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WISC-III profile patterns of learning disabled children

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WISC-III PROFILE PATTERNS
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Abstract

The present study examined the performance of a heterogeneous population of learning disabled children (N=171) and children with learning disabilities in reading (LD-R), math (LD-M), and reading and math (LD-R+M) on the WISC-III ACID and SCAD subtests (Arithmetic, Coding, Information, Digit Span, and Symbol Search). Archival WISC-III scores of children that have been verified as having a learning disability in fourteen Midwestern school systems were used to answer the research questions in this study. Two different methods of examining performance on the ACID and SCAD subtests were used in this study, the index score method and the profile method. The results showed that the heterogeneous LD sample performed significantly lower on the ACID index than on the SCAD index, p =.017. The subgroups (LD-R, LD-M, LD-R+M) did not significantly differ from each other on ACID index or the SCAD index, p = .108. Also, the ACID and SCAD indexes did not differ for the subgroups, p = .424. However, the Arithmetic subtest was low for the LD-M group relative to the LD-R group. Additionally, the Information subtest was low for the LD-R group relative to the LD-M group. The final index score comparison showed that the Freedom From Distractibility (FD) portion of the SCAD index was significantly lower than the Processing Speed (PS) portion of the SCAD index for the LD-R group, p = .006,

the LD-M group, $p = .002$, and the LD-R+M group, $p = .004$. The heterogeneous LD sample performed equally poorly on the ACID and SCAD profiles. However, for the subgroups the LD-M group displayed greater frequencies of the ACID and SCAD profiles than the LD-R or LD-R+M groups. Although the current study had some limitations the results have significant implications for school psychologists assessing students with learning disabilities.

Literature Review

Intelligence tests are widely used by professionals in diagnosing learning problems. To accurately interpret intelligence test profiles examiners must have a good grasp of research findings and a sound theoretical framework. Interpretation of intelligence test scores from a well-researched theory of intelligence or learning can provide meaning to a set of profile fluctuations that would otherwise be uninterpretable (Kaufman, 1994).

To aid the examiner in intelligence test profile interpretation, several clinically useful theoretical approaches to recategorizing the subtests from the Wechsler Intelligence Scales have been developed (e.g. Bannatyne, 1974; Horn, 1985; Mayman, & Dean, 1983). One particular recategorization of the Wechsler tests that has achieved widespread use in the assessment of children is the empirically derived ACID grouping. ACID refers to four subtests from the WISC-R (Arithmetic, Coding, Information, and Digit Span).

Historically, there have been two different methods of looking at the ACID grouping, the profile method and the index/standard score method. As defined by Prifitera and Dersh (1993), the ACID profile occurs when the scaled scores on all four of the ACID subtests are equal to or less than the lowest scaled score on any of the remaining subtests, not including Mazes. This is not the only formula used to calculate the ACID profile, but it is the simplest and most practical method (Prifitera & Dersh, 1993).

The ACID profile is of use to examiners because it delineates a certain pattern of cognitive deficits that suggests an exceptionality (e.g. learning disabilities). While the absence of the ACID profile does not rule out exceptionality, the presence of the ACID profile strongly suggests an exceptionality and, hence, the need to obtain further information (Kaufman, 1994).

The index score method involves computing a standard score (X=100, SD=15) from the four ACID subtest scaled scores. The ACID grouping has been associated with learning disabilities (Kaufman, 1990). Practitioners noticed that reading disabled and learning disabled children's scoreson the ACID index were substantially lower than non learning disabled children's (Kaufman, 1994). Additionally, it was noticed that a greater percentage of exceptional samples such as children with learning disabilities and attention deficit hyperactivity disorder displayed the "ACID profile."

Many researchers have reported the ACID profile with exceptional samples. For example, Sandoval, Aassenrath, and Penaloza (1988) found that the ACID subtests were the lowest for a group of thirty 16 year old children with learning disabilities on both the Wechsler Intelligence Scale for Children-Revised (WISC-R) and the Wechsler Adult Intelligence Scale-Revised (WAIS-R). In addition, McCue, Shelly, and Goldstein (1986) studied a group of 100 adults with learning disabilities that scored approximately one half a standard deviation below their Full Scale IQ on the ACID subtests. Thus, it appears that the ACID profile occurs with both children and adults with learning disabilities.

Kaufman (1990) computed ACID standard scores for two previous studies of the WAIS-R. The first study (Salvia, J., Gajar, & Salvia, S., 1988) involved seventy-four college students with learning disabilities. In this study the ACID subtests were found to be significantly lower for these college students with learning disabilities than for a comparison group of randomly selected incoming freshman. Also, from this study Kaufman (1990) found that the college students with learning disabilities obtained an ACID standard score (101.6) that was suppressed approximately one-half of a standard deviation below their mean Full Scale IQ of 108.9. The second study (Frauenheim & Heckerl, 1983) was longitudinal in nature and followed 11 adults with dsylexia. From this study Kaufman computed an ACID score of 76.3 from the student's performance on the WAIS-R which was more than one standard deviation below their Full Scale IQ of 92. This ACID-Full Scale IQ discrepancy remained stable from testing on the WISC when the students were ten years of age until the students were twenty-seven and were tested on the WAIS-R.

In a meta-analytic investigation of 94 studies on WISC and WISC-R results for students with learning disabilities Kavale and Forness (1984) found the largest effect sizes for the ACID subtests (Digit Span = -.61, Arithmetic = -.44, Coding = -.41, and Information = -.38). The effect size (ES) statistic represents a mean difference score transformed into a common metric comparable to a z-score. The ES statistic can be transformed into the WISC-R scaled score units (ES X WISC-R SD = Unit Deviation). Thus, the effect sizes in this case translate into the following scaled scores: Digit Span = 8.17, Arithmetic = 8.69, Coding =8.77, and Information = 8.87. Kavale and Forness (1984) state that this poor performance of students with learning disabilities relative to students without learning disabilities is not clinically significant and thus, does not differentiate students with learning disabilities from students without learning disabilities. However, while these effect sizes are not clinically significant they are statistically significant and are consistent with several studies. