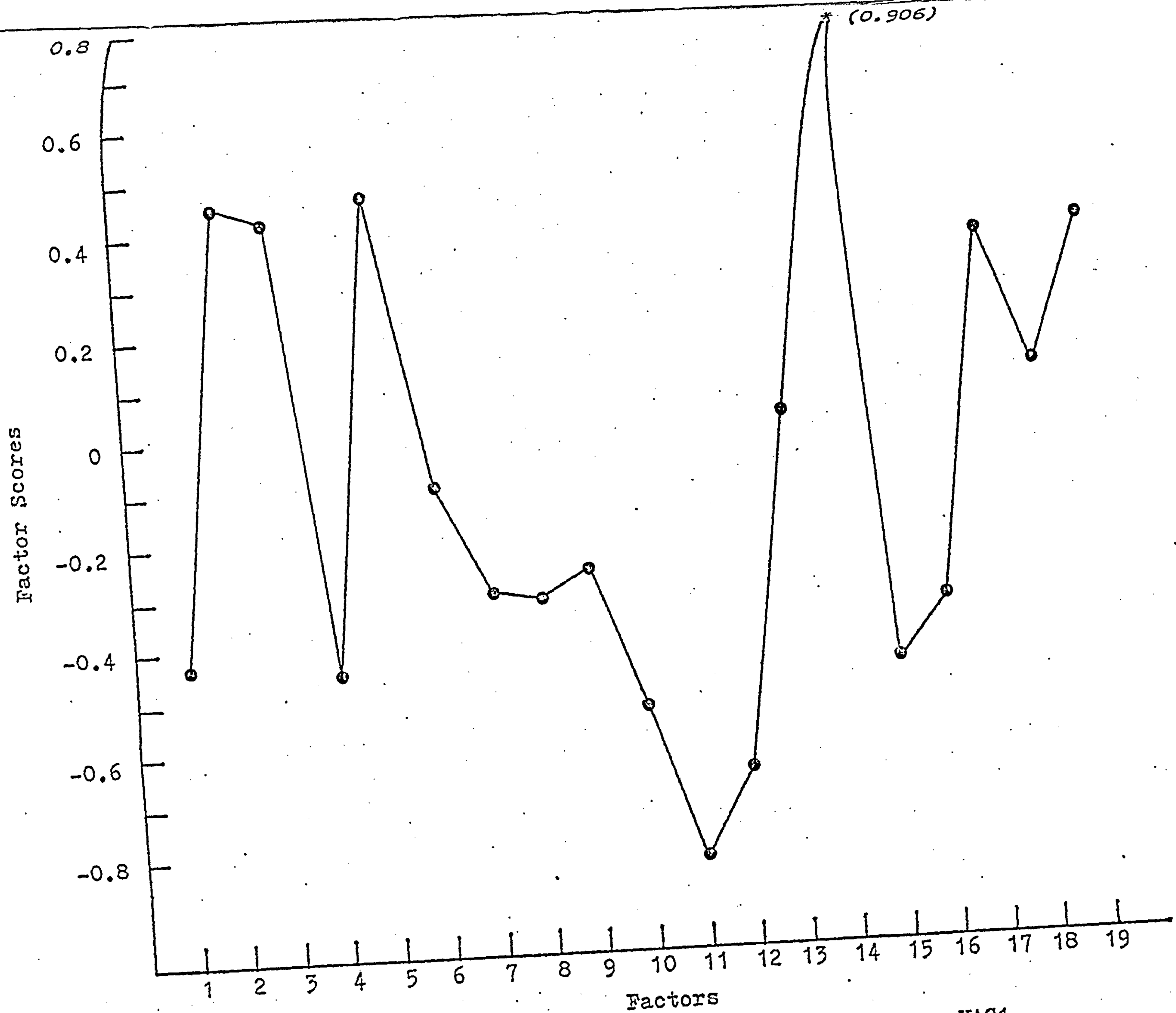


Figure 20. Mean factor score plot for Young LD-ACID cluster YAC1.

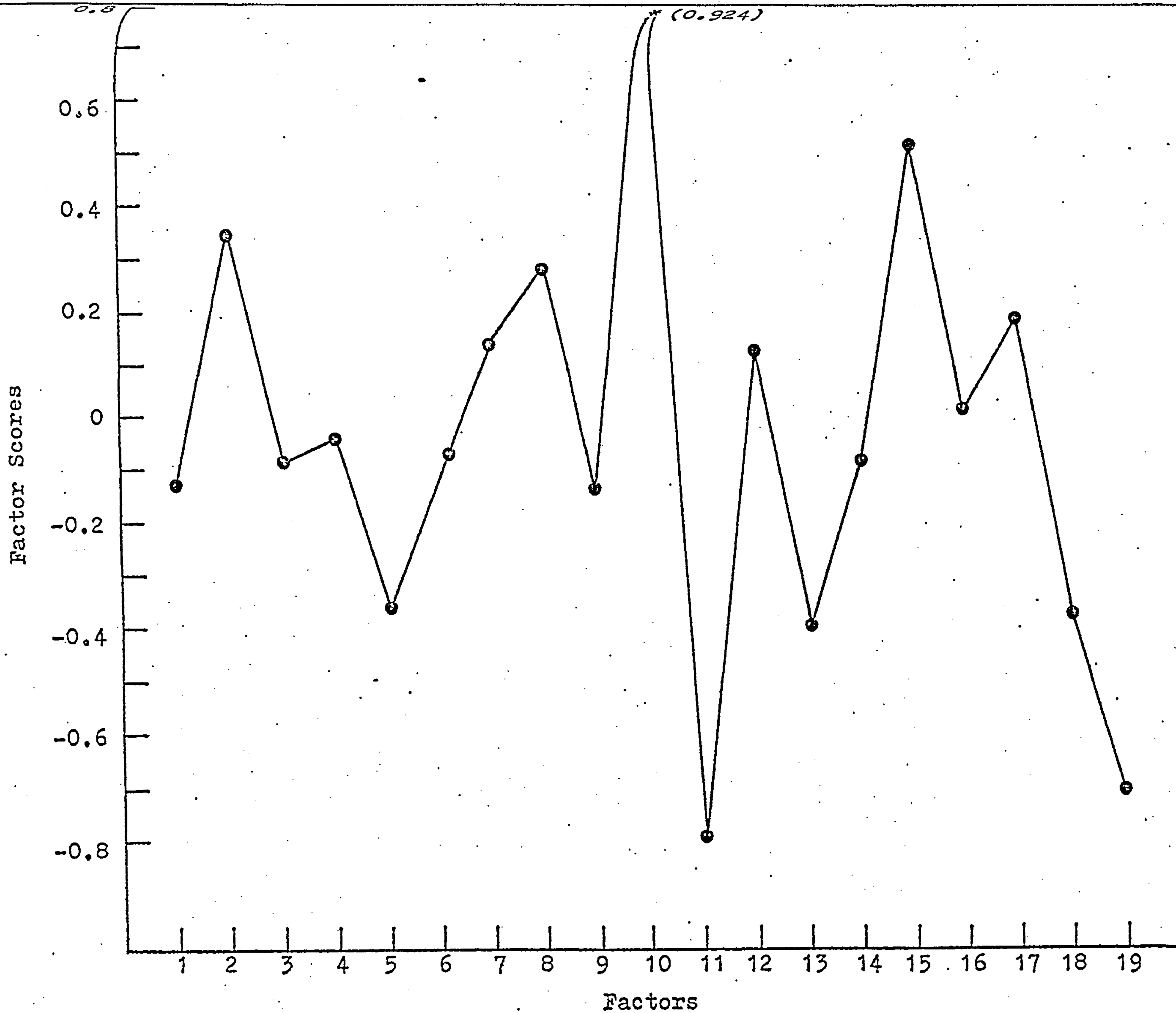


Figure 21. Mean factor score plot for Young LD-ACID cluster YAC2.

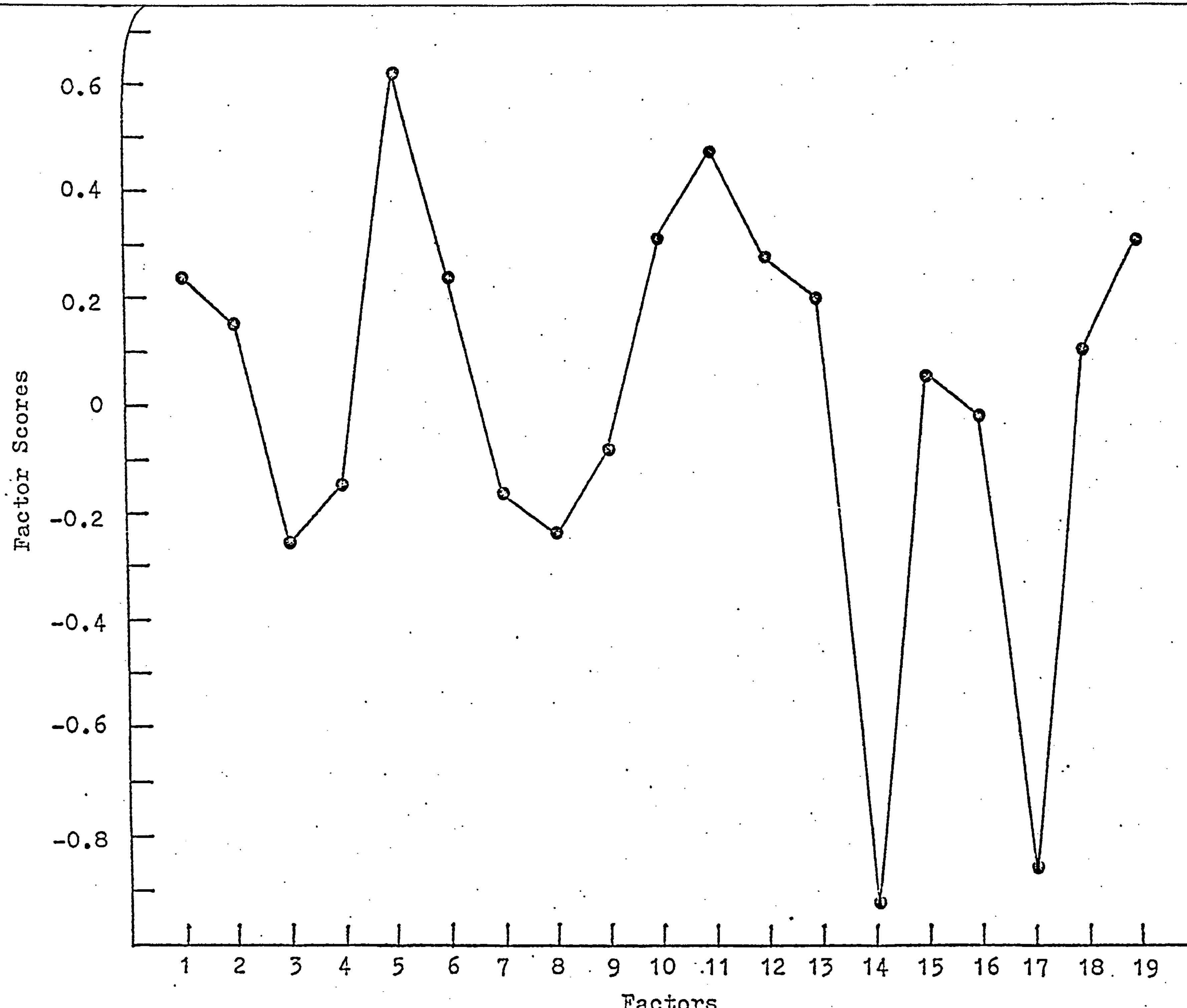


Figure 22. Mean factor score plot for Young LD-ACID cluster YAC3.

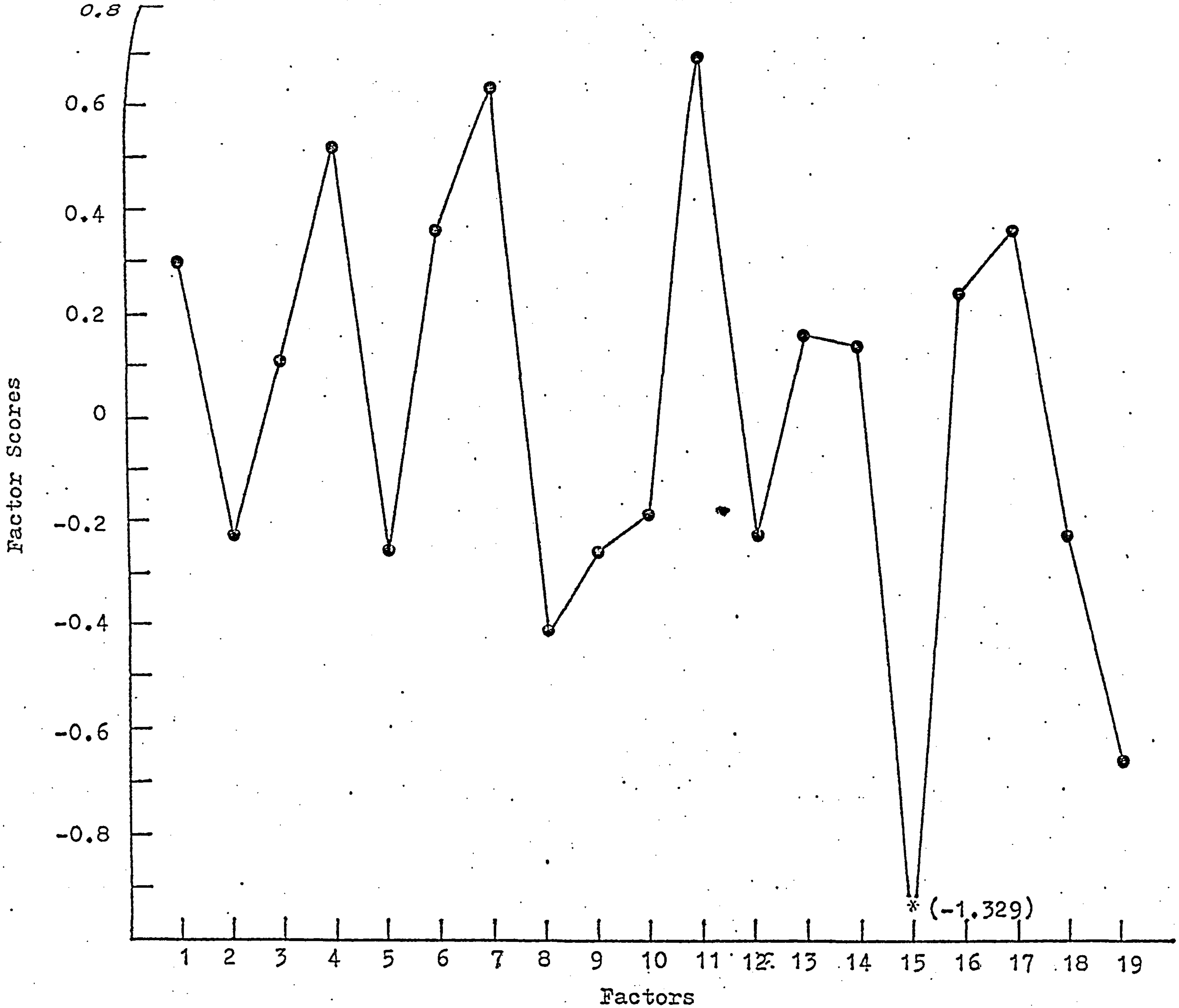
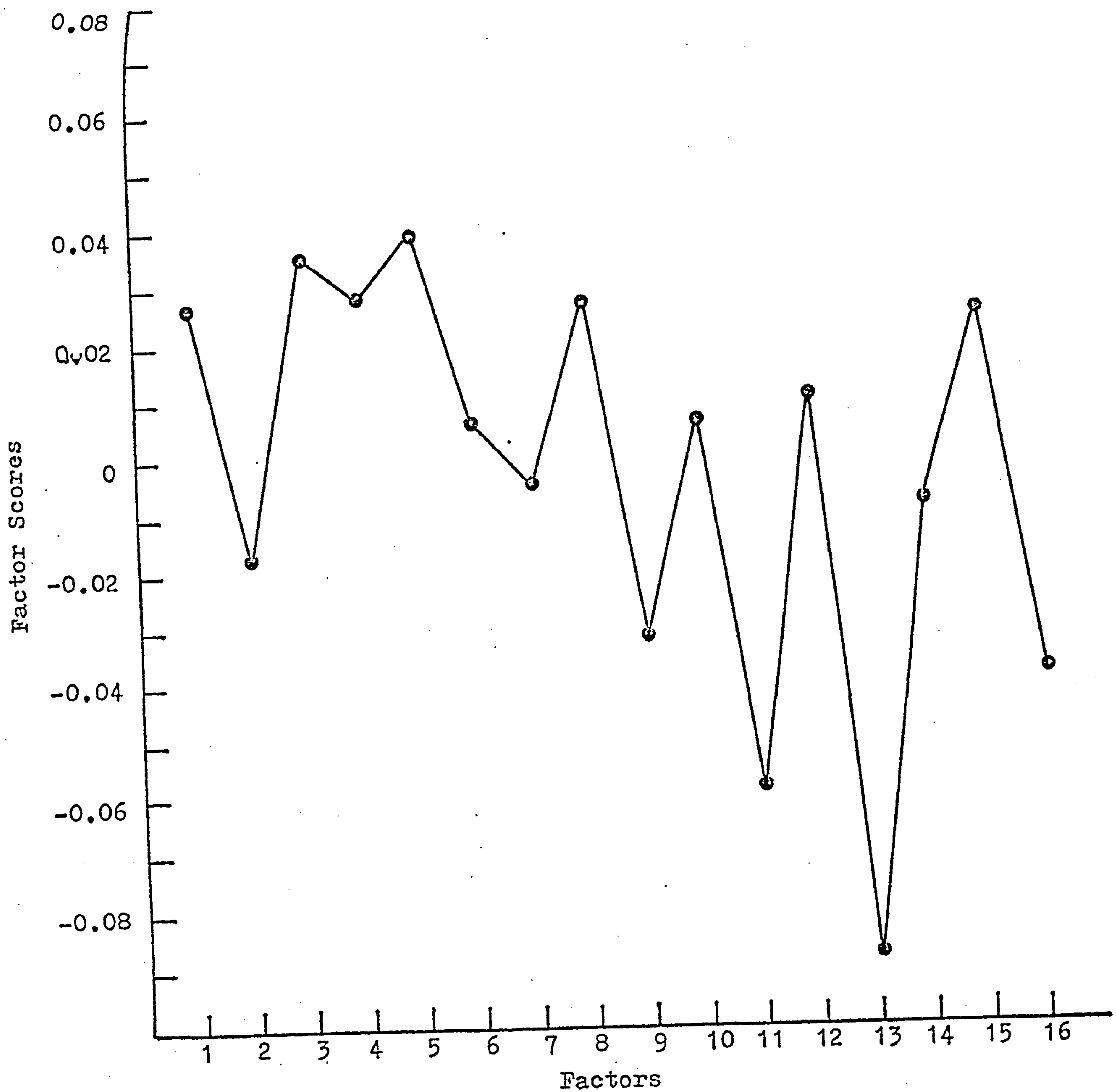


Figure 23. Mean factor score plot for Young LD-ACID cluster YAC4



score plot for Old LD-ACID cluster OAC1.

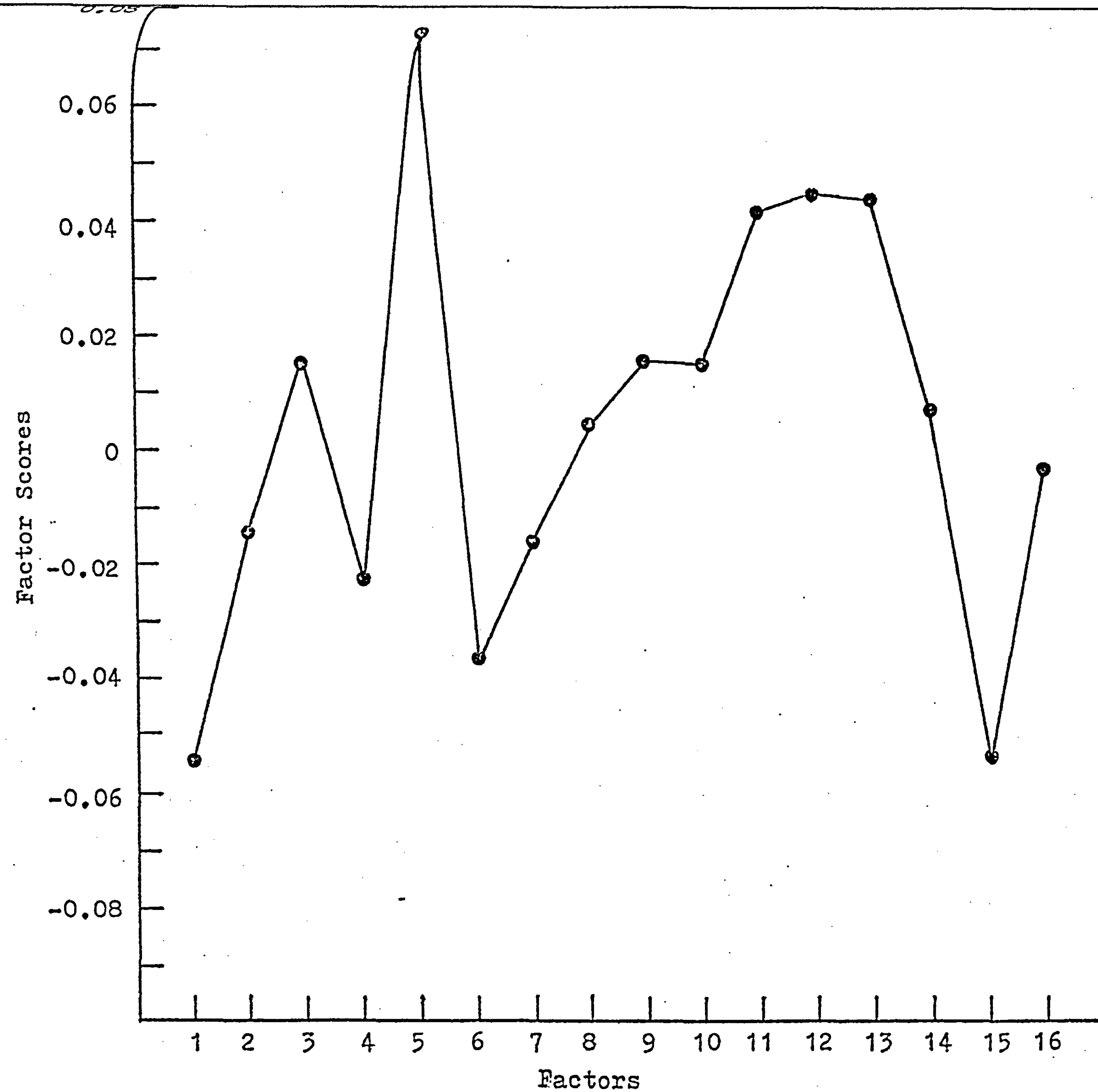


Figure 25. Mean factor score plot for Old LD-ACID cluster OAC2.

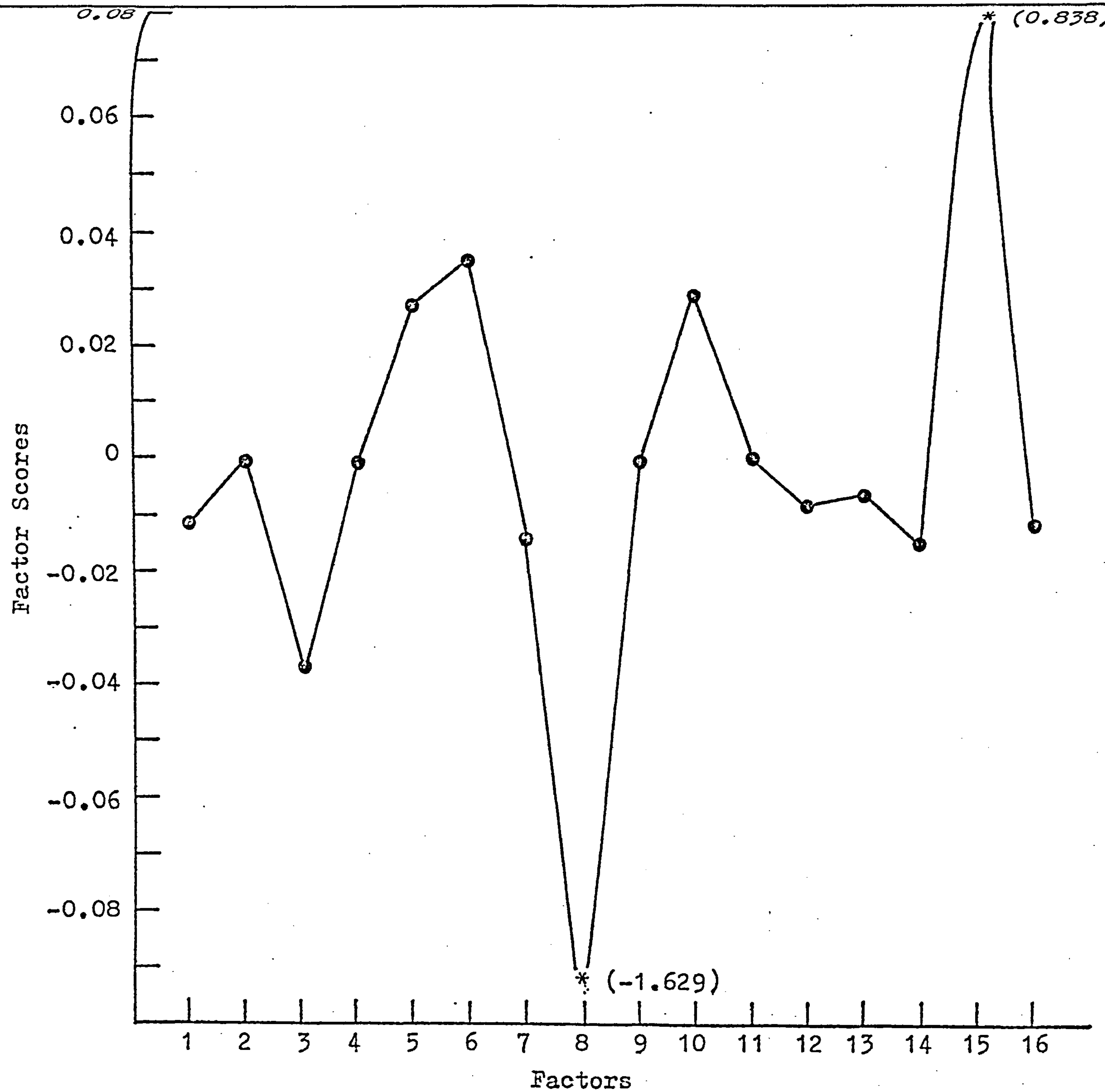
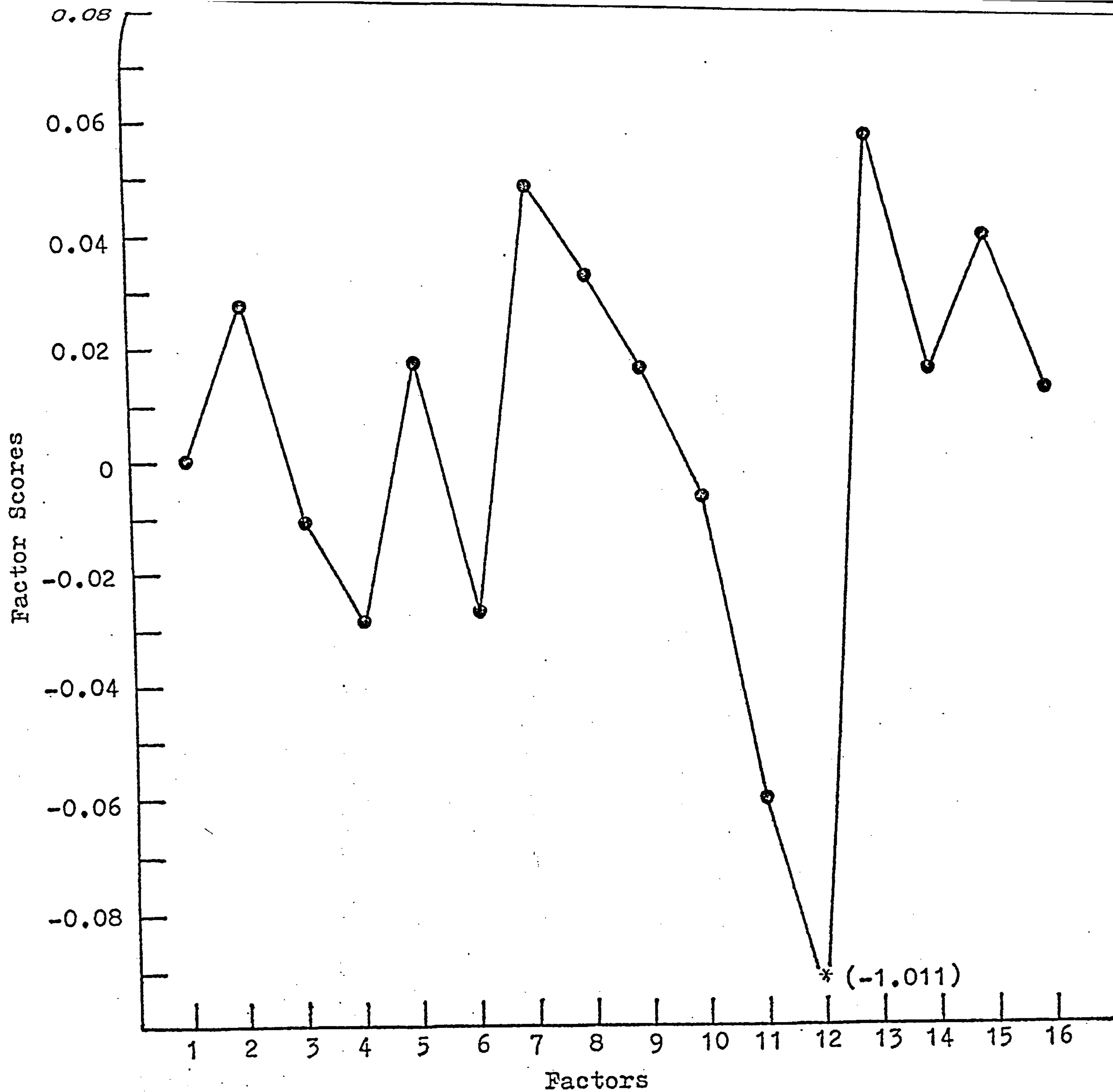


Figure 26. Mean factor score plot for Old LD-ACID cluster OAC3.



... plot for Old LD-ACID cluster OAC4.

Old LD-ACID group; these data are presented in Appendix L. Inspection of Appendices K and L provided the basis for the descriptions of the cluster profiles of neuropsychological abilities presented in the next chapter.

CHAPTER V

DISCUSSION

The data indicate that (1) LD children exhibiting the ACID pattern on the WISC are not a homogeneous group with respect to their patterns of neuropsychological abilities and (2) reliable subtypes of LD-ACID children can be identified. Prior to the discussion of these results, however, some methodological limitations of this research will be considered. Then, the success with which reliable subtypes were identified will be discussed. A description of these subtypes and their relationships to the findings of previous investigations will follow. Finally, the implications of this investigation and suggestions for further research will be presented.

Methodological Considerations

The present study employed a "clinic" sample of LD-ACID and LD-C children. Since all subjects were screened to fit a commonly accepted definition of "learning disability" (see Rourke, 1978a), the use of children from a clinic setting was not considered to be particularly problematical. Nonetheless, local subject characteristics and referral procedures are still limitations when making generalizations. Therefore, the findings of this research can only be viewed as suggestive and should be cross-validated in other settings.

The WISC Full Scale IQs of the LD-ACID children utilized in this investigation ranged from 80 to 124. Therefore, the generalizability of the present findings must be limited to LD-ACID children within this range of psychometric intelligence. Additional and/or very different subtypes might eventuate from the use of subjects within a broader range of WISC Full Scale IQs.

The present study employed subjects in two separate age ranges (6 — 0 to 8 — 11 and 9 — 0 to 14 — 11) that were analysed separately. This cross-sectional design limits generalizations related to developmental trends (i.e., the extent to which the ability profiles of LD-ACID children change with age). The differences in the neuropsychological measures administered to the two age-based samples further limits comparisons between the results generated for the two groups.

The determination of the ACID pattern based on the relative pattern of Wechsler subtest scores further limits the generalizability of the present results. A different subtype structure might eventuate if the ACID pattern were determined on the basis of a certain minimum difference (e.g., the standard error of measurement or the abnormality of the difference; Piotrowski, 1978) between the ACID subtests and the remaining Wechsler scales.

A number of issues related to the cluster analyses may also affect the generalizability of the present findings. The choice of the clustering variables, similarity coefficient, clustering algorithms, and terminal cluster solutions all involved basically a subjective decision on the part of the author. Clearly, other choices, which may have affected the derived subtype structure, were possible.

The clustering variables (i.e., factor scores) were derived from principal components analyses of the combined LD-ACID and LD-C groups at each of the two age levels. It is possible that different principal components solutions, and hence a different subtype structure, might have resulted were principal components analyses applied only to the LD-ACID groups. Since one of the objectives of this research was to determine if subtypes of LD-ACID children differed from other LD children, it seemed reasonable to utilize the combined samples of LD-ACID and LD-C children. In addition, it can be argued that the use of larger samples has the effect of providing more stable correlation coefficients and, therefore, more stable principal components solutions (Comrey, 1978).

The choice of the variables subjected to the principal components analyses, viz. the majority of the measures in the neuropsychological assessment battery, was itself a subjective categorization of the data. This choice, however, reflects the view of the author and others (e.g., Rourke & Strang , 1981) that a taxonomy of LD children should be based on a fairly comprehensive, clinical assessment of the various abilities thought to be subserved by the cerebral cortex. Different results may have been derived from the use of other measures and/or a subset of the neuropsychological measures utilized in this investigation.

As has been discussed previously, the similarity measure utilized in a cluster analysis can affect the resultant solution. The choice of the correlation coefficient as the similarity measure in this research resulted in the elucidation of a stable LD-ACID subtype structure. Post hoc analyses utilizing squared Euclidean distance, however, resulted in the "chaining" of the LD-ACID subjects and a very different cluster solution; dendrograms very much like those in Figures 12 – 19 were produced when the young and old LD-ACID groups were subjected to group average and centroid sorting analyses utilizing the distance coefficient.

As has been discussed in Chapter III, different clustering algorithms may produce very different classifications of the same data set. Therefore, a different subtype structure might have been derived had other clustering procedures been used in the present research. The results of post hoc furthest neighbour clustering (complete linkage) utilizing correlation as the measure of similarity (CLUSTAN, version 1C2, procedure HIERARCHY, method FURTHEST NEIGHBOUR; Wishart, 1975) demonstrates this point. The partitions of the LD-ACID groups derived from this latter clustering technique were clearly different than those derived from the group average and centroid sorting analyses utilized in this investigation. This is not believed to be a problem vis-à-vis the findings of the present research, however, because furthest neighbour clustering does not focus on group structure (it only measures the similarity between two individuals) and tends to produce irregular results (Wishart, 1975).

The choice of the "stopping point" in a hierarchical cluster analysis is generally considered to be problematical (Everitt, 1974). The four-cluster terminal solutions in this investigation were chosen primarily on the basis of a commonly accepted criterion, a "significant" drop in the clustering coefficient. Nonetheless, this was basically a subjective decision. Clearly, a different subtype structure, viz. a fewer or greater number of subtypes, would have eventuated if a different level of the hierarchical solution were chosen.

Finally, the subtype structure of the LD-ACID children derived in the present study needs to be confirmed empirically before it can be accepted as valid. In this regard, a number of "internal" validation procedures were carried out in the present research. In general, the cluster solutions were well-preserved across clustering methods and different sets of variables and subjects; this will be discussed further in the next section. The LD-ACID subtypes were also well differentiated in terms of their ability profiles (see Figures 20 — 27). These subtypes, however, were not distinguished on the basis of level of performance on the subtests of the WRAT. Since meaningful subtypes should be predictive of behaviour external to the behavioural measures utilized in the classification, intercomparisons of the subjects on other criterion measures (e.g., on prenatal, perinatal, or neonatal developmental histories; on parental characteristics; on teacher/parent observation; on personality characteristics; on qualitative aspects of, say, their spelling performance; on response to specific remedial approaches, etc.) is needed to assess the meaningfulness of the present classification of LD-ACID children.

Identification of Reliable LD-ACID Subtypes

Four types of LD-ACID children were extracted from each of the two age-based samples utilized in this research. Tables 15 and 16 suggest that two subtypes at each age level (YAC2 and YAC4 for the younger group; OAC1 and OAC2 for the older group) were quite reliable in that they remained well-defined over five different methods of clustering the data. This is supported by the results obtained from the clustering of different sets of variables (see Tables 17 & 18) and, to a somewhat lesser extent, by the results obtained from the clustering of the combined samples of LD-ACID children and their matched controls. Tables 19 and 20 summarize this differential stability of the LD-ACID subtypes over the different clustering methods and sets of variables.

The procedures described above indicate that the same clusters consistently appear in these data, but this only demonstrates the consensual validity of the derived categorization (Kendell, 1975). The clinical meaningfulness of the subtypes generated in this research, which ultimately is related to the predictive validity of the classification, is dealt with in the next section.

Description of Subtypes

In this section, the LD-ACID subtypes are described in general terms. Table 25 contains a summary of the neuropsychological test performances of the four Young LD-ACID subtypes; Table 26 which contains the corresponding data for the older subtypes is presented on pages 115 – 116. Down the left-hand columns of these tables are the abbreviations for the neuropsychological measures listed on pages 23 – 28. In order to simplify intercomparisons of the subtypes, these

TABLE 25

Summary of the Neuropsychological Performance of the Young LD-ACID Subtypes

Neuropsychological Measures [1]	YAC4 (89.58)*	YAC2 (88.16)*	YAC3 (58.33)*	YAC1 (52.78)*
	Young LD-ACID Subtypes			
Tactile-Perceptual				
TACR	+	--	+	+
TACL	+	+	-	+
FAGR	-	--	-	----
FAGL	--	--	-	----
ASTR	+	+	-	-
ASTL	+	+	-	+
FTWRR	+	---	+	----
FTWRL	+	--	+	---
TPTRT	+	-	-	-
TPTLT	+	+	-	-
TPTBT	-	+	-	----
TPTMEM	+	-	-	-
TPTLOC	-	-	--	---
Visual-Perceptual				
WISC PICCOM	+	+	+	++
WISC BLKDES	+	++	+	+
WISC OBASS	+	++	+	+
COLFRMT	--	----	--	--
PROFIGT	-	--	-	-
STARE	+	---	-	+
CONSQE	----	---	----	-----
Auditory-Perceptual and Language-Related				
AUDR	+	-	--	-
AUDL	+	-	+	+
SSPER	*	-----	-----	*
AUDCLO	-	-	+	--
SENMEM	-----	-----	--	----
FLUENCY	--	----	---	----
PPVTIQ	-	+	+	+
WISC INFO	--	--	--	--
WISC COMP	-	+	+	+
WISC SIM	-	+	++	++
WISC VOCB	+	+	+	++

TABLE 25 cont'd

Neuropsychological Measures	Young LD-ACID Subtypes YAC4	YAC2	YAC3	YAC1
Sequencing: Auditory and Visual Sequential Perception, Sequential Motor Responding				
TARGET	----	---	--	----
WISC PICARR	-	+	+	+
MFIGE	----	+	-	+
MATVE	---	--	---	--
WISC DSYM	--	--	--	---
WISC DSPAN	---	--	--	--
WISC ARITH	--	--	--	--
TAPRH	--	++	+	-
TAPLH	--	++	+	--
TAPRF	----	--	---	----
TAPLF	----	---	---	----
Concept Formation, Reasoning				
CATTOT	-	-	+	---
MATPXT	+	-	-	-
Motor				
MAZERT	-	--	+	--
MAZERC	-	--	+	--
MAZERS	--	-	----	---
MAZELT	-	----	--	----
MAZELC	-	----	-	-----
MAZELS	--	--	---	--
HOLESRT	-	--	-	--
HOLESLT	---	---	---	-----
PEGSRT	+	+	-	-
PEGSLT	+	+	-	---
Academic				
WRAT READSTS	---	--	--	---
WRAT SPELSTS	---	---	--	---
WRAT ARITHSS	--	--	--	--

[1]Abbreviations as per Table 2, pages 23 – 25.
*Reliablity coefficient.
Note: "+" corresponds to a _T_ score range of 50 – 55; "++" corresponds to a _T_ score range of 56 – 60; "+++" corresponds to a _T_ score range of 61 – 65, etc. "-" corresponds to a _T_ score range of 49 – 45; "--" corresponds to a _T_ score range of 44 – 40; "---" corresponds to a _T_ score range of 39 – 35, etc. "*" corresponds to a _T_ score less than 20.

measures have been grouped into 7 areas: tactile-perceptual, visual-perceptual, auditory-perceptual and language-related, sequential perception and sequential motor responding, concept formation and reasoning, motor, and academic.

The body of Tables 25 and 26 contain a symbolic summary of the performances of the subtypes on the neuropsychological measures. The test scores have been converted to symbols corresponding to 1/2 standard deviation units above and below the T score mean ($\overline{X}$ = 50, SD = 10). The scores have been coded such that the symbol "+" corresponds to a score in the range of 50 – 55 T score points, while the symbol "++" corresponds to a score in the range 56 – 60 T score points. Similarly, the symbol "-" corresponds to a score in the range of 49 – 45 T score points, while the symbol "--" corresponds to a score in the range of 44 – 40 T score points. The symbol "*" corresponds to a score greater than three standard deviations below the mean (i.e., a T score less than 20).

Wherever possible, the subtypes are related to relevant data from previous investigations in this area. The Young LD-ACID subtypes will be described first and will be presented in order of their reliability coefficients. The Old LD-ACID subtypes will then be described also in order of their reliability coefficients.

In order to familiarize the reader with the data presented in Tables 25 and 26, the subtypes will be described initially with reference to each of the seven categories of neuropsychological measures. Later, however, only the distinguishing features of the subtypes will be emphasized in the verbal descriptions.

Type YAC4. This type was the most reliably reproduced of any of the Young LD-ACID subtypes and contained 12 subjects in a ratio of five males to one female. As demonstrated in Table 25, the feature which distinguished Type YAC4 from the other Young LD-ACID subtypes is a pattern of consistently poorer performances on the tests in the sequencing category. The neuropsychological test performances of Type YAC4 on the tests in the other categories can be characterized as follows: a) performances generally within 1/2 standard deviation about the mean on measures of tactile- and visual-perceptual abilities, although performance on one measure (CONSQE) in the latter category was almost two standard deviations below the mean; b) performances within one standard deviation about the mean on most auditory-perceptual and language-related measures; performances well below the mean, however, were evident on tests involving auditory-visual matching (SSPER) and sentence memory (SENMEM); c) performances within 1/2 standard deviation about the mean on tests in the concept formation and reasoning category; and d) performances generally within one standard deviation about the mean on tests in the motor category.

Compared to the other Young LD-ACID subtypes, type YAC4 exhibited the lowest WISC Verbal and Full Scale IQs and a Verbal IQ-Performance IQ discrepancy of 7.24 IQ points in favour of the Performance scale. They also exhibited the lowest Peabody Picture Vocabulary Test IQ and the poorest performance on a test involving sustained attention and auditory sequencing (Seashore Rhythm Test). Their WRAT Reading and Spelling subtest scores were somewhat poorer than their Arithmetic scores.

In summary, inspection of the mean profile of type YAC4 shows deficits in auditory, visual-spatial, and motoric sequential processing. This may be the limiting feature responsible for the academic difficulties of this group. Whether immediate auditory-verbal and visual-spatial memory problems per se are also present or whether the apparent mnemonic deficiency is a reflection of a "sequencing" deficit is moot. Qualitative analyses of the Digit Span and Sentence Memory performance of these subjects could be expected to shed some light on this issue. Nonetheless, various authors (reviewed by Rourke, 1978b) have postulated that sequencing deficits may account for reading disorders in some children. In particular, Denckla (1977) and Mattis (1978) have described small groups of learning disabled children with isolated sequencing deficits who bear a striking resemblance to subtype YAC4. Petrauskas and Rourke (1979) have described a subtype of 7- and 8-year-old retarded readers who as a group exhibited the ACID pattern and "sequencing" difficulties. This latter group, however, differed in a number of ways from Type YAC4. Most notably, Type YAC4 did not exhibit the tactile finger localization and concept formation (MP) deficiencies exhibited by Petrauskas and Rourke's Type 2 subjects. Also, YAC4 subjects exhibited a larger Verbal IQ-Performance IQ discrepancy and a pattern of poorer WRAT Reading and Spelling and better WRAT Arithmetic performances than Petrauskas and Rourke's subjects. Finally, only 7 out of the 26 subjects in Petrauskas and Rourke's group would seem to have actually exhibited the ACID pattern on an individual basis.

There is a recent trend to distinguish between "simultaneous" and "successive" (sequential) processing and to relate them to right and left hemisphere functions, respectively (Levy, 1974; Leong, 1976). In view of the sequencing deficiences evident in Type YAC4 and the overall profile of neuropsychological strengths and weaknesses exhibited by this group, it would seem reasonable to hypothesize that some of the abilities thought to be subserved by the fronto-temporal region of the left cerebral hemisphere are compromised in this LD-ACID subtype.

Type YAC2. This type consisted of 19 males and was the second most reliable Young LD-ACID subtype. Type YAC2 subjects exhibited a pattern of poorer performances with the right upper extremity relative to the left upper extremity on a number of measures in the tactile-perceptual category. Their poorest performance in this area was on a test involving the perception of symbols written on the fingertips (FTWRR). In comparison to the other Young LD-ACID subtypes, Type YAC2 exhibited a pattern of outstandingly poor performances on four tests (COLFRMT, PROFIGT, STARE, CONSQE) in the visual-perceptual category. With the exception of performances well below the mean on tests involving auditory-visual matching (SSPER), sentence memory (SENMEM), and verbal fluency (FLUENCY), performances on tests in the auditory-perceptual and language-related category were within one standard deviation about the mean. Likewise, the performances of Type YAC2 subjects on the measures in the sequencing and concept formation categories were generally within one standard deviation about the mean. Within the motor category, Type YAC2 exhibited an outstanding deficiency in kinetic steadiness ability with the left upper extremity (MAZELT, MAZELC).

Type YAC2 exhibited the highest Full Scale and Performance IQs and the largest Verbal IQ-Performance IQ discrepancy (10.58 IQ points) of any of the Young LD-ACID subtypes. Their WRAT Spelling subtest scores were somewhat poorer than their Reading and Arithmetic scores.

In general, there is some similarity between the pattern of neuropsychological strengths and weaknesses exhibited by type YAC2 and the symptoms of lesions of the temporal and adjacent posterior regions of the left cerebral hemisphere (Luria, 1973). With respect to the underlying neuropsychological deficit affecting academic performance, Type YAC2 children may be experiencing a predominant deficiency in the "revisualization" of symbols. This would seem to be reflected in the poor performances of this type on the Fingertip Symbol Writing Recognition Test, the WRAT Spelling subtest, the Speech-Sounds Perception Test, the WISC Coding subtest and, possibly, the WISC Arithmetic and Digit Span subtests and the Target test. Further investigations, including a qualitative analysis of the spelling and reading errors evidenced by Type YAC2 children, will be necessary to test this hypothesis.

Similar problems in revisualization have been described by Johnson and Myklebust (1967) in their discussion of disorders of written language in learning disabled children. Type YAC2 may be similar to Boder's (1971) "dyseidetic dyslexia" group and to a subtype of reading problem children described by Doehring and Hoshko (1977) who exhibit poor auditory-visual matching involving syllables and words.

Type YAC3. This type did not emerge reliably from the classification procedure and contained 15 subjects in a ratio of approximately 6 males to 1 female. Compared to the other Young LD-ACID types, Type YAC3 exhibited the fewest deficits overall. As a group, they exhibited borderline performances on the WRAT subtests and a minimal Verbal IQ-Performance IQ discrepancy (3.14 IQ points).

The test performance of Type YAC3 can be characterized as follows: a) performances generally within 1/2 standard deviation about the mean on measures of tactile- and visual-perceptual abilities, although performance on one measure (CONSQE) in the latter category was almost two standard deviations below the mean; b) performances within one standard deviation about the mean on most auditory-perceptual and language-related measures; performances greater than one standard deviation below the mean, however, were evident on tests involving auditory-visual matching (SSPER) and sentence memory (SENMEM); c) the majority of the tests in the sequencing category within one standard deviation about the mean; d) performances on tests in the concept formation and reasoning category within 1/2 standard deviation about the mean; and e) in comparison to the other subtypes, outstandingly slow performances bilaterally on a measure of kinetic steadiness ability (MAZERS, MAZELS).

Overall, the mean T score profile of this type bore the least resemblance of any of the four Young LD-ACID types to neuropsychological profiles encountered in clinical practice. Among other things, this suggests that this type may be an artifact of the clustering procedure.

Type YAC1. This type was the least reliably reproduced of the Young LD-ACID subtypes and contained 9 male subjects. Type YAC1 seems to be distinguished by a pattern of deficiencies in certain tactile- and visual-perceptual skills (FAGR, FAGL, FTWRR, FTWRL, TPTBT, TPTLOC, CONSQE), sequencing skills (TARGET, DSYM, TAPLH), concept formation and reasoning skills (CATTOT), and motor skills with the left upper extremity (MAZELT, MAZELC, HOLESLT, PEGSLT). Compared to the other Young LD-ACID types, Type YAC1 exhibited the lowest performances on the WRAT subtests (with lower scores on Reading and Spelling than on Arithmetic) and almost equal WISC Verbal and Performance IQs (98.44 and 98.77, respectively).

The profile of strengths and weaknesses exhibited by Type YAC1 suggests that some of the abilities normally thought to be subserved by the right frontal and left temporoparietal cortical regions are compromised in this group of LD-ACID children. It is clear, however, that the present study was not designed to test this hypothesis. Although Type YAC1 was the least reliably reproduced of the four Young LD-ACID subtypes and therefore may represent an artificial grouping forced on the data by the classification procedure, the mean group profile of these subjects bears considerable similarity to neuropsychological profiles seen in clinical practice. This type would seem to exhibit a pattern of neuropsychological strengths and weaknesses similar to one of the subtypes of 7- and 8-year-old retarded readers described by Petrauskas and Rourke (1979).

Type OAC1. This type was the most reliably reproduced of the Old LD-ACID subtypes. It consists of 41 subjects in a ratio of approximately 20 males to 1 female. Type OAC1 was distinguished from the other Old LD-ACID types by a pattern of normal performances (within one standard deviation about the mean) on

TABLE 26

Summary of the Neuropsychological Performance of the Old LD-ACID Subtypes

Neuropsychological Measures [1]	Old LD-ACID Subtypes OAC1 (83.54)*	OAC2 (80.88)*	OAC3 (69.04)*	OAC4 (54.54)*
Tactile-Perceptual				
TACR	+	--	-	+
TACL	++	+	-	+
FAGR	--	--	-----	*
FAGL	-	+	----	*
ASTR	-	---	+	-
ASTL	-	----	+	-
FTWRR	-	--	*	-
FTWRL	-	---	*	--
TPTRT	+	+	+	--
TPTLT	+	+	--	-
TPTBT	-	-	--	-
TPTMEM	+	-	+	-
TPTLOC	+	--	-	-
Visual-Perceptual				
WISC PICCOM	++	+	+	++
WISC BLKDES	+	+	+	+
WISC OBASS	++	++	+	+
Auditory-Perceptual and Language-Related				
SSPER	----	----	--	-----
AUDCLO	-	-	---	--
SENMEM	--	---	----	----
FLUENCY	---	---	---	----
PPVTIQ	+	+	-	-
WISC INFO	--	--	---	--
WISC COMP	+	+	-	-
WISC SIM	+	+	+	+
WISC VOCB	+	+	+	-
Sequencing: Auditory and Visual Sequential Perception, Sequential Motor Responding				
TARGET	--	--	---	--
WISC PICARR	+	+	+	-
WISC DSYM	--	--	---	--
WISC DSPAN	--	---	---	---
WISC ARITH	--	--	---	---

TABLE 26 cont'd

Neuropsychological Measures	Old LD-ACID Subtypes OAC1	OAC2	OAC3	OAC4
TRAILAT	---	--	--	-
TRAILBT	----	--	----	---
TAPRH	+	+	-	-
TAPLH	-	-	+	-
TAPRF	--	--	--	-
TAPLF	--	---	--	--
Concept Formation, Reasoning				
CATTOT	+	-	+	-
Motor				
MAZERT	+	-----	-	--
MAZERC	++	--	-	-
MAZERS	-----	--	---	-
MAZELT	-	----	----	--
MAZELC	-	---	--	--
MAZELS	-----	-	---	-
HOLESRT	--	--	-	--
HOLESLT	+	+	+	+
PEGSRT	--	-	--	--
PEGSLT	--	-	---	-
Academic				
WRAT READSTS	--	---	--	---
WRAT SPELSTS	---	---	---	---
WRAT ARITHSS	---	---	---	--

[1]Abbreviations as per Table 3, pages 26 – 28.
*Reliability coefficient.
Note: "+" corresponds to a T score range of 50 – 55; "++" corresponds to a T score range of 56 – 60, etc.
"-" corresponds to a T score range of 49 – 45; "--" corresponds to a T score range of 44 – 40; "---" corresponds to a T score range of 39 – 35, etc.
"*" corresponds to a T score less than 20.

the measures in the tactile-perceptual category, deficient performances on two symbolic sequencing and visual-spatial scanning tasks (TRAILAT, TRAILBT), and outstandingly slow performances bilaterally on a measure of kinetic steadiness ability (MAZERS, MAZELS). Type OAC1 also exhibited the highest WISC Full Scale IQ and the smallest Verbal IQ-Performance IQ discrepancy (9.22 IQ points) of the Old LD-ACID subtypes. Their WRAT Spelling and Arithmetic scores were somewhat poorer than their Reading scores.

In view of the average tactile- and visual-perceptual skills and the circumscribed sequencing, motor and auditory-perceptual and language-related deficiencies exhibited by Type OAC1, it would seem reasonable to hypothesize that some of the abilities thought to be subserved by the frontotemporal region of the left cerebral hemisphere are compromised in this LD-ACID subtype. As such, this type bears some resemblance to Young LD-ACID Type YAC4. Thus, Type OAC1 may represent an "older version" of Type YAC4. A longitudinal tracking of Type YAC2 children, however, would be necessary to verify this assertion.

Type OAC2. This type was the second most reliably reproduced Old LD-ACID subtype. It contained 33 males and 1 female. Type OAC2 exhibited the largest WISC VIQ-PIQ discrepancy (11.76 IQ points) of the four Old LD-ACID subtypes. They exhibited a pattern of mildly impaired performances on all three of the WRAT subtests.

The distinguishing features of the neuropsychological test performances of Type OAC2 would seem to be: a) poor performances on a number of tactile-perceptual measures, particularly those involving the "mental imaging" of numbers (FTWRR, FTWRL) and objects (ASTR, ASTL, TPTLOC) and b) outstandingly poor kinetic steadiness abilities bilaterally (MAZERT, MAZELT). This pattern of tactile-perceptual and kinetic steadiness deficiencies, together with the deficiencies in certain auditory-perceptual (SSPER) and language-related skills (SENMEM, FLUENCY), is similar to neuropsychological profiles seen in clincal practice and indicates that some of the abilities thought to be subserved by the temporal and adjacent posterior cortical regions of the left cerebral hemisphere (Luria, 1977) are compromised. This pattern of neuropsychological strengths and weaknesses bears some resemblance to that of Young LD-ACID Type YAC2. A longitudinal tracking of Type YAC2 children, however, will be necessary to determine whether Type OAC2 children represent an older version of the younger ACID subtype.

Type OAC3. This type was comprised of 19 males and 2 females and was the oldest ($\overline{X}$ = 12.5 years) of the Old LD-ACID subtypes; it was less reliably reproduced than Types OAC1 and OAC2. Type OAC3 exhibited the lowest WISC Verbal, Performance, and Full Scale IQ values and the lowest scores on the ACID subtests of any of the Old LD-ACID subtypes. Their WRAT Spelling and Arithmetic subtest scores were somewhat poorer than their Reading scores. A pattern of poor performances on certain tactile-perceptual measures (FAGR, FAGL, FTWRR, FTWRL), sequencing measures (TRAILBT, TARGET, DSYM), and motor measures with the left upper extremity (MAZELT, MAZELC, MAZELS, PEGSLT) seems to distinguish Type OAC3 from the other Old LD-ACID types.

Although Type OAC3 was not highly stable over the various clustering approaches utilized in this research and therefore may represent an artificial grouping forced on the data by the clustering algorithm, this type bears considerable similarity to Young LD-ACID Type YAC1. In particular, the deficiencies in fingertip symbol/number writing perception, finger recognition, auditory-verbal processing, and motor performance with the left hand are quite similar for both groups. The pattern of neuropsychological strengths and weaknesses exhibited by Type OAC3 also resembles profiles encountered in clinical practice.

Type OAC4. This type was the least reliably reproduced of the four Old LD-ACID subtypes and consisted of 22 males. This group exhibited a lower Verbal IQ than Performance IQ on the WISC and they obtained uniformly deficient performances on all three WRAT subtests. The distinguishing features of the neuropsychological test performances of this type would appear to be: a) marked difficulty on tests for finger localization (FAGR, FAGL), b) an inferior performance with the right upper extremity on the Tactile Performance Test (TPTR), and c) the poorest performances overall on the measures in the auditory-perceptual and language-related areas.

Although Type OAC4 was not reproduced reliably and, therefore, may represent an artificial classification of the data, the mean profile of this group is similar to some neuropsychological profiles seen in clinical practice. This type also bears some resemblance to one of the subtypes of uniformly learning disabled children described by Fisk and Rourke (1979) and one of the subtypes of 7- and 8-year-old retarded readers described by Petrauskas and Rourke (1979).

Evaluation of Expectations

The general expectations contained in Hypothesis (1) received clear support. Two highly reliable subtypes of LD-ACID children emerged at each of the two age levels studied. Subhypotheses (1a) and (1b) were not supported in that Young LD-ACID types with either outstandingly poor reading scores and low average WISC Verbal and Performance IQs or uniformly depressed reading, spelling and arithmetic scores, low average WISC FSIQ, and a greater Performance than Verbal IQs did not emerge in the present investigation. Subhypothesis (1c) received some marginal support; Young LD-ACID Type YAC1 exhibited the expected pattern of low reading and spelling scores relative to arithmetic, average WISC FSIQ, and no appreciable Verbal-Performance discrepancy. Type YAC1, however, was the least reliable of the Young LD-ACID types.

At first glance, the failure to find reliable LD-ACID subtypes similar to groups of LD-ACID children described in the literature is perplexing. There is at least one major difference, however, between the subjects used in the present research and those used in previous investigations which may account for this phenomenon. All of the LD-ACID subjects utilized in the present research individually exhibited the ACID pattern. There is little evidence to indicate that the ACID groups described in previous investigations consisted of such well defined ACID children; in most cases, it would seem that group means rather than individual profiles served to define the ACID groups (e.g., see Ackerman et al., 1976, 1977; Petrauskas & Rourke, 1979).

Although there was no support for the expectations contained in Hypothesis (2), viz. that at least one LD-ACID subtype would be characterized by poorer reading, spelling, and arithmetic performance than a matched group of LD-C children, there were some clear differences between the LD-ACID and LD-C groups in their performances on the WRAT. The Young LD-ACID children as a group obtained significantly poorer WRAT Reading and Arithmetic scores than the matched LD-C group. With respect to the WRAT performance of the older subjects, only the Arithmetic subtest (favoring the controls) differentiated the two groups.

Within the constraints of this sort of cross-sectional research, Hypothesis (3) obtained some support. Subtypes with some similarity to Young LD-ACID Types YAC1, YAC2, and YAC4 emerged from the cluster analytic classification of the Old LD-ACID children. This would seem to indicate that the ability profiles of young LD-ACID children do not vary dramatically as a consequence of developmental changes. It cannot be concluded with certainty, however, that the Old LD-ACID subtypes represent an older version of the Young LD-ACID types; a longitudinal investigation would be necessary to deal with this issue.

Finally, there was no support for the expectations contained in Hypothesis (4). A subtype of young LD-ACID children with pronounced distractibility, attentional difficulties, and pervasive neuropsychological defects did not emerge from the present data.

Implications

Clinical experience and the available literature suggests that children who exhibit the ACID pattern on the Wechsler scales are a heterogeneous population with respect to their adaptive ability structure. The purpose of the present study was to determine whether this heterogeneity could be demonstrated objectively by an automatic multidimensional classification procedure.

On the basis of the results of this study, the following generalizations would seem to be warranted.

(1) Children who individually demonstrate depressed scores on the WISC Arithmetic, Coding, Information, and Digit Span subtests do not appear to constitute a homogeneous group in terms of their neuropsychological, adaptive abilities. The results of this investigation indicate that there are at least two types of LD-ACID children at each of the two age levels studied. The present findings have obvious implications for school psychologists and others who might tend to base academic recommendations on a unitary view of the ACID pattern as, say, a measure of "freedom from distractibility". Although there is some evidence to indicate that the subtypes found in the older age group are similar to, and therefore possibly an older version of, the Young LD-ACID subtypes, a longitudinal study would be necessary to support this hypothesis.

(2) The identification of subtypes in this study is in line with the results of previous investigations (Doehring & Hoshko, 1977; Doehring et al., 1979; Fisk & Rourke, 1979; Mattis, 1978; Petrauskas & Rourke, 1979; Satz et

al., 1979) which have indicated that learning disabled children are quite a heterogeneous group.

(3) The similarities of the LD-ACID types identified in the present study to other specific groups of LD children described in the literature (e.g., the similarity of Type YAC4 to groups of children described by Denckla, 1977, and Mattis, 1978) are encouraging vis-à-vis the consensual validity of the LD-ACID subtypes. Further in-depth qualitative analyses of the deficiences exhibited by these types, however, would be necessary to confirm these similarities. Such analyses of the LD-ACID types would also help to specify more exactly the nature of the information processing deficiences experienced by these children (e.g., the extent to which Type YAC4 children are experiencing mnemonic versus "sequencing" problems).

(4) The dissimilarities between the LD-ACID Types identified in this study and children who as a group exhibit the ACID pattern has been discussed in the previous section of this paper. These dissimilarities would seem to highlight the difficulties inherent in attributing clinical utility to profiles based on mean scores which may not be representative of individual LD children constituting the group. Previous conclusions based on such group profiles, e.g., that the ACID pattern per se portends particularly poor prognosis for academic performance in reading, spelling, and arithmetic, as measured by the WRAT (Ackerman et al., 1976), must be viewed with some caution. The results of the present cross-sectional study would not support this conclusion vis-à-vis LD children in general; although the older LD-ACID group obtained lower WRAT Arithmetic scores than a group of matched learning disabled controls who did not evidence the ACID pattern, the two groups were not differentiated significantly in terms of their reading or spelling performances. Clearly, a longitudinal investigation is necessary to address fully this issue.

(5) On the basis of the results of this study, children who exhibit the ACID pattern would seem to differ in a number of ways from other children with learning disabilities who do not exhibit the ACID pattern. The LD-ACID children obtained poorer WRAT Reading and Arithmetic scores than the LD-C children at the younger ages and poorer Arithmetic scores at the older ages. There was also some evidence to suggest that the LD-ACID children exhibited qualitatively different ability profiles than the learning disabled controls.

(6) Although samples of LD children commonly exhibit the ACID pattern as a group (e.g., Ackerman et al., 1971, 1977; Lutey, 1977; Swartz, 1974), only a small proportion of LD children would seem to exhibit this pattern on an individual basis. Of the large number of children contained in the data base utilized in the present study, less than six percent exhibited the ACID pattern.

(7) As stated above in a number of places, a more detailed evaluation of the subtypes identified in this research, including qualitative analyses of their test performances, is necessary to specify more exactly the nature of the information processing deficiences experienced by these types and to establish the predictive validity of the taxonomy generated in this study. Related to the predictive validity of the present classification are the issues of the etiology and the remediation of learning disabilities. With respect to the former, if the LD-ACID subtypes should be differentiated on the basis of, say, birth-related trauma or learning disabilities in other family members, these subtypes could be used to evaluate those views which ascribe CNS insult or genetic factors to the genesis of learning disabilities. The subtypes identified in the present study could also be used to evaluate the appropriateness of specific remedial techniques for certain "types" of learning disabilities. One might expect that Type YAC4 would benefit from specific training in visual and auditory sequencing while Type YAC2 would seem to require an approach which encourages visualization through the

use of a tactile- and kinesthetic-perceptual approach to spelling (e.g., the multisensory methods of G. Fernald, 1943).

(8) Finally, a direct comparison of different multidimensional classification techniques, such as the comparisons of cluster analysis and _Q_ factor analysis carried out by Doehring et al. (1979), would be helpful in assessing the reliability and validity of the subtypes generated in the present research. Two previous studies (Fisk & Rourke, 1979; Petrauskas & Rourke, 1979) utilizing the same data base as the present study have demonstrated the utility of _Q_ factor analysis in generating classifications of "uniformly" learning disabled children and 7- and 8-year-old retarded readers, respectively. A comparison of the _Q_ factor analytic and cluster analytic methodologies with the sort of extensive neuropsychological data utilized in this and the latter two studies, however, would help in determining which of these two approaches are most sensitive to the differences in the neuropsychological ability profiles which define subtypes of learning disabled children.

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APPENDIX A

Description of Tests[1]

[1] Adapted from the description of tests distributed by the Department of Neuropsychology, Windsor Western Hospital Centre, Windsor, Ontario.

TESTS ADMINISTERED TO ALL CHILDREN (AGES 5-15)

WECHSLER INTELLIGENCE SCALE FOR CHILDREN. (Wechsler, 1949)

Full Scale IQ. A composite score derived from the total scaled subtest scores. Indicative of overall "intellectual" functioning.

Verbal IQ. A prorated score derived from the total scaled scores of six Verbal subtests. Indicative of overall "verbal" functioning.

Performance IQ. A composite score derived from the scaled scores of the five Performance subtests (excluding the Mazes test). Indicative of overall non-verbal, "visual-perceptual" functioning.

Verbal Subtests

Information. 30 questions. Involves elementary factual knowledge of history, geography, current events, literature, and general science. Score: number of items correct. Task Requirement: retrieval of acquired verbal information. Stimulus: spoken question of fact. Response: spoken answer.

Comprehension. 14 questions. Involves the ability to evaluate certain social and practical situations. Score: number of items correct. Task Requirement: evaluation of verbally formulated problem situations. Stimulus: spoken request for opinion. Response: spoken answer.

Arithmetic. 16 arithmetic problems of increasing difficulty. Score: number of problems correctly solved, within time credit. Task Requirement: arithmetic reasoning. Stimulus: spoken (first 13 items) or printed (last 3 items) question. Response: spoken answer.

Similarities. 16 pairs of words. The most essential semantically common characteristic of word pairs must be stated. Score: number correct. Task Requirement: verbal abstraction. Stimulus: spoken question. Response: spoken answer.

Vocabulary. 40 words. Spoken definition of words. Score: number of words correct. Task Requirement: verbal definition. Stimulus: spoken word. Response: spoken definition.

Digit Span. Repetition in forward order of three- to nine-digit numbers and repetition in reversed order of two- to eight-digit numbers. Score: simple total of forward and reversed digit span. Task Requirement: short-term memory for digits. Stimulus: spoken numbers. Response: spoken numbers.

Performance Subtests

Picture Completion. 20 pictures of familiar objects, each with a part missing. The missing part is identified from simple line drawings. Score: number of missing parts correctly identified. Task Requirement: location of missing part on the basis of memory of the whole object. Stimulus: picture. Response: spoken name of missing part.

Picture Arrangement. 11 series of picture cards. Pictures are sequentially arranged to form a story. Score: total credits for speed and accuracy of arrangement. Task Requirement: manipulation of the order of picture cards to form the most probable sequence of events. Stimulus: pictures. Response: simple motor manipulation.

Block Design. 10 designs. Arrangement of coloured blocks to form designs which match those on printed cards. Score: total score for speed and accuracy of block placement. Task Requirement: arrangement of blocks to match a printed design. Stimulus: printed geometric design. Response: manipulation and arrangement of blocks.

Object Assembly. 4 formboards (puzzles). Parts of each formboard are to be arranged to form a picture. Score: total score for speed and accuracy of assembly. Task Requirement: spatial arrangement of parts to form a meaningful whole. Stimulus: disarranged parts of picture. Response: complex manipulation and arrangement of parts.

Coding. 93 digits, preceded by a code which relates digits to symbols. Symbols are to be written below digits as rapidly as possible. Score: number of symbols correctly written within a fixed time. Task Requirement: association of digits and symbols by direct visual identification and/or by short-term memorization. Stimulus: printed digits and symbols. Response: rapid co-ordination of visual identification with a complex writing response.

PEABODY PICTURE VOCABULARY TEST FORM A. (Dunn, 1965)

Picture Vocabulary, Oral Raw Score, Oral IQ, Mental Age derived from I.Q. 150 sets of 4 line drawings, with which 150 words of increasing difficulty are to be associated. The words are those of Form A of the Peabody Vocabulary Test. Score: total correct picture-word associations. Task Requirement: selection of picture most appropriately related to the spoken word. Stimulus: 4 visual pictures, 1 spoken word. Response: simple pointing or verbal response. Oral IQ is the transformation of the oral raw score to an IQ score on the basis of test norms.

WIDE RANGE ACHIEVEMENT TEST. (Jastak & Jastak, 1965)

Reading. Standardized test of oral word reading achievement. Score: centile score based on total number of words correctly read aloud. Task Requirement: association of printed letters with spoken words. Stimulus: printed word. Response: spoken word.

Spelling. Standardized test of written spelling achievement. Score: centile score based on total number of words correctly spelled. Task Requirement: written production of spoken word. Stimulus: spoken word. Response: written word.

Arithmetic. Standardized test of written arithmetic achievement. Score: centile score based on total number of correct solutions to progressively more difficult arithmetic problems. Task Requirement: solution of arithmetic problems. Response: written answers.

OLDER CHILDREN'S BATTERY (AGES 9-14)

TESTS FOR SENSORY-PERCEPTUAL DISTURBANCES. (Reitan & Davison, 1974)

Tactile Perception

The child is required to identify correctly (without vision) the hand or face (left or right) which receives tactile stimulation. The stimulus is produced by a light touch. Following this determination of the child's ability to perceive unilateral stimulation, simultaneous bilateral hand stimulation and contralateral hand-face stimulation is interspersed with unilateral stimulation. The score is the number of errors for each hand and each side of the face under all conditions.

Auditory Perception

The child is required to identify correctly (without vision) the ear to which an auditory stimulus is presented. The stimulus is produced by rubbing the fingers together lightly. Following the determination of the child's ability to perceive unilateral stimulation, bilateral stimulation is interspersed with the unilateral stimulation. The score is the number of errors for each ear under all conditions.

Visual Perception

The child is required to identify correctly slight finger movements presented in a confrontation manner to the visual fields. Stimulation is presented initially unilaterally and then simultaneous bilateral stimulation is interspersed with the unilateral trials. The score is the number of errors made within the quadrants of the visual fields.

Finger Agnosia

The child is required to identify (without the aid of vision) the finger which has been touched. Each of the five fingers is stimulated four times in random order. First the right hand and then the left hand is stimulated. The score is the number of errors made with each finger for each hand.

Finger-Tip Number-Writing Perception

The child is required to verbalize (without the aid of vision) which of the numbers 3, 4, 5 or 6 has been written on his fingertips. A different finger of the right hand is used for each trial until four trials had been given for each finger. The procedure is then repeated for the left hand. The score is the number of errors made with each finger for each hand.

Coin Recognition

The child is required to identify, by tactile perception only, 1-, 5-, and 10-cent pieces placed in his right hand, then his left hand, and then each coin placed simultaneously in both hands. The order of presentation is unsystematic. The score is the number of errors made with each hand under each condition.

TARGET TEST. (Reitan & Davison, 1974)

The child is required to make a delayed response in reproducing visual-spatial configurations of increasing complexity tapped out by the examiner. The score is the number of items out of 20 correctly reproduced.

TRAIL MAKING TEST. (Reitan & Davison, 1974; Rourke & Finlayson, 1975)

The Trail Making Test consists of two parts, A and B. In Trails A, the child is required, under time pressure, to connect the numbers 1 to 15 arranged on a page. The requirements are essentially similar in Trails B except that it is necessary to alternate between the numeric and the alphabetic series. The scores recorded are the number of seconds required to finish each part plus the number of errors made on each part.

SWEEP HEARING TEST.

The child is required to indicate whether or not he can detect a series of pure tones, ranging from 125 hertz to 8000 hertz. Each tone is presented unilaterally through ear phones. The decibel level of each tone is systematically decreased until the minimal audible level is determined.

AUDITORY CLOSURE. (Kass, 1964)

The child is required to blend into words 23 progressively longer chains of sound elements presented on tape. The score is the number of words correctly identified.

SENTENCE MEMORY. (Benton, 1965)

The child is required to repeat sentences of gradually increasing length (from 1 to 26 syllables). These are presented on a tape recorder. The score is the number of sentences correctly repeated.

SPEECH-SOUNDS PERCEPTION TEST. (Reitan & Davison, 1974)

The child is required to attend to 30 tape-recorded nonsense syllables and to select the correct response alternative from among three printed choices. The score is the number of sounds correctly identified.

VERBAL FLUENCY.

The child is required to name as many words as he can, within 60 seconds, which begin with the sound "P", as in pig. This is repeated with the sound "C", as in cake. The score is the mean number of correct words for the two trials.

HALSTEAD-WEPMAN APHASIA SCREENING TEST. (Reitan & Davison, 1974)

Naming (Dysnomia). Five items which require the child to name familiar objects. Scores: number of errors.

Spelling (Spelling Dyspraxia). The child is required to spell orally three spoken words. Score: number of errors.

Writing (Dysgraphia). Two items. The child is required to write a word and a sentence which are presented to him orally. Score: number of errors.

Enunciation (Dysarthria). Three items. The child is required to repeat three increasingly complex words spoken to him by the examiner. Score: number of errors.

Reading (Dyslexia). Six items. The child is required to read numbers, letters, and words. Score: number of errors.

Reproduction of Geometric Forms (Constructional Dyspraxia). Four items. The child is required to copy a square, a triangle, a Greek cross, and a key. Score: number of errors.

Arithmetic (Dyscalculia). Two items. The subject is required to solve two problems: one subtraction (written) and one multiplication (oral). Score: number of errors.

Understanding Verbal Instructions (Auditory-Verbal Agnosia). Four items. Subject is required to demonstrate an understanding of four verbal items. Score: number of errors.

SEASHORE RHYTHM TEST. (Reitan & Davison, 1974)

The Rhythm Test is a subtest of the Seashore Tests of Musical Talent. The child is required to differentiate between 30 pairs of rhythmic patterns which are sometimes the same and sometimes different. The score is the number of errors.

HALSTEAD CATEGORY TEST. (Reitan & Davison, 1974)

This tests consists of 168 visual choice stimulus figures which are presented to the child individually on a milk-glass screen located on the front of the apparatus. An answer panel is provided for the child. This consists of four answer buttons which are individually identified by the numbers 1, 2, 3, and 4. The child's task is to view the stimulus-figure and to offer his answer by depressing one of the four answer buttons. A pleasant bell sounds after each correct response and a harsh buzzer sounds after each incorrect response. The bell and buzzer, therefore, provide the essential information necessary for determining the concept underlying the stimulus figures. In successive sequences of trials, the abstraction of principals of numerosity, oddity, spatial position, and relative extent is required for successful responding. The final subtest of the Category Test is sumerical in nature and therefore does not have a principal to be discerned. The child is told that he should try to remember the correct answer based on his previous observation of the item and to give that same answer again. The score is the number of errors.

TESTS FOR LATERAL DOMINANCE. (Harris, 1947; Miles, 1929)

Hand Preference. The child is required to demonstrate the hand used to throw a ball, hammer a nail, cut with a knife, turn a doorknob, use scissors, use an eraser, and write his name. The number of tasks performed with each hand is recorded.

Eye Preference. The child is required to demonstrate the manner in which he would look through a telescope and use a rifle. The eye used for each task is recorded. In addition, the subject is given the Miles ABC Test for Ocular Dominance, in which (without ordinarily realizing that he is doing so) he has to choose one eye or the other to look through a conical apparatus to identify a visual stimulus. The eye chosen on each of 10 trials is recorded.

Foot Preference. The child is asked to demonstrate the manner in which he would kick a football and step on a bug. The foot used on each trial is recorded.

STRENGTH OF GRIP. (Reitan & Davison, 1974)

The Smedley Hand Dynamometer is used to measure strength of grip. The child is required to squeeze the dynamometer three times with his dominant hand and three times with his nondominant hand, alternating between hands on each trial. The mean pressure which he exerts on the three trials is recorded (in kgs.) for each hand.

WRITING SPEED. (Reitan & Davison, 1974)

The child is required to write his name with a pencil as rapidly as possible, first with his preferred hand and then with his non-preferred hand. The score is the time taken for each hand.

FINGER TAPPING. (Reitan & Davison, 1974); FOOT TAPPING. (Knights & Moule, 1967)

For finger tapping the child uses alternately the index finger of the dominant hand and of the nondominant hand. Four trials are given of 10 seconds each for both hands. The foot tapping test employs the same principles and instructions, but this time the child uses his feet, alternating between the dominant foot and the nondominant foot. Four trials of 10 seconds are given for each foot. The score for both finger and foot tapping is the average of the best three out of four trials.

MAZE TEST. (Kløve, 1963; Knights & Moule, 1968; Rourke & Telegdy, 1971)

The child is required to run a stylus through a maze which has the blind alleys filled and is placed at a 70 degree angle (on the Tactual Performance Test stand). Three scores are obtained: the number of contacts with the side of the maze, the total amount of time during which the stylus contacts the side of the maze, and the speed (total time from start to finish). These are electrically recorded. There are two successive trials with each hand. The scores are the totals for the two trials with the dominant hand and the two trials with the nondominant hand.

GRADUATED HOLES TEST. (Kløve, 1963; Knights & Moule, 1968; Rourke & Teledy, 1971)

The child is required to fit a stylus into a series of progressively smaller holes. The idea is to hold the stylus in the centre of the holes for a 10-second period without contacting the edge. Two scores are obtained: the number of contacts with the edge of the hole, and the duration of the contact. These are recorded electrically. The test is performed once with the right hand and once with the left hand.

GROOVED PEGBOARD TEST. (Kløve, 1963; Knights & Moule, 1968; Rourke, Yanni, MacDonald, & Young, 1973)

The child is required to fit keyhole-shaped pegs into similarly shaped holes on a 4-in. x 4-in. board beginning at the left side with the right hand and at the right side with the left hand. They are urged to fit all 25 pegs in as rapidly as possible. One trial is performed with the dominant hand followed by one trial with the nondominant hand. The scores obtained are the length of time required to complete the task with each hand and the total number of times the pegs are dropped with each hand.

TACTUAL PERFORMANCE TEST. (Reitan & Davison, 1974)

This test is Reitan's modification for children of the test developed by Halstead (1947). Halstead's test was based in turn, upon a modification of the Sequin-Goddard formboard. The child is blindfolded and not permitted to see the formboard or blocks at any time. The formboard is placed in a vertical disposition at an angle of 70 degrees on a stand situated on a table immediately in front of the child. He (she) is to fit six blocks into the proper spaces with the dominant hand, then with the non-dominant hand, and a third time using both hands. After the board and blocks have been put out of sight, the blindfold is removed and the child is required to draw a diagram of the board representing the blocks in their proper spaces. In all, six measures are obtained. Scoring is based on the time taken with the right, left and both hands. The Memory component of this test is the number of blocks correctly reproduced in the drawing of the board; the Location component is the number of blocks correctly localized in the drawing.

YOUNGER CHILDREN'S BATTERY (AGES 5-8)

(A) The following tests are the same as those administered to children 9-15 years of age:

The tactile, auditory, visual, and finger agnosia portions of sensory-perceptual disturbances tests.

Target Test

Sweep Hearing Test

Seashore Rhythm Test

Auditory Closure Test

Sentence Memory Test

Speech-Sounds Perception Test

Verbal Fluency Test

Lateral Dominance Examination

Strength of Grip

Name-Writing Speed

Finger- and Foot-Tapping Speed

Mazes

Children's Word-Finding Test

Underlining Test

(B) The following tests differ somewhat from those administered to children 9-15 years of age.

Finger-Tip Symbol-Writing Recognition. The procedure is identical to that described above, except that Xs and Os are used instead of numbers.

Tactile-Form Recognition. The child is required to identify familiar forms placed in his hands. Four forms are used. Each of these is placed in either hand separately. Then, different pairings of the forms are placed in both hands simultaneously. In all, there are 8 possible correct identifications for each hand. Task Requirement: recognition of forms by touch only. Response: spoken name of object or pointing to a representation of it.

HALSTEAD-WEPMAN APHASIA SCREENING TEST. (Reitan & Davison, 1974)

Naming (Anomia). 4 items. Otherwise the same.

Writing (Dysgraphia). 1 item written, 1 item printed. Otherwise the same.

Reading (Dyslexia). 3 items. Otherwise the same.

Drawing (Constructional Dyspraxia). 3 items. Otherwise the same.

Arithmetic (Dyscalculia). 4 items. Otherwise the same.

Body Orientation 4 items. The child is required to show or point to his nose, tongue, eyebrow, and elbow. Score: the number of errors.

Right-Left Discrimination. 2 items. The child is required to put his right hand on his nose, and his left hand on his head. Score: number of errors.

CATEGORY TEST. The Category Test utilizes the same general apparatus and procedure as the Halstead Category Test. However, the test consists of 80 stimulus figures divided into five subtests. The answer panel consists of four answer buttons which are individually identified by red, blue, yellow, and green lights. The principles involved are colour, quantity, oddity, and colour prominance. As in the Halstead Category Test the final subtest is sumerical in nature and therefore does not have a principle to be discerned.

GRADUATED HOLES TEST. The procedure is identical to that described above except that only the four largest holes are used.

GROOVED PEGBOARD TEST. The procedure is identical to that described above except that only the first two rows (ten holes) are used.

(C) The following tests are used only with children 5-8 years of age:

COLOR FORM TEST. (Reitan & Davison, 1974)

The Color Form Test uses stimulus material of various colors and shapes. Initially, the child is instructed that he should follow a sequence of progress from one figure to another by shifting between shape and color as stimulus clues. After a sample, in which careful instruction is given, the test itself is administered. The subject moves from the initial figure to one having the same shape even though the color is different, next proceeds to a figure that is different in shape but has the same color, and continues to alternate in this fashion.

PROGRESSIVE FIGURES TEST. (Reitan & Davison, 1974)

This test is presented on an 8¼" x 11" sheet of paper on which are printed eight stimulus figures. Each stimulus figure consists of a large outside figure (such as a circle) and a smaller figure of another shape inside (such as a square). The child's task is to use the small inside figure as the clue for progressing to the outside shape of the next stimulus figure. For example, if the child is located at a large circle enclosing a small square, the small square would indicate the next move would be to a large square. If the large square then enclosed a small triangle, the small triangle would serve as a clue for the next move. In this way the child progresses from inside figure to outside figure, moving from one stimulus configuration to the next.

MATCHING PICTURES. (Reitan & Davison, 1974)

The test consists of five pages, the first of which is a practice page. The task requires the child to match pictures located at the top of the page with their appropriate pairs shown across the bottom of the page. While the practice items require only matching of identical figures, the test progresses in such a way that a limited degree of generalization is required. For example, on one page a picture of a woman must be used to match the stimulus figure of a man, a girl to match a boy, etc. On another page a horse matches a cow, a chicken matches a rooster, etc. The test is so organized that it requires the child to respond in terms of equivalent categories in order to perform the test correctly.

MATCHING FIGURES and MATCHING Vs. (Reitan & Davison, 1974)

The child is asked to match figures printed on little blocks with the same figures printed on a single card. These figures become progressively more complex along the card. The little blocks are presented to each subject in a standardized manner. Score: the time in seconds required to complete the task and the number of errors.

DRAWING OF STAR and CONCENTRIC SQUARES. (Reitan & Davison, 1974)

The child is required to copy the figure presented to him. The examiner points out specifically how the figure is made up. The score is the time in seconds required to complete the drawing, and the number of errors.

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APPENDIX B

Varimax Rotated Factor Matrix for Data Set Young

AUDR	-0.01932	0.12992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUDL	-0.06975	0.08316	0.73273	0.04194	0.19264	0.05985	0.18982	0.0427
VISR	0.02964	0.06535	0.87855	0.04319	0.06213	0.11352	0.01606	0.0232
VISL	0.02072	0.12441	0.70290	0.08096	-0.07753	0.17559	-0.04749	0.0111
FAGR	0.08815	0.09322	0.23508	0.06579	-0.06375	0.01379	0.02623	0.1852
FAGL	0.04119	0.21524	0.00191	0.15957	0.09902	0.18751	0.05528	0.1393
FTWRR	0.08601	0.05715	0.09401	-0.07291	-0.01020	0.05507	-0.01276	0.0358
FTWRL	0.21753	0.09263	0.10304	0.07208	0.14042	0.18634	0.06397	-0.0790
ASTR	0.19076	0.43900	0.00661	0.09444	0.21584	0.02493	0.46429	0.2412
ASTL	0.06785	0.46760	0.31979	0.04428	0.23486	-0.15778	0.24665	0.1300
NAMER	0.11639	0.06629	-0.01631	0.04111	-0.04986	-0.06339	0.07639	0.0533
NAMEL	0.12016	-0.09083	-0.05211	0.06540	0.01686	0.05426	0.03953	-0.0194
MAZERT	0.60001	0.03841	-0.00383	0.36420	0.28062	0.10250	0.17195	0.1214
MAZERC	0.64639	-0.08122	0.00025	0.35879	0.32318	0.13227	0.06594	0.1673
MAZERS	-0.19943	-0.20809	-0.06309	-0.10018	-0.77479	-0.06430	-0.03935	-0.0754
MAZELT	0.62874	-0.01508	0.00673	0.15694	-0.06646	0.09636	0.12316	0.0271
MAZELC	0.70088	-0.11889	-0.02186	0.16995	-0.12001	0.13426	0.01334	0.0930
MAZELS	-0.14743	-0.15396	-0.01850	-0.06706	-0.83100	-0.03908	0.01787	0.0504
HOLESRT	0.86824	0.11255	-0.01820	0.10721	0.20101	-0.04355	0.03932	-0.0695
HOLESRC	0.90206	0.03400	-0.01272	0.01396	0.14837	-0.04622	0.02577	0.041
HOLESLT	0.88337	0.07570	-0.00676	0.14146	0.08113	-0.07350	-0.01647	0.0122
HOLESLC	0.88907	-0.02167	0.00539	-0.08582	-0.02066	-0.16948	0.05762	0.0724
PEGSRT	0.16691	-0.04292	0.04166	0.84327	0.10225	-0.00359	0.07004	0.0392
PEGSLT	0.30998	0.14791	-0.04201	0.76037	-0.02402	0.08189	0.02966	0.0566
TPTDT	0.05280	0.16661	0.26691	0.25147	0.13813	-0.12090	0.26121	0.2298
TPTNDT	-0.17705	0.19989	0.08643	0.22597	-0.25182	-0.26623	0.16686	0.2174
TPTBT	-0.02260	0.07950	0.12249	0.19656	-0.02074	-0.05018	0.48841	0.0532
MFIGT	0.18489	0.21696	0.19683	0.12730	0.55255	-0.07614	0.01876	0.1374
MFIGE	-0.01153	0.27640	0.15307	-0.04022	0.38673	-0.25639	0.04921	-0.1262
START	-0.02953	0.00593	0.15626	0.09529	0.01428	0.06547	0.27028	0.0342
MATVT	0.05017	0.23298	-0.01885	0.07979	0.07446	0.07235	0.14180	0.229
MATVE	0.15389	0.06930	-0.00548	-0.03149	0.24548	0.33880	0.23004	0.4451
CONSQT	-0.02936	0.07353	0.09759	0.18687	-0.01159	-0.09337	0.02590	0.1762
CONSQE	0.05145	0.02679	0.27278	0.17837	0.00399	0.13313	0.09371	0.2024
PROFIGT	-0.13331	0.05084	0.17550	0.08216	0.06299	0.80370	-0.00531	-0.0561
PROFIGE	-0.16120	0.16085	0.47710	0.06522	0.11514	0.59060	0.14316	-0.00
COLFRMT	0.01268	0.02334	-0.05005	0.10841	0.05164	0.18700	0.04163	0.043
COLFRME	0.02708	0.02289	0.04562	-0.26402	-0.15835	-0.04342	0.04298	0.00
MATPXT	0.01910	0.21217	0.15909	0.10384	-0.08066	0.62699	0.17245	0.154
COMP	0.02610	0.69119	0.35091	0.10183	0.01353	0.02732	0.01879	-0.129
SIM	-0.03309	0.75919	0.02562	-0.02726	0.27948	0.12622	-0.03034	-0.03
VOCB	-0.03859	0.72829	0.15121	0.01142	0.19812	0.19850	0.09600	0.143
PICCOM	0.16779	0.32252	0.05933	-0.07534	0.06654	0.09809	0.16417	-0.056
PICARR	0.04137	0.26266	0.26150	-0.10984	0.20884	0.20425	0.27510	0.164
BLKDES	0.04340	0.16608	0.04376	-0.00450	0.02995	0.00826	0.18995	0.025
OBASS	0.04968	0.11506	0.17362	0.06008	0.09345	0.12870	0.15194	0.088
PPVTIQ	-0.16281	0.26231	-0.06323	-0.06267	-0.22252	0.31120	-0.24284	0.012
AUDCLO	0.18019	0.45365	0.04239	0.31486	0.09336	0.06290	0.08668	0.208
SENMEM	0.15314	0.45433	-0.01313	0.36159	0.25987	0.09296	-0.01772	0.003
FLUENCY	0.19726	0.36400	0.05033	0.03818	0.28949	0.21672	0.04498	-0.001
TAPRH	0.04743	-0.03503	0.02301	0.24080	0.10082	0.02244	-0.00734	0.780
TAPLH	0.08399	-0.00540	0.10824	0.02377	-0.08588	-0.00295	0.02838	0.827
TAPRF	0.28212	0.10049	0.01358	0.20980	0.01951	0.04577	-0.04265	0.270
TAPLF	0.33867	0.02336	0.05611	0.11000	0.04203	0.06346	-0.01086	0.250
DYNF	-0.04232	0.02797	0.19088	0.05519	0.11225	0.00579	0.12245	0.049
DYNL	-0.04866	0.04235	0.16513	0.01884	0.10687	-0.00557	0.14593	0.055
TPTMEM	0.06217	0.02235	0.02039	-0.13758	0.05217	0.15183	0.64592	0.056
TPTLOC	0.10740	0.03675	0.10906	0.11456	-0.07013	0.05963	0.83349	-0.023
TARGET	0.08955	0.11118	0.11304	0.53797	0.26941	0.29337	-0.09332	0.102

TACR	0.11850	-0.01170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TACL	0.11060	0.10509	0.06471	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUDR	0.10971	0.10679	0.22818	0.05108	-0.17539	0.04336	-0.01541	[illegible]
AUDL	0.00320	-0.05934	0.07361	0.22451	0.03099	-0.06690	0.11903	0.09910
VISR	0.14877	0.13211	0.01847	0.06310	0.03762	0.00412	0.00640	0.01696
VISL	0.21458	0.15439	0.11954	-0.08961	-0.02322	-0.03078	-0.07567	-0.09279
FAGR	0.10576	0.08225	0.13522	0.78424	0.03316	0.16144	-0.05635	-0.11473
FAGL	0.15999	-0.03058	0.21865	0.71428	0.04165	-0.03373	0.04135	0.05458
FTWRR	0.04667	0.09389	0.81306	0.26098	0.09284	0.14324	0.01368	-0.02534
FTWRL	0.07339	0.11276	0.74727	0.12319	-0.00159	-0.03339	0.09495	0.12964
ASTR	0.24126	-0.08527	0.05234	-0.15253	-0.05716	0.06083	-0.06492	-0.07223
ASTL	0.36609	0.11717	0.19980	-0.08068	0.19639	0.05381	0.01977	0.00332
NAMER	0.16117	-0.02689	0.17265	-0.01178	0.11825	0.84736	0.02261	0.02643
NAMEL	0.07727	0.17097	-0.06664	0.09040	0.10141	0.89035	0.03835	0.04741
MAZERT	-0.02847	0.10665	0.10312	-0.07069	0.12687	0.09038	0.14601	-0.12500
MAZERC	-0.10411	0.09876	0.06167	-0.01414	-0.00087	0.04149	0.11526	-0.11739
MAZERS	-0.10298	-0.03850	-0.10795	0.01428	-0.01258	0.00833	-0.04664	-0.00031
MAZELT	0.16402	0.10466	0.16156	-0.05907	0.26018	0.06750	0.15679	-0.05708
MAZELC	0.07926	0.03903	0.10885	0.05866	0.08633	-0.04054	0.07300	-0.05660
MAZELS	-0.10896	0.00672	-0.04203	-0.01771	0.08599	0.04449	-0.01375	-0.00309
HOLESRT	-0.01675	0.00936	0.05236	0.00197	0.01310	0.09341	0.09955	0.00861
HOLESRC	-0.05310	-0.01238	0.02450	0.02424	-0.04505	0.09704	0.05635	-0.03897
HOLESLT	0.00472	0.04617	0.02912	0.01438	-0.08528	-0.01124	0.09061	0.03479
HOLESLC	-0.02273	0.04035	0.02988	0.10346	0.03202	0.05743	0.02346	0.04437
PEGSRT	0.01301	0.06204	-0.03641	0.10833	0.01126	0.11960	0.10889	0.01400
PEGSLT	0.03530	-0.02244	0.07257	0.13743	-0.14498	0.00742	0.10122	0.14411
TPTDT	0.19243	0.27438	0.31314	0.21652	0.23462	0.08615	0.02139	0.03261
TPTNDT	-0.11277	0.07267	0.33141	-0.12782	0.04002	0.05220	0.15946	-0.07860
TPTBT	-0.03281	0.06738	0.12721	0.53634	0.12528	-0.02141	0.22790	-0.02686
MFIGT	-0.00073	0.23007	-0.03933	0.04016	0.02354	0.15162	-0.08395	0.00390
MFIGE	0.15144	0.09384	-0.11527	-0.01144	-0.02609	-0.03979	0.33256	-0.06445
START	0.00075	0.07184	0.10911	0.07078	-0.03165	0.11387	0.18274	0.54229
MATVT	-0.03237	0.02773	0.22098	0.05224	-0.01746	0.35522	-0.01850	0.22526
MATVE	0.05880	0.19505	0.01032	-0.06602	0.00465	0.09790	-0.04738	-0.15005
CONSQT	0.11590	0.04797	0.05559	-0.04224	-0.07380	0.05171	-0.00917	0.33898
CONSQE	-0.03087	0.29596	0.08534	0.07704	0.00232	-0.00394	0.09552	-0.09723
PROFIGT	-0.06982	0.06541	0.07781	0.07999	0.07883	0.00628	0.07936	-0.04380
PROFIGE	0.07907	0.15531	0.02056	0.04330	-0.06734	-0.03580	0.20618	-0.02811
COLFRMT	0.03214	0.01492	-0.02959	0.07406	0.90662	0.08232	0.02094	-0.02607
COLFRME	0.08409	0.15101	0.17228	0.02406	0.82196	0.16502	-0.01054	-0.07326
MATPXT	0.04064	0.02048	0.10856	0.03243	0.15703	0.00524	-0.10402	-0.12963
COMP	0.04023	0.04776	0.08592	0.08695	0.12093	0.01050	0.13733	0.02659
SIM	-0.05911	0.19401	0.03316	0.15284	0.11125	-0.02328	0.14685	0.09398
VOCB	0.02478	0.16686	-0.00732	0.13605	-0.11209	0.06177	-0.07992	-0.01026
PICCOM	-0.03344	0.21057	-0.10861	0.14617	0.23131	0.00209	0.04777	-0.05539
PICARR	-0.07089	0.33880	0.03608	0.16417	0.08753	0.30636	0.11707	0.03111
BLKDES	0.06696	0.74546	0.09127	-0.15382	0.01650	0.08544	0.01013	-0.13162
OBASS	0.13352	0.69201	0.04889	0.15960	0.07704	0.14166	0.09236	0.01799
PPVTIQ	-0.21789	0.00155	-0.39476	0.20038	-0.16722	0.00100	-0.05796	0.18553
AUDCLO	0.14999	0.16664	0.22153	0.22955	-0.11925	-0.10277	-0.04381	0.03675
SENMEM	0.03410	-0.04891	0.03781	-0.04405	-0.21607	-0.08697	0.00425	-0.11698
FLUENCY	0.03305	0.10820	0.06193	0.09151	-0.10326	-0.10944	-0.28007	0.18272
TAPRH	0.04700	0.04107	0.00016	0.21206	0.03237	0.06225	0.22554	0.05146
TAPLH	0.04710	0.01478	0.00368	0.15007	0.01867	-0.02127	0.22284	0.08969
TAPRF	0.14300	0.04180	0.04183	0.03605	-0.00214	0.03894	0.76350	0.04798
TAPLF	0.06026	0.02799	0.10722	0.02380	0.01674	0.04669	0.78684	-0.03378
DYNR	0.88384	0.15208	0.07843	0.12336	0.04371	0.09032	0.07549	0.07254
DYNL	0.87204	0.06741	0.03771	0.09705	0.05558	0.14454	0.10375	0.06649
TPTMEM	0.25978	0.33317	-0.00903	0.02999	-0.01686	0.06659	-0.12697	0.05962
TPTLOC	0.09300	0.22783	0.02230	0.10136	0.09136	0.07920	0.00498	0.04065
TARGET	0.08817	0.12533	-0.07141	0.05492	0.07444	-0.03106	0.11432	0.06698

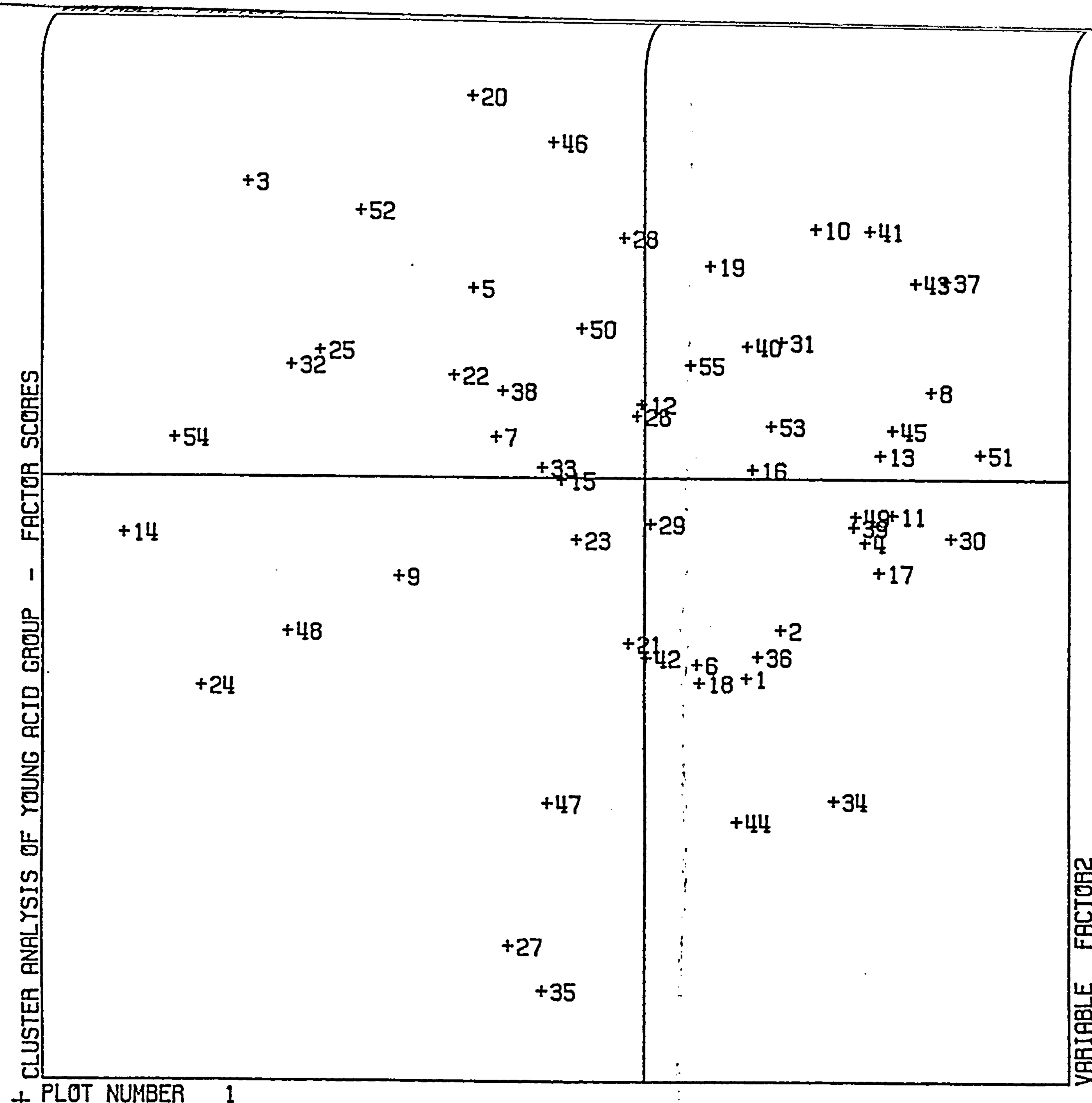
[illegible]	[illegible]	[illegible]	[illegible]
APHASIA	0.01274	0.27814	0.36944
TACR	0.14135	-0.02659	0.47367
TACL	0.21999	0.10330	0.13894
AUDR	0.59561	0.13344	-0.01330
AUDL	-0.07782	0.08944	-0.03530
VISR	-0.08089	-0.06525	0.00240
VISL	0.27786	-0.07999	-0.00132
FAGR	0.01791	-0.00902	-0.00369
FAGL	-0.00031	0.00207	0.09871
FTWRR	-0.00992	0.04321	-0.03012
FTWRL	0.04520	0.12829	0.09703
ASTR	0.02740	-0.08236	-0.16235
ASTL	0.21526	-0.06598	-0.06694
NAMER	0.00297	0.09929	-0.03223
NAMEL	0.04867	0.01083	0.04548
MAZERT	-0.07428	0.23599	0.16720
MAZERC	-0.09407	0.22195	0.14454
MAZERS	0.00397	-0.01179	-0.05099
MAZELT	-0.08411	0.48629	-0.15509
MAZELC	-0.05692	0.46342	-0.17368
MAZELS	0.02677	0.08172	0.05719
HOLESRT	0.07887	-0.10970	0.11750
HOLESRC	0.07110	-0.05599	0.09367
HOLESLT	-0.05840	-0.00567	-0.10679
HOLESLC	0.04683	-0.06517	-0.03709
PEGSRT	0.06196	0.06227	-0.05306
PEGSLT	0.01695	-0.06965	-0.11608
TPTDT	0.19494	0.16700	-0.22250
TPTNDT	-0.14933	-0.19524	0.24362
TPTBT	0.15562	0.13174	-0.10756
MFIGT	0.10345	0.35575	0.07686
MFIGE	-0.05736	0.31065	0.07169
START	-0.13420	0.18936	-0.42988
MATVT	0.11432	0.56929	0.05584
MATVE	0.15003	0.02102	-0.12586
CONSQT	-0.01342	-0.05551	-0.01548
CONSQE	-0.03217	-0.10378	-0.08977
PROFIGT	0.08094	0.08621	0.04504
PROFIGE	0.15760	0.03163	0.08714
COLFRMT	-0.00609	0.04727	0.02037
COLFRME	0.06345	-0.00217	0.00019
MATPXT	-0.10148	-0.06411	-0.04112
COMP	0.02326	0.15305	-0.04494
SIM	0.02922	-0.02194	0.06588
VOCB	0.12884	0.10557	0.08626
PICCOM	0.52707	-0.11173	0.24812
PICARR	-0.16091	-0.00535	0.10209
BLKDES	0.04762	0.06667	0.03197
OBASS	0.16019	0.00291	-0.11919
PPVTIQ	-0.32404	0.10282	0.11498
AUDCLU	-0.38686	-0.06419	0.05419
SENMEM	-0.45736	0.00430	-0.01901
FLUENCY	-0.01786	-0.10457	-0.37026
TAPRH	-0.03923	0.10082	0.00026
TAPLH	0.00351	0.03511	0.07414
TAPRF	0.03524	-0.06062	0.00182
TAPLF	-0.00918	0.06279	-0.02839
DYNF	-0.01293	0.03992	0.01279
DYNL	0.03620	0.01759	0.03672
TPTMEM	0.04580	0.10406	0.08823
TPTLOC	-0.02460	0.02074	0.03113
TARGET	-0.03152	0.21531	0.23450

APPENDIX C

Varimax Rotated Factor Matrix for Data Set Old

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8
CATTOT	-0.11446	0.14069	-0.10174	0.39652	0.15897	0.03410	0.23121	[illegible]
APHASIA	0.15386	0.03597	0.66237	-0.04134	-0.07699	0.04469	0.06893	[illegible]
TACR	0.12568	-0.03893	-0.01971	-0.04109	0.11890	0.17045	0.19144	0.17030
TACL	0.21426	0.01280	0.07454	-0.02616	0.12798	0.08968	0.35539	0.10013
VISR	-0.18912	0.22172	-0.07684	0.07039	0.06646	-0.01405	-0.02568	0.04730
VISL	0.01691	0.00941	0.01375	0.05958	-0.05629	-0.01261	-0.17219	0.11909
FAGR	0.00893	0.05612	0.04332	0.16420	0.00866	-0.00607	0.01306	[illegible]
FAGL	0.14796	0.06104	0.08931	-0.02122	0.07177	0.04601	-0.02655	[illegible]
FTWRR	0.07688	-0.02025	0.12867	0.05992	0.02702	0.00136	0.07662	[illegible]
FTWRL	0.10719	0.04297	0.10947	0.13017	0.00510	-0.01279	0.10088	[illegible]
ASTR	0.08280	0.04701	0.08810	0.07221	-0.04670	0.05123	-0.07535	-0.11159
ASTL	0.15280	0.01560	0.09902	0.03177	0.01799	0.01134	0.12383	-0.05474
NAMER	0.08340	0.02997	0.02879	-0.02922	-0.01750	0.08136	0.00704	0.00032
NAMEL	0.08646	0.11697	-0.04981	-0.03106	-0.01841	0.02960	0.11825	0.04709
MAZERT	0.77909	0.17553	0.01932	0.19466	0.06315	0.07606	0.12932	0.03518
MAZERC	0.78210	0.27711	0.05025	0.12638	0.07184	0.09398	0.11498	0.10059
MAZERS	-0.00830	-0.08129	-0.03076	0.08481	0.00387	0.00990	0.04868	0.02131
MAZELT	0.54830	0.09077	-0.03696	-0.09762	-0.06867	0.00873	0.07395	-0.00631
MAZELC	0.65716	0.37780	-0.02182	0.11952	0.06920	0.08174	0.13386	0.02830
MAZELS	-0.15002	-0.03043	-0.05682	0.00896	0.03985	-0.02951	0.02891	0.06778
HOLESRT	0.36725	0.78714	0.04690	-0.00287	-0.02330	0.02663	0.04762	-0.04090
HOLESRC	0.16737	0.86294	0.06634	-0.01172	-0.01299	0.04817	0.07417	0.05003
HOLESLT	0.32236	0.77343	-0.00808	0.01891	0.01487	0.02847	0.13487	-0.11318
HOLESLC	-0.05713	0.84914	0.00738	-0.03433	-0.03497	0.02795	0.02139	0.07061
PEGSRT	0.58139	0.00430	-0.01767	0.12100	0.33285	-0.18650	0.02662	0.11316
PEGSLT	0.60966	0.08983	-0.04697	0.14282	0.33856	-0.06491	0.11048	0.07793
TPTDT	0.07449	0.03536	-0.01722	0.47720	0.32267	-0.03348	0.00521	0.13342
TPTNDT	0.18772	-0.01756	-0.01984	0.47572	0.25372	-0.36787	0.02998	0.33172
TPTBT	0.19493	-0.05619	0.01413	0.55116	0.12365	-0.25819	0.07792	0.19095
SSPER	0.07260	0.19837	0.36068	0.07077	0.01096	0.04791	0.30899	-0.31776
TRAILAT	0.09660	0.07192	-0.01503	0.12577	0.08863	-0.01435	0.16550	-0.01747
TRAILAE	0.00053	0.08163	0.08704	-0.23326	-0.01761	0.07992	-0.03941	0.07043
TRAILBT	-0.00833	-0.04406	0.04239	0.19524	0.08165	0.08976	-0.01693	0.14106
TRAILBE	0.08797	-0.09419	0.05576	-0.02302	0.02141	0.01078	-0.05277	-0.01532
COMP	-0.09746	-0.03602	0.50216	0.15229	0.20918	0.14890	-0.10648	0.10731
SIM	0.00004	0.00208	0.60800	0.01063	0.32728	-0.03293	-0.05069	0.05560
VOCB	-0.07835	-0.05184	0.75507	-0.11608	0.26518	-0.13429	-0.04398	0.13133
PICCOM	0.23155	0.03238	0.25680	0.11797	0.52048	0.00041	-0.02875	0.10139
PICARR	0.19040	-0.06859	0.05566	0.15496	0.47266	-0.00468	0.39146	0.06778
BLKDES	0.28560	0.00367	0.14936	0.19977	0.57039	0.19210	-0.07334	0.05863
OBASS	0.14828	-0.06332	0.09967	0.16769	0.73334	0.13262	0.04550	-0.05767
PPVTIQ	0.17145	-0.05756	0.43467	0.17102	-0.28881	0.17788	-0.10381	-0.06150
AUDCLD	-0.04790	0.11749	0.49322	0.00653	0.07322	-0.11776	0.33980	-0.02650
SENMEM	-0.05784	0.11383	0.60607	0.15377	0.01738	0.03761	0.03561	0.13699
FLUENCY	-0.13022	-0.00059	0.14732	-0.06084	0.54386	-0.20132	-0.04623	-0.10760
TAPRH	0.16248	0.10018	0.07080	-0.04220	0.06874	0.10926	0.18344	0.07015
TAPLH	0.17061	0.08349	-0.04202	-0.00976	0.01556	0.17209	0.19410	0.00085
TAPRF	0.25293	0.12832	0.01541	0.04570	-0.00550	0.10435	0.75795	0.09605
TAPLF	0.15790	0.16066	-0.03742	0.05823	-0.05587	0.15226	0.73374	0.11300
DYNR	0.05854	0.03830	0.01423	0.02741	0.05977	0.91801	0.07183	-0.01028
DYNL	0.05103	0.03157	-0.00264	-0.00082	0.03009	0.91328	0.12527	0.01018
TPTMEM	0.12432	-0.04098	0.08558	0.77278	0.05023	0.01217	-0.07609	-0.06250
TPTLOC	0.17022	-0.01125	0.08782	0.78188	0.04036	0.12780	0.07768	0.09177
TARGET	0.36306	0.05310	0.04994	0.31113	0.21153	0.07520	0.10258	0.25075

	FACTOR 9	FACTOR 10	FACTOR 11	FACTOR 12	FACTOR 13	FACTOR 14	FACTOR 15	FACTOR 16
CATTUT	0.01042	-0.19743	0.01207	0.23336	-0.02495	-0.10854	0.09619	-0.03532
APHASIA	0.28754	-0.03159	0.07576	0.12248	-0.01296	-0.01627	0.01510	0.09075
TACR	-0.04636	-0.01600	-0.00583	0.00756	-0.12899	0.55140	0.26520	0.02343
TACL	-0.09034	-0.14498	-0.01555	0.16471	-0.09668	0.44994	0.12785	-0.15751
VISR	-0.02098	0.18251	-0.08742	-0.00517	0.09381	0.63841	0.03254	0.00855
VISL	-0.01814	-0.00822	0.02601	0.24187	0.14746	0.67108	-0.11261	0.02838
FAGR	0.08029	0.09962	0.07932	0.66157	-0.11750	0.30848	0.07307	0.01711
FAGL	-0.04406	0.13477	-0.02548	0.81876	0.05512	0.05807	-0.02008	-0.01412
FTWRR	0.05903	0.03342	0.02886	0.15010	0.07977	0.17281	-0.19658	0.04501
FTWRL	0.04399	0.02738	0.03986	0.07418	0.00461	0.16155	-0.07643	0.00149
ASTR	-0.03203	0.00526	0.05107	0.04755	0.08099	0.05905	0.82998	0.02769
ASTL	0.09481	-0.04141	0.05572	0.00761	0.00356	0.03904	0.84151	-0.01406
NAMER	0.10265	0.00860	0.86045	-0.01579	0.03250	0.00618	0.03361	-0.02714
NAMEL	0.02037	0.04988	0.82287	0.05989	0.06693	-0.06712	0.06152	-0.00026
MAZERT	0.07979	0.08284	0.04335	0.06253	-0.14060	-0.04618	0.12964	-0.00071
MAZERC	0.05250	0.07199	0.02091	0.03295	-0.22066	-0.02698	0.09732	0.01453
MAZERS	-0.08059	-0.07158	0.08357	-0.00582	0.87218	0.05131	0.05743	0.06715
MAZELT	0.34836	0.08053	-0.14653	0.24797	0.13295	-0.14185	-0.01718	-0.19625
MAZELC	-0.01256	0.14973	0.07783	0.04152	-0.18891	0.07737	-0.02561	0.00808
MAZELS	0.12981	-0.02390	0.02105	-0.01590	0.87005	0.02674	0.02231	-0.04576
HOLESRT	-0.05120	0.06553	0.09782	0.16886	-0.02456	-0.04851	0.02575	-0.01619
HOLESRC	-0.08839	0.08796	0.00306	0.04687	-0.07572	0.01761	0.07784	0.05895
HOLESLT	0.03424	-0.00981	0.19144	0.09438	-0.03950	0.04470	-0.02660	0.01152
HOLESLC	-0.01966	0.03384	-0.05004	-0.10112	0.01409	0.13867	-0.00787	0.07442
PEGSRT	-0.08449	0.12945	0.22630	0.00702	0.15797	0.07266	0.19268	0.21515
PEGSLT	-0.10365	0.17536	0.24253	0.01209	0.19676	0.12562	0.11260	0.15185
TPTDT	0.07364	0.20710	0.16989	0.35255	0.05224	-0.20092	0.13282	0.05732
TPTNDT	0.09770	0.11328	-0.04783	0.12166	0.06794	-0.09057	0.20824	0.04228
TPTBT	0.05960	0.17750	-0.03317	0.29876	0.12825	-0.00983	0.18188	-0.02239
SSPER	0.20364	-0.19754	0.25804	0.27211	-0.07644	0.18960	0.11164	0.05629
TRAILAT	0.16457	0.18653	0.13461	-0.11582	0.13691	0.10414	-0.01518	0.66460
TRAILAE	0.01590	-0.17255	-0.16324	0.10991	-0.10212	-0.09781	0.03086	0.71499
TRAILBT	0.76149	0.04701	0.24372	-0.00036	0.05883	-0.01319	0.10296	0.17435
TRAILBE	0.89032	-0.03758	-0.03360	0.02753	-0.01777	-0.05946	-0.02302	0.00512
COMP	-0.03376	0.07533	0.14633	-0.05314	-0.13817	-0.09607	0.18929	-0.16283
SIM	0.03179	-0.01942	-0.08416	-0.20524	0.00614	0.10226	-0.00357	-0.01719
VOCB	-0.04872	0.04524	-0.07052	0.02462	-0.02313	-0.01947	0.02201	-0.16861
PICCUM	0.18402	0.08410	-0.12344	-0.07896	-0.01944	0.17767	0.00107	-0.05305
PICARR	0.20260	-0.11307	0.16054	-0.09942	0.07403	0.16624	-0.14360	0.05247
BLKDES	0.11749	0.03668	-0.02670	0.18508	0.06915	0.01281	-0.02487	0.14845
OBASS	-0.03482	-0.06873	0.08433	0.10945	0.09131	0.02418	-0.07082	0.09384
PPVTIQ	-0.07875	0.13717	0.06554	0.01992	0.10277	0.08577	-0.01862	0.11725
AUDCLO	0.11962	0.07100	-0.09438	0.25006	-0.06616	0.06465	-0.02475	0.10028
SENMEM	-0.13508	-0.11393	-0.03329	0.10422	-0.02459	-0.16293	0.15313	0.17182
FLUENCY	-0.05853	0.17767	-0.14955	0.02416	-0.18413	-0.04698	0.12525	-0.14997
TAPRH	0.00093	0.79712	-0.00216	0.14970	-0.08439	0.04969	-0.06169	-0.02917
TAPLH	0.00194	0.79556	0.06454	0.11818	-0.04722	0.04921	0.02247	0.01954
TAPRF	-0.08647	0.31473	0.10534	-0.03985	0.03530	-0.03060	0.01074	0.06992
TAPLF	-0.03771	0.27374	0.06093	-0.01424	0.10795	-0.04125	0.05490	0.05521
DYNR	0.04848	0.11013	0.06045	-0.00459	-0.00037	0.04278	0.04760	0.04915
DYNL	0.05527	0.15765	0.05017	0.05237	-0.01526	0.04435	0.05111	0.00421
TPTMEM	0.09522	0.00377	-0.06406	-0.11964	0.00622	0.12574	-0.09611	-0.03035
TPTLOC	-0.04805	-0.11817	-0.01539	0.02771	0.01924	0.08274	0.03411	-0.04094
TARGET	0.26720	-0.09105	0.08360	-0.10159	0.10394	0.01312	0.07427	0.14266


CLUSTER ANALYSIS OF YOUNG ACID GROUP - FACTOR SCORES
+ PLOT NUMBER 1
VARIABLE FACTOR2
+20
+46
+3
+52
+28
+10
+41
+19
+43
+37
+5
+50
+25
+32
+40
+31
+55
+22
+38
+12
+26
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+30
+9
+17
+48
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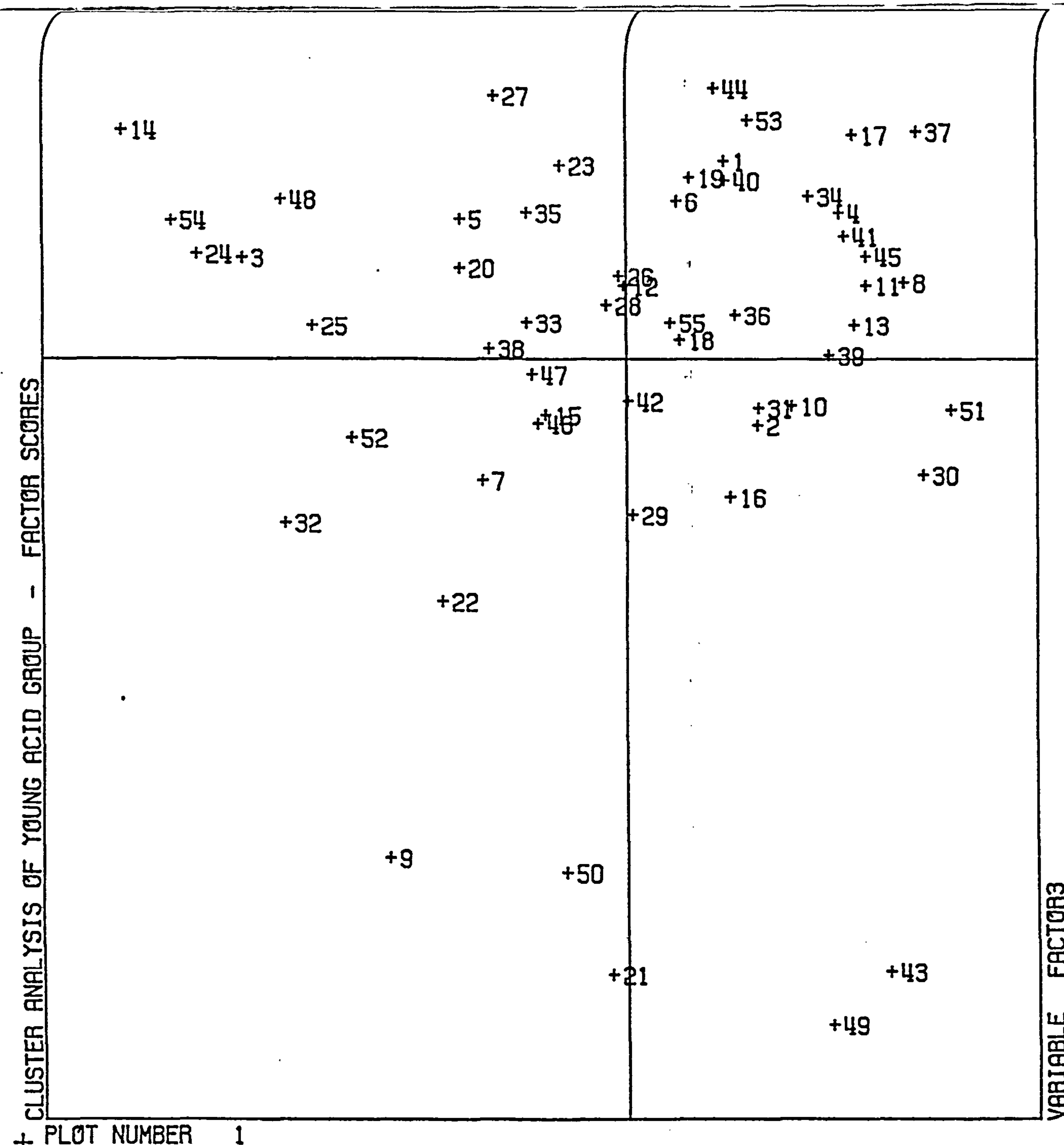
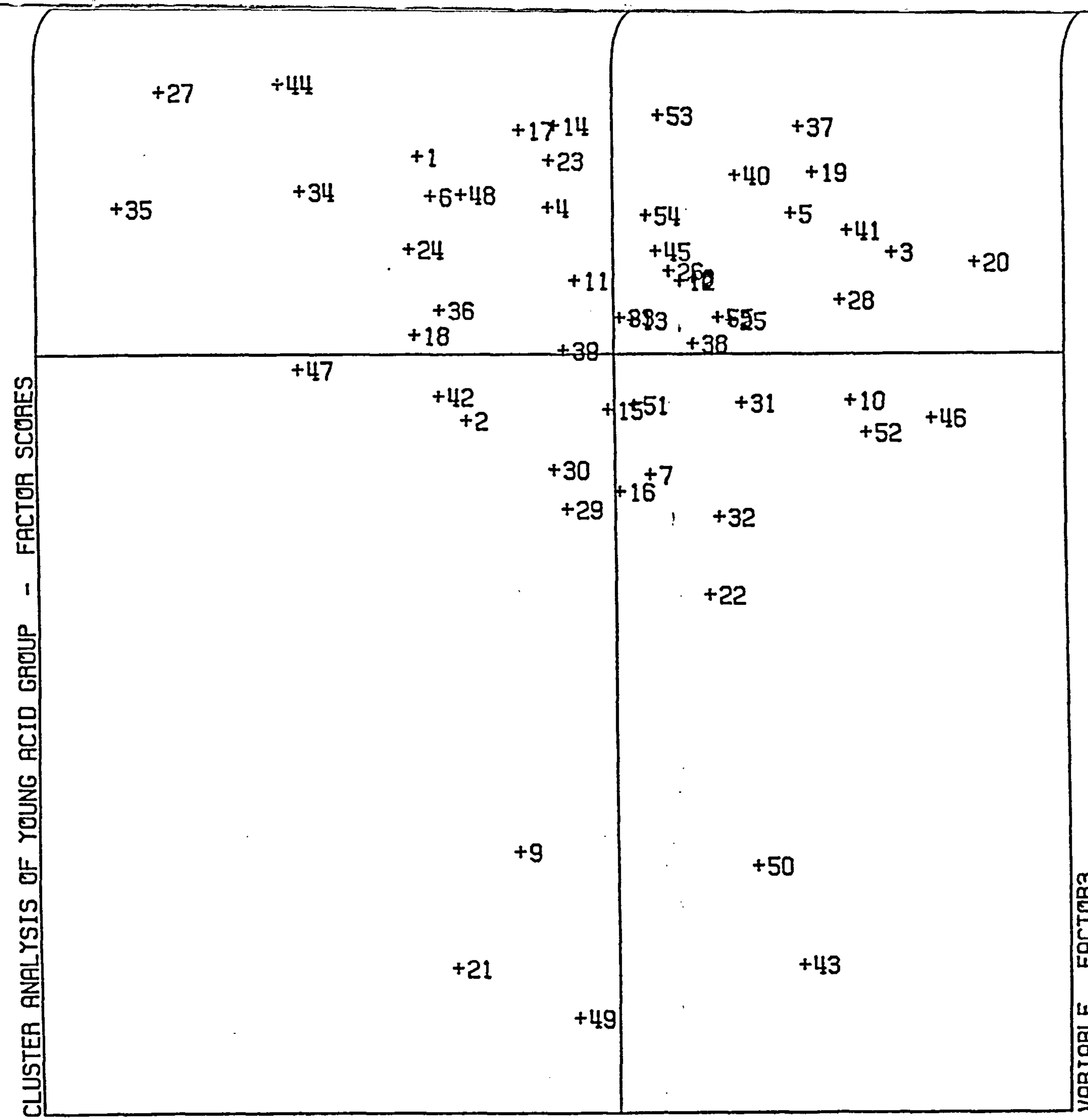
+6
+18
+1
+24
+47
+34
+44
+27
+35

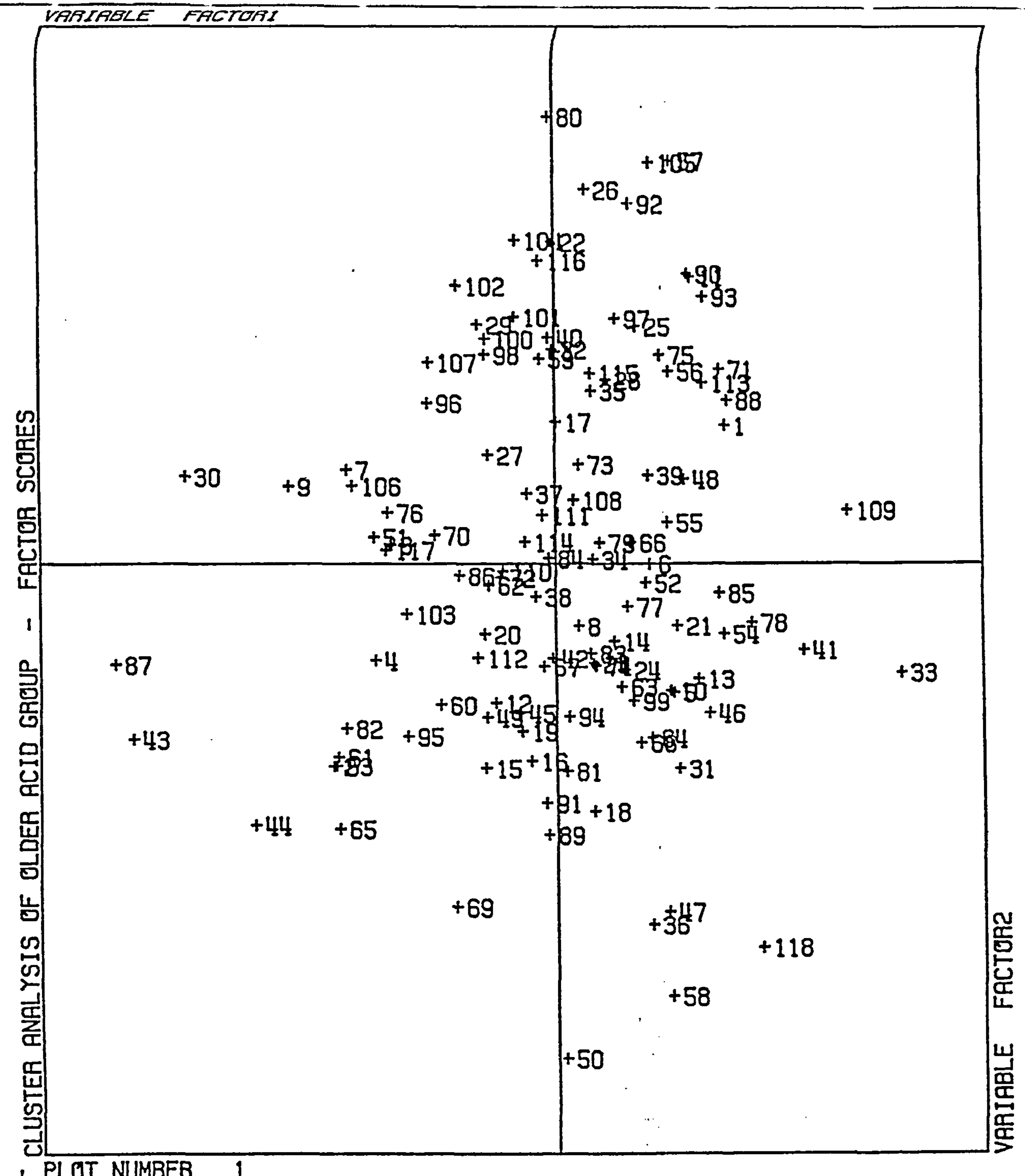
APPENDIX D



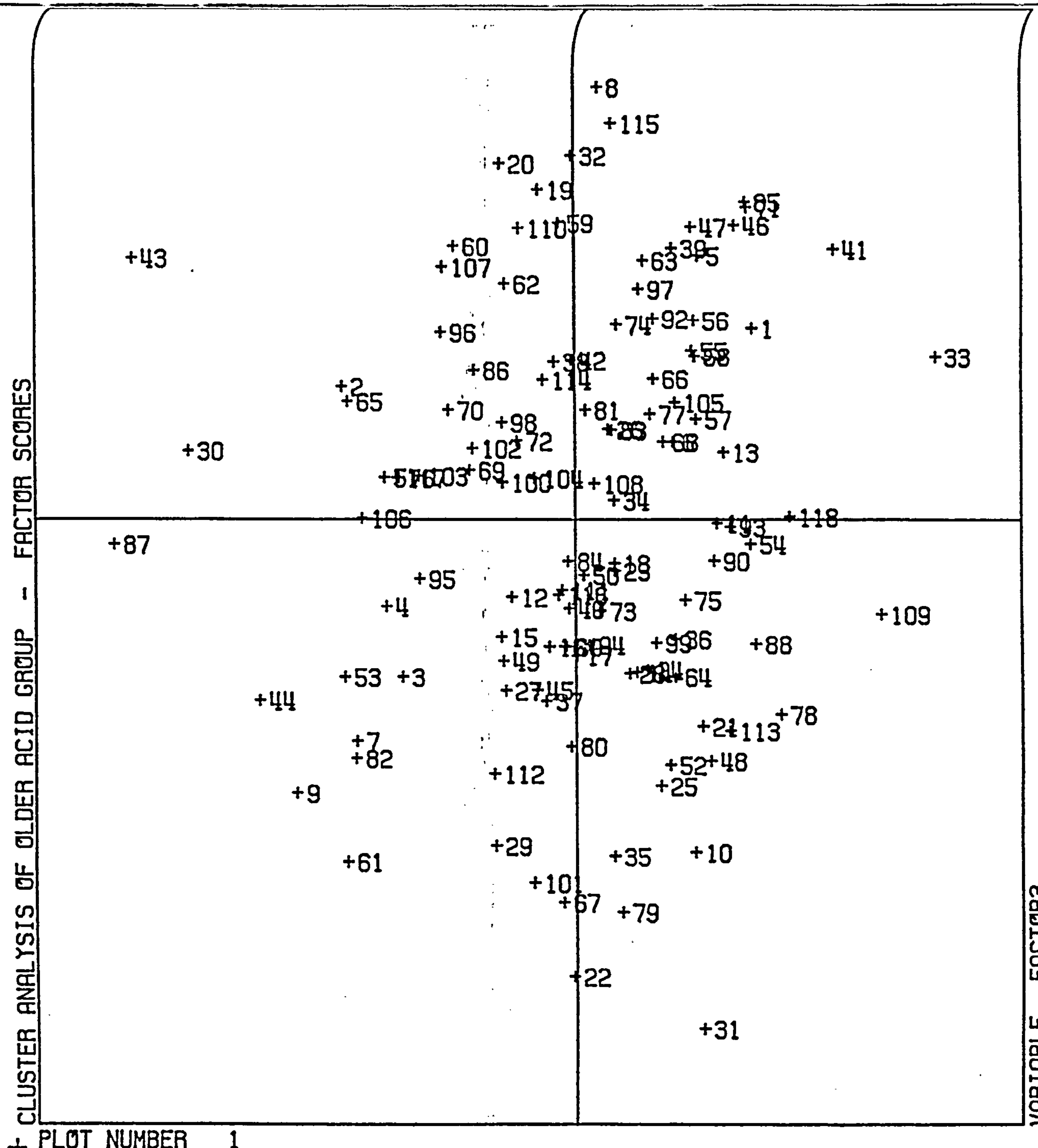
APPENDIX D cont'd



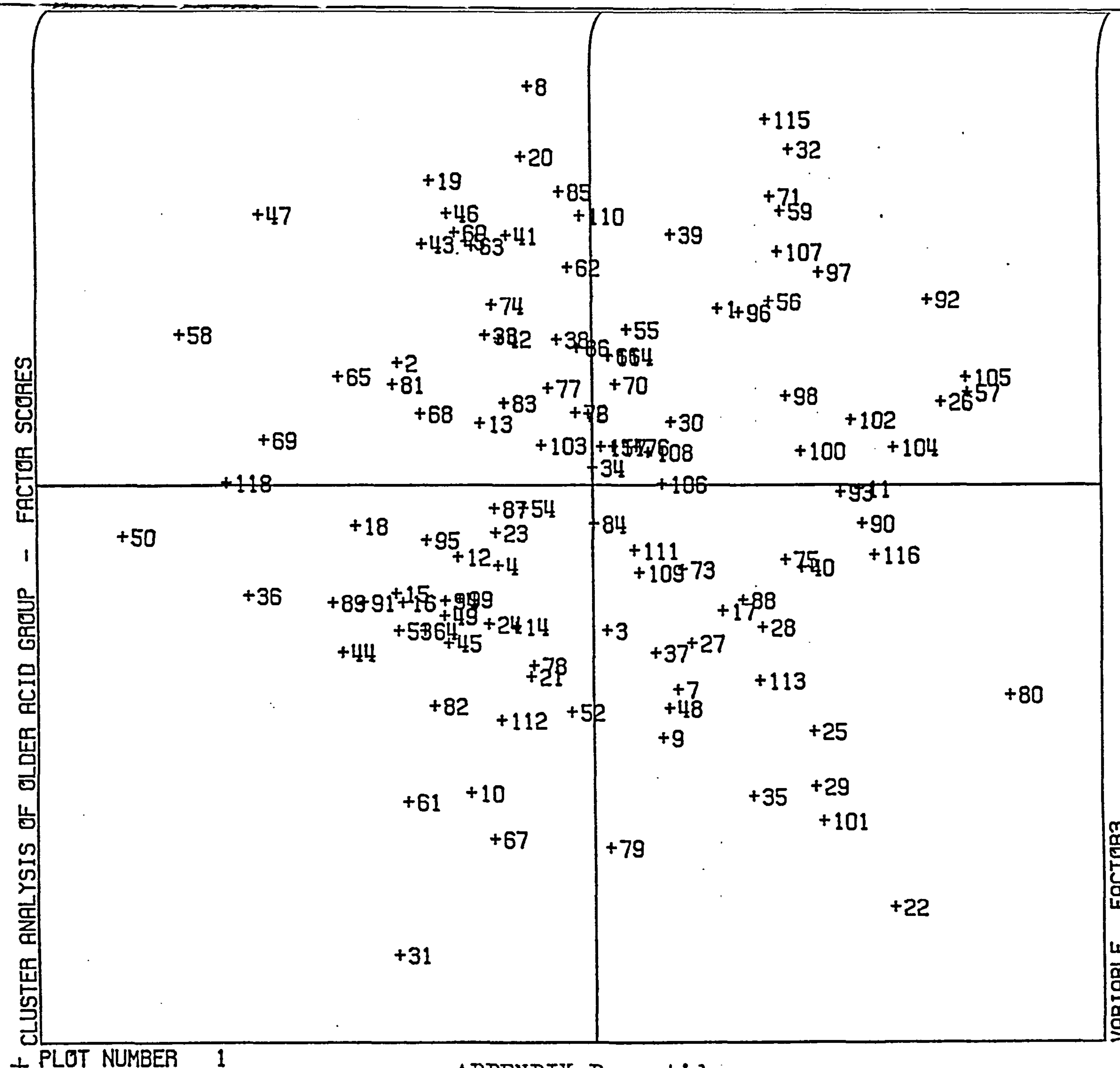
APPENDIX D cont'd



APPENDIX D cont'd



APPENDIX D cont'd



APPENDIX D cont'd

APPENDIX E

Four-cluster classification arrays for cluster solutions YOUNG FS-AL, YOUNG FS-AL-IR, YOUNG FS-CS, YOUNG FS-CS-IR, and YOUNG FS-IR(RANDOM)

YOUNG FS-AL

1	2	2	2	1	2	2	1	9	1	9	2	1	2	9	16	9	9	2	2
9	9	2	1	2	16	2	2	9	9	2	2	1	1	9	1	16	2	2	2
9	1	2	1	9	16	9	9	2	2	16	1	1	9	2					

YOUNG FS-AL-IR

3	4	1	2	1	2	2	3	3	3	4	2	3	1	4	3	4	4	2	2
4	3	2	1	2	3	2	2	2	4	2	2	1	3	4	1	3	2	2	2
4	3	2	4	4	3	3	1	3	2	3	1	1	3	4					

YOUNG FS-CS

1	2	2	2	5	2	2	2	1	2	1	2	2	2	1	16	1	2	2	2
1	16	2	1	2	16	2	2	1	1	2	2	5	1	1	5	16	2	2	2
1	1	2	1	1	16	1	1	2	2	16	2	5	16	2					

YOUNG FS-CS-IR

1	2	4	2	4	2	2	1	1	1	5	2	1	2	5	1	5	5	4	2
5	1	2	4	4	4	2	2	2	5	2	2	4	1	5	4	1	2	2	2
5	1	2	5	5	1	1	5	1	2	1	2	4	1	5					

YOUNG FS-IR(RANDOM)

6	1	2	1	2	3	6	6	6	6	3	1	6	1	3	1	3	3	2	2
3	6	1	2	2	2	1	1	1	6	1	1	2	6	3	6	1	1	1	1
3	6	1	3	3	6	6	3	1	1	1	1	2	6	3					

Note: Each number in row 1 of each of the classifcation arrays corresponds to subjects 1 through 20; row 2 corresponds to subjects 21 through 40; row 3 corresponds to subjects 41 through 55.
Subjects with identical numbers have been grouped into the same cluster. Thus, for solution YOUNG FS-AL, subjects 1, 5, 8, 10, 13, 24, 33, 34, 36, 42, 44, 52, & 53 have been grouped together and are distinguished from, say, subjects 16, 26, 37, 46, & 51.

APPENDIX F

Four-cluster classification arrays for cluster solutions OLD FS-AL, OLD FS-AL-IR, OLD FS-CS, OLD FS-CS-IR, and OLD FS-IR(RANDOM)

OLD FS-AL

1	1	3	4	5	5	3	5	4	1	5	1	5	3	1	4	5	4	5	5
5	1	1	5	5	5	3	5	1	5	1	5	5	5	1	4	4	4	5	4
5	1	5	4	4	5	5	4	4	4	4	4	5	1	5	5	3	5	1	5
5	5	5	5	4	5	5	5	4	1	5	4	3	4	1	3	4	5	1	5
1	4	5	5	4	1	4	5	5	5	4	5	3	3	1	5	5	5	3	4
3	1	4	5	5	4	3	5	1	1	5	5	3	5	5	1	4	1		

OLD FS-AL-IR

4	1	2	3	2	4	2	3	3	1	4	1	4	2	4	3	3	4	4	4
2	1	2	3	2	3	2	1	1	3	1	4	4	4	1	2	3	3	4	3
4	4	3	3	3	3	4	3	3	3	3	4	2	1	4	3	1	4	1	3
2	4	4	4	4	4	4	4	3	1	4	3	2	3	1	2	1	4	4	4
1	3	4	4	3	1	3	4	4	4	2	1	2	2	1	3	4	4	2	3
2	1	3	3	2	3	2	4	1	1	3	4	2	4	4	1	3	4		

OLD FS-CS

1	1	3	1	1	1	3	1	1	10	1	12	10	3	1	1	1	10	10	1
10	10	10	10	1	1	3	12	3	1	10	10	10	10	3	10	1	1	10	1
1	1	1	1	1	1	10	1	1	1	1	1	10	12	10	1	1	10	12	1
1	10	10	10	10	10	10	10	1	1	1	1	3	1	1	3	1	10	10	1
10	1	10	10	1	1	1	10	10	10	10	1	3	3	12	1	10	10	3	1
3	1	1	1	1	1	3	10	12	3	1	10	3	10	10	1	1	10		

APPENDIX F cont'd

OLD FS-CS-IR

1	6	3	2	3	1	3	2	2	6	1	6	1	3	1	2	2	1	1	1
3	6	3	2	3	2	3	6	6	2	6	1	1	1	6	3	2	2	1	2
1	1	2	2	2	2	1	2	2	2	2	1	3	6	1	2	6	1	6	2
3	1	1	1	1	1	1	1	2	6	1	2	3	2	6	3	6	1	1	1
6	2	1	1	2	6	2	1	1	1	3	6	3	3	6	2	1	1	3	2
3	6	2	2	3	2	3	1	6	6	2	1	3	1	1	6	2	1		

OLD FS-IR(RANDOM)

1	3	5	3	5	2	5	2	2	2	2	3	1	5	1	3	3	1	1	2
1	1	1	2	2	2	1	5	5	3	1	1	1	1	1	1	3	3	1	2
2	1	3	3	3	2	1	3	3	3	3	1	1	1	1	2	5	1	5	3
5	2	1	1	1	1	2	1	3	3	2	3	5	3	3	5	3	1	1	2
1	3	1	1	3	3	3	1	1	1	1	2	5	5	3	5	2	1	5	2
5	1	3	2	2	2	5	1	1	5	2	1	5	1	1	2	2	1		

Note: See APPENDIX E for an explanation of the meaning of a classification array.

APPENDIX G

Four-cluster classification arrays for cluster solutions
YOUNG TS-CS-IR and YOUNG FS¯-CS-IR

YOUNG TS-CS-IR																				
	1	1	3	4	5	1	5	1	1	1	3	1	1	3	4	5	4	1	1	3
	4	3	4	3	3	4	4	4	4	4	4	3	1	1	4	5	1	1	1	1
	3	5	1	4	5	5	1	3	1	1	4	3	3	5	1					
YOUNG FS¯-CS-IR																				
	1	1	3	3	5	1	1	1	5	1	11	3	1	3	11	3	11	11	3	3
	11	11	3	11	3	3	3	3	3	1	3	3	1	1	11	1	3	3	3	3
	11	1	3	11	11	11	5	5	3	3	3	1	1	11	11					

Note: See APPENDIX E for an explanation of the meaning of a classification array.

APPENDIX H

Four-cluster classification arrays for cluster solutions
OLD TS-CS-IR and OLD FS^--CS-IR

OLD TS-CS-IR

6	1	1	6	1	3	1	1	5	1	3	1	5	5	6	3	3	3	5	1
6	3	6	3	1	3	6	6	6	6	3	3	5	5	6	5	6	1	6	6
5	5	1	1	1	1	3	6	1	1	1	3	5	3	5	3	6	5	3	1
1	1	6	6	5	3	3	5	1	1	3	1	6	1	1	1	1	6	5	3
3	1	6	6	3	1	1	6	6	3	5	6	6	1	1	1	5	3	6	3
1	6	1	3	6	5	5	3	6	1	1	3	5	5	5	1	5	1		

OLD FS^--CS-IR

2	5	5	1	1	2	1	1	2	5	2	6	6	1	5	1	1	6	2	2
2	6	6	1	2	1	2	6	5	1	6	6	2	2	5	6	5	1	2	1
2	2	1	1	1	1	6	5	1	1	1	2	6	6	2	2	5	6	6	1
6	2	2	2	5	6	6	6	1	5	2	1	2	1	5	1	5	6	6	2
6	5	2	6	1	5	1	2	6	6	2	2	2	2	5	1	2	2	2	1
1	6	1	1	2	2	2	6	5	5	1	6	2	6	2	5	2	6		

Note: See APPENDIX E for an explanation of the meaning of a classification array.

APPENDIX I

Nine-cluster classification array for the Young LD-ACID and Young LD-C samples combined.

1	2	2	4	12	3	3	1	6	1	7	3	1	2	7	13	7	7	3	4
7	9	4	12	4	6	4	4	4	1	12	3	3	1	7	12	6	4	4	4
7	1	3	7	7	9	9	2	13	13	13	2	12	9	2	3	3	3	1	9
3	9	3	12	6	2	13	13	1	3	6	9	6	3	12	3	2	2	9	9
2	13	1	6	6	12	4	9	7	4	13	3	6	3	9	9	9	9	2	7
12	6	2	3	12	1	9	7	12	3										

Note: See APPENDIX E for an explanation of the meaning of a classification array.

APPENDIX J

Eleven-cluster classification array for the Old LD-ACID and Old LD-C samples combined

1	2	3	12	2	2	5	6	1	5	6	9	10	3	1	6	6	16	10	2
3	10	10	4	2	6	5	12	13	1	5	10	4	13	5	13	1	13	10	1
6	6	12	6	6	6	10	1	1	2	16	4	10	10	13	6	9	10	9	2
2	1	12	10	13	10	4	10	6	1	2	2	12	6	9	3	9	10	2	4
10	1	1	10	6	9	9	1	10	10	13	6	3	3	9	2	4	10	3	16
3	10	1	4	1	4	3	10	12	13	1	10	3	10	10	9	1	10	16	9
16	9	6	13	4	5	1	4	5	2	16	1	5	9	16	12	13	16	12	16
12	5	13	16	10	10	9	9	3	12	5	6	4	2	5	1	3	9	2	5
1	2	5	6	9	16	4	4	13	4	9	16	2	16	4	4	5	5	1	12
10	12	1	9	6	13	4	4	9	9	4	4	9	9	4	5	10	9	5	6
1	10	9	10	4	3	13	2	12	13	12	9	13	2	5	12	9	13	5	9
2	12	1	5	2	16	16	13	1	4	6	9	1	9	4	1				

Note: See APPENDIX E for an explanation of the meaning of a classification array.

APPENDIX K

CLUSTER	FSIQ	VIQ	PIQ	INFO	COMP	ARITH	SIM
YAC1							
N	9	9	9	9	9	9	9
MEAN	48.81	48.96	49.19	41.85	54.07	43.70	57.04
SD	4.93	4.76	5.67	6.26	8.13	5.39	4.23
YAC2							
N	19	19	19	19	19	19	19
MEAN	51.23	47.75	54.81	41.23	55.44	41.58	55.61
SD	6.13	5.96	7.54	8.26	8.83	4.89	7.54
YAC3							
N	15	15	15	15	15	15	15
MEAN	49.64	48.58	50.67	41.78	52.67	40.44	59.56
SD	6.07	4.89	7.64	5.17	5.37	6.02	6.15
YAC4							
N	12	12	12	12	12	12	12
MEAN	46.50	44.56	49.39	41.39	49.72	41.39	49.72
SD	4.09	7.11	3.94	7.58	5.59	6.58	8.10

APPENDIX K cont'd

CLUSTER	VOCB	DSPAN	PICCOM	PICARR	BLKDES	OBASS	DSYM
YAC1							
N	9	9	9	9	9	9	9
MEAN	57.04	40.37	57.41	50.74	50.37	50.00	38.52
SD	6.55	3.09	7.22	6.62	7.16	5.53	6.46
YAC2							
N	19	19	19	19	19	19	19
MEAN	54.91	40.88	54.04	55.26	57.72	58.95	41.93
SD	6.22	4.56	10.75	10.14	8.54	7.12	7.96
YAC3							
N	15	15	15	15	15	15	15
MEAN	54.22	43.56	52.39	54.00	54.44	50.44	40.44
SD	8.21	4.45	6.53	7.47	8.33	7.55	6.13
YAC4							
N	12	12	12	12	12	12	12
MEAN	53.06	38.61	52.50	49.17	52.50	52.50	41.11
SD	7.17	5.59	8.42	4.74	8.54	6.69	3.58

APPENDIX K cont'd

CLUSTER	PPVTIQ	CATTGT	READSTS	SPELSTS	ARITHSS	APHASIA	SSPER
YAC1							
N	9	9	9	9	9	9	7
MEAN	51.33	35.45	36.96	37.48	40.81	38.00	8.34
SD	6.23	13.99	3.93	2.92	4.37	11.20	18.77
YAC2							
N	19	19	19	19	19	19	16
MEAN	52.32	49.34	40.04	38.91	41.44	36.90	27.16
SD	8.52	8.99	5.94	4.77	3.53	12.87	17.92
YAC3							
N	15	15	15	15	15	15	14
MEAN	51.69	54.00	42.76	40.18	43.16	45.35	22.95
SD	11.92	7.60	4.65	3.98	3.13	9.96	18.16
YAC4							
N	12	12	12	12	12	12	11
MEAN	45.17	48.30	37.94	38.67	41.33	40.55	17.94
SD	7.15	6.98	6.01	4.75	4.40	9.33	16.91

APPENDIX K cont'd

CLUSTER	AUDCLD	SENMEM	FLUENCY	TACR	TACL	AUDR	AUDL
YAC1							
N	9	9	9	9	9	9	9
MEAN	40.08	30.93	33.373	54.04	53.68	45.74	54.78
SD	6.00	10.78	6.893	9.99	11.09	22.16	.44
YAC2							
N	17	18	18	19	19	19	19
MEAN	48.81	29.85	34.383	44.57	52.62	49.73	48.16
SD	10.88	11.94	9.207	14.98	6.80	10.46	12.27
YAC3							
N	15	15	15	15	15	15	15
MEAN	55.96	43.57	37.802	51.91	48.91	42.16	51.98
SD	11.58	9.73	9.701	10.25	15.23	24.09	8.16
YAC4							
N	11	12	12	12	12	12	12
MEAN	48.70	28.16	41.994	54.29	51.08	53.26	50.75
SD	10.73	14.56	12.712	5.95	19.27	.24	9.70

APPENDIX K cont'd

CLUSTER		VISR	VISL	FAGR	FAGL	FTWRR	FTWRL	ASTR
YAC1								
	N	8	8	9	9	9	9	9
	MEAN	51.50	48.97	33.89	31.85	31.59	39.03	43.93
	SD	7.07	9.24	31.00	24.38	22.43	9.81	8.93
YAC2								
	N	19	19	19	19	19	19	19
	MEAN	46.74	48.07	44.79	42.98	35.55	41.68	51.45
	SD	16.40	13.27	18.82	20.13	21.31	14.33	6.47
YAC3								
	N	15	15	15	15	15	15	15
	MEAN	46.13	43.87	45.00	48.72	53.93	55.74	48.16
	SD	18.28	16.53	17.63	9.30	9.79	7.60	11.84
YAC4								
	N	12	12	12	12	12	12	12
	MEAN	47.33	52.31	45.42	40.07	53.24	53.32	53.27
	SD	13.03	5.77	15.29	17.48	11.93	7.22	.23

APPENDIX K cont'd

CLUSTER	ASTL	TAPRH	TAPLH	TAPRF	TAPLF	DYNR	DYNL
YAC1							
N	9	9	9	9	9	9	9
MEAN	52.00	46.2761	44.0170	33.3531	31.8633	57.7886	59.6558
SD	0.0	15.1359	13.6647	6.3036	5.5517	7.4309	7.9972
YAC2							
N	19	19	19	19	19	19	19
MEAN	51.16	58.8243	53.0416	42.9335	39.7257	60.4287	60.4185
SD	4.73	16.4166	16.0767	8.3936	8.2743	5.7716	6.1740
YAC3							
N	15	15	15	15	15	15	15
MEAN	49.60	54.4316	50.8069	39.7246	38.5936	61.7057	59.9350
SD	7.22	7.2970	9.7297	6.4033	6.5804	6.1342	8.0919
YAC4							
N	12	12	12	12	12	12	12
MEAN	52.00	44.1534	43.1431	31.6135	30.0065	58.4776	59.1199
SD	0.0	20.6088	15.9672	7.4236	8.8956	5.1204	4.2426

APPENDIX K cont'd

CLUSTER	NAMEP	NAMEL	MAZERT	MAZERC	MAZERS	MAZELT	MAZELC
YAC1							
N	9	9	9	9	9	9	9
MEAN	54.65	51.59	42.3492	42.13	38.60	33.0896	23.94
SD	4.87	4.49	12.4657	10.92	9.60	9.7471	14.20
YAC2							
N	19	19	19	19	19	19	19
MEAN	45.43	46.31	42.1095	42.27	45.41	36.6299	36.30
SD	14.50	8.90	12.9211	12.60	12.76	16.0799	14.86
YAC3							
N	15	15	15	15	15	15	15
MEAN	41.57	36.43	51.3620	53.35	27.38	44.8704	46.49
SD	12.89	15.33	10.2349	13.57	22.74	12.9102	12.78
YAC4							
N	12	12	12	12	12	12	12
MEAN	50.14	46.72	48.4090	47.14	40.24	46.5566	45.36
SD	8.65	7.75	8.3190	9.65	13.17	11.5435	10.57

APPENDIX K cont'd

CLUSTER	MAZELS	HOLESRT	HOLESRC	HOLESLT	HOLESLC	PEGSRT	PEGSLT
YAC1							
N	9	9	9	9	9	9	9
MEAN	41.17	42.1315	36.87	24.1905	25.04	46.31	39.69
SD	8.32	10.6584	15.62	21.4226	13.59	6.91	12.73
YAC2							
N	19	19	19	19	19	19	19
MEAN	44.92	41.6251	39.48	42.3309	38.33	50.13	51.62
SD	9.05	11.7340	14.22	10.1447	15.86	9.12	7.94
YAC3							
N	15	15	15	15	15	15	15
MEAN	30.52	46.9912	46.57	41.5616	37.91	48.23	47.31
SD	22.10	14.9655	19.00	15.5103	20.73	10.03	7.72
YAC4							
N	12	12	12	12	12	12	12
MEAN	44.03	47.1461	43.57	42.7168	37.35	54.73	54.54
SD	7.19	13.2971	13.38	13.9112	17.74	4.32	4.69

APPENDIX K cont'd

CLUSTER	TPTDT	TPTNDT	TPTBT	TPTMEM	TPTLOC	MATPXT	MFIGE
YAC1							
N	9	9	9	9	9	9	9
MEAN	45.6133	45.0444	34.1948	46.41	37.79	42.08	50.830
SD	7.3208	10.4231	15.6658	5.55	6.36	15.18	3.387
YAC2							
N	19	19	19	19	19	19	19
MEAN	49.0031	51.5553	50.1206	49.86	45.27	45.67	50.947
SD	5.5350	4.0562	6.8226	5.94	3.58	10.67	3.583
YAC3							
N	15	15	15	15	15	15	15
MEAN	48.2469	49.9950	46.4808	47.22	44.17	45.46	49.841
SD	5.4999	4.9808	6.9300	7.40	7.60	10.23	4.744
YAC4							
N	12	12	12	12	12	12	12
MEAN	51.9043	50.8625	46.1202	50.83	48.59	52.09	34.877
SD	3.3830	5.2791	18.4145	5.60	9.43	10.49	21.446

APPENDIX K cont'd

CLUSTER	START	STARE	MATVT	CONSQT	CONSQE	PROFIGT	PROFIGE
YAC1							
N	9	2	9	9	9	9	9
MEAN	38.39	53.22	51.54	43.70	27.92	45.74	58.07
SD	14.99	0.0	7.53	14.08	15.05	10.15	11.49
YAC2							
N	19	6	19	19	19	19	19
MEAN	50.87	36.15	48.62	49.46	37.61	44.09	61.69
SD	10.12	11.92	9.51	10.61	12.22	12.93	8.90
YAC3							
N	15	3	15	15	15	15	15
MEAN	44.40	48.65	49.20	46.91	32.41	48.53	62.48
SD	8.82	7.92	8.56	10.66	14.03	8.01	7.07
YAC4							
N	12	1	12	12	12	12	12
MEAN	52.52	53.22	51.99	48.91	30.46	47.59	58.24
SD	7.05	M	5.18	13.49	12.59	9.14	11.26

APPENDIX K cont'd

CLUSTER	COLFRMT	COLFRME	TARGET
YAC1			
N	9	9	9
MEAN	40.53	49.21	33.908
SD	17.10	26.96	12.752
YAC2			
N	18	18	18
MEAN	34.00	37.23	36.941
SD	21.97	26.34	9.461
YAC3			
N	15	15	15
MEAN	44.99	44.88	41.707
SD	13.60	16.37	13.566
YAC4			
N	12	12	12
MEAN	43.08	49.72	34.510
SD	10.07	9.24	11.227

APPENDIX L

CLUSTER	FSIQ	VIQ	PIQ	INFO	COMP	ARITH	SIM
OAC1							
N	41	41	41	41	41	41	41
MEAN	51.09	48.03	54.23	44.72	54.23	41.38	55.28
SD	7.04	5.38	9.56	6.28	7.67	5.63	6.32
OAC2							
N	34	34	34	34	34	34	34
MEAN	50.18	46.49	54.33	43.24	51.86	40.39	54.80
SD	7.07	5.23	9.81	5.29	7.07	6.13	6.57
OAC3							
N	21	21	21	21	21	21	21
MEAN	45.40	42.41	49.33	38.25	48.89	38.89	51.59
SD	5.56	4.85	7.52	4.67	7.40	5.20	6.80
OAC4							
N	22	22	22	22	22	22	22
MEAN	48.06	44.39	52.48	41.06	48.03	39.39	53.94
SD	5.13	5.17	7.42	5.67	7.10	4.56	5.97

APPENDIX L cont'd

CLUSTER	VOCB	DSPAN	PICCUM	PICARR	BLKDES	OBASS	DSYM
OAC1							
N	41	41	41	41	41	41	41
MEAN	53.98	40.92	59.76	50.73	55.37	57.80	41.30
SD	6.84	5.74	10.91	8.77	9.45	9.59	7.26
OAC2							
N	34	34	34	34	34	34	34
MEAN	52.35	39.71	55.00	55.00	54.02	58.73	43.73
SD	5.60	5.88	10.68	10.13	8.87	9.92	7.56
OAC3							
N	21	21	21	21	21	21	21
MEAN	47.78	38.25	50.63	49.84	51.90	55.56	39.68
SD	4.98	5.93	8.21	7.41	7.79	10.61	7.31
OAC4							
N	22	22	22	22	22	22	22
MEAN	51.36	39.39	58.33	54.85	53.33	51.52	41.06
SD	6.14	5.79	10.96	6.32	9.92	8.89	6.46

APPENDIX L cont'd

CLUSTER	PPVTIQ	CATTOT	READSTS	SPELSTS	ARITHSS	APHASIA	SSPER
OAC1							
N	41	41	41	41	41	41	40
MEAN	53.93	50.84	41.02	36.39	39.20	27.63	30.64
SD	8.39	7.05	8.67	5.53	4.38	15.03	23.54
OAC2							
N	34	34	34	34	34	34	33
MEAN	51.39	48.50	39.80	36.59	38.76	27.99	33.28
SD	8.33	8.79	6.23	4.00	3.69	9.72	19.24
OAC3							
N	21	21	20	20	20	21	21
MEAN	49.90	50.16	42.97	37.77	37.53	24.31	41.19
SD	9.41	9.48	5.83	6.04	3.61	17.22	13.01
OAC4							
N	22	22	22	22	22	22	22
MEAN	49.03	48.73	38.48	35.85	38.45	22.72	26.77
SD	9.29	9.17	5.90	4.44	4.27	17.66	17.83

APPENDIX L cont'd

CLUSTER	AUDCLU	SENMEM	FLUENCY	TACR	TACL	AUDR	AUDL
OAC1							
N	38	38	38	41	41	15	41
MEAN	45.16	41.65	38.233	52.40	56.52	46.67	50.84
SD	9.53	11.23	13.550	8.80	3.45	35.19	13.16
OAC2							
N	34	34	34	34	34	18	34
MEAN	46.09	35.45	36.435	43.43	53.17	10.00	48.62
SD	11.05	10.72	7.688	17.77	10.15	120.05	16.35
OAC3							
N	21	21	21	21	21	1	21
MEAN	37.98	31.38	36.974	45.43	48.77	60.00	52.12
SD	13.96	9.28	12.042	20.45	13.46	M	10.91
CAC4							
N	22	22	22	22	22	9	22
MEAN	42.68	34.51	30.313	52.38	54.84	26.67	47.68
SD	11.58	12.15	11.119	9.15	6.72	70.71	15.78

APPENDIX L cont'd

CLUSTER	VISR	VISL	FAGR	FAGL	FTWRR	FTWRL	ASTR
OAC1							
N	40	40	41	41	41	41	41
MEAN	47.15	33.87	43.51	46.00	45.75	45.27	45.79
SD	23.40	43.76	23.68	12.03	12.49	13.47	12.40
OAC2							
N	34	34	34	34	34	34	34
MEAN	54.47	48.24	44.06	50.51	44.43	38.70	36.98
SD	8.11	22.05	23.76	9.46	16.49	17.65	15.35
OAC3							
N	21	21	21	21	21	21	21
MEAN	49.24	29.76	27.33	34.67	-9.13	-17.24	53.43
SD	25.73	58.19	34.50	29.11	69.14	64.20	3.08
OAC4							
N	22	22	22	22	21	21	21
MEAN	54.82	25.91	15.45	16.55	48.63	43.79	46.22
SD	10.81	73.66	46.37	28.89	13.03	14.88	11.63

APPENDIX L cont'd

CLUSTER	ASTL	TAPRH	TAPLH	TAPRF	TAPLF	DYNR	DYNL
OAC1							
N	41	41	41	40	40	40	40
MEAN	45.89	51.0463	48.3989	42.7078	42.6599	68.0982	66.5256
SD	13.89	11.6909	9.0048	7.9399	9.0203	11.7073	10.3163
OAC2							
N	34	34	34	34	34	34	34
MEAN	34.61	50.0273	46.1564	40.8664	38.0313	64.4907	63.9498
SD	13.47	11.2451	8.3861	9.4613	10.6064	9.5512	8.4869
OAC3							
N	21	21	21	21	21	21	21
MEAN	54.61	48.8502	50.9619	42.6387	40.0581	73.2625	71.4855
SD	12.79	10.5656	9.0026	10.9174	9.9136	19.5114	17.5382
OAC4							
N	21	22	22	22	22	22	22
MEAN	48.34	46.6833	47.4044	46.3151	44.7026	65.8326	63.5255
SD	10.33	10.8020	9.1055	10.1837	11.1169	9.3828	8.7716

APPENDIX L cont'd

CLUSTER	NAMER	NAMEL	MAZERT	MAZERC	MAZERS	MAZELT	MAZELC
OAC1							
N	40	40	41	41	40	41	41
MEAN	40.09	40.59	51.5061	56.81	25.23	45.7450	48.10
SD	14.45	9.40	10.3133	7.10	16.07	14.5229	14.66
OAC2							
N	34	34	34	34	34	34	34
MEAN	50.28	48.39	29.6531	42.30	41.09	34.7531	37.32
SD	6.83	8.72	27.7314	15.56	16.14	19.1682	15.06
OAC3							
N	21	21	21	21	21	21	21
MEAN	48.67	44.07	47.7805	49.85	36.80	34.3617	40.99
SD	6.57	14.29	11.2167	12.59	17.63	23.7226	16.62
OAC4							
N	22	22	22	22	22	22	22
MEAN	39.79	43.14	40.5695	49.64	46.02	41.2453	44.99
SD	21.01	11.49	16.0995	10.00	7.62	15.1199	14.33

APPENDIX L cont'd

CLUSTER	MAZELS	HOLESRT	HOLESRC	HOLESLT	HOLESLC	PEGSRT	PEGSLT
OAC1							
N	40	41	41	41	41	41	41
MEAN	26.07	44.9285	52.66	36.4011	51.10	44.79	41.37
SD	16.47	13.5693	8.43	15.2421	7.66	10.65	12.89
OAC2							
N	34	34	34	34	34	34	34
MEAN	46.01	40.2592	49.20	39.6874	51.08	45.05	46.42
SD	9.11	13.5679	9.60	13.0130	8.02	15.81	14.70
OAC3							
N	21	21	21	20	21	21	21
MEAN	36.40	45.8817	53.34	41.7903	50.23	42.48	37.82
SD	12.50	13.0094	9.07	15.7413	10.22	16.30	24.85
OAC4							
N	22	21	21	21	21	22	22
MEAN	45.69	44.5370	54.29	43.0407	55.88	44.56	45.11
SD	8.18	15.4681	10.18	14.6542	8.92	13.76	11.94

APPENDIX L cont'd

CLUSTER	TRAILAE	TRAILBT	TRAILBE
OAC1			
N	41	41	40
MEAN	45.67	22.89	41.74
SD	17.49	24.38	17.55
OAC2			
N	34	33	33
MEAN	46.12	40.78	47.16
SD	15.97	20.62	12.84
OAC3			
N	21	21	17
MEAN	43.32	34.75	42.73
SD	21.46	15.76	17.52
OAC4			
N	22	22	22
MEAN	49.95	35.79	46.18
SD	9.80	19.14	15.60

APPENDIX L cont'd

CLUSTER	TPTOT	TPTNOT	TPTBT	TPTMEM	TPTLOC	TARGET	TPAILAT
OAC1							
N	40	40	40	40	40	41	41
MEAN	52.5540	51.2158	48.7868	54.79	54.38	44.084	36.41
SD	8.3691	6.3166	17.0294	8.01	12.71	10.904	13.14
OAC2							
N	34	34	34	33	33	34	34
MEAN	52.8393	51.2766	45.6946	49.19	44.38	40.362	42.67
SD	10.3019	11.7235	21.3836	9.92	11.35	12.718	16.75
OAC3							
N	21	21	21	21	21	21	21
MEAN	50.7766	41.6453	40.3918	51.23	45.90	37.114	42.10
SD	8.3230	16.4075	20.6455	13.36	14.96	13.601	10.13
OAC4							
N	22	22	22	22	22	22	22
MEAN	43.9848	49.3089	45.5005	49.36	47.33	42.402	47.53
SD	17.3840	9.7060	15.5832	10.43	11.85	13.709	8.65

VITA AUCTORIS

1952	Born in Hohenkirchen, West Germany to Anna Elizabeth and Leo Joschko.
1957 – 1966	Primary education obtained in the Guelph and Niagara Falls, Ontario Public School systems.
1966 – 1971	Attended Niagara Falls Collegiate Vocational School and graduated with a secondary school honours diploma.
1975	Graduated with a Bachelor of Science Degree, summa cum laude, in Psychology from McMaster University, Hamilton, Ontario
1977	Graduated with a Master of Arts in Psychology from the university of Windsor, Windsor, Ontario.
1977 – 1981	Graduate student in clinical psychology at the University of Windsor, Windsor, Ontario.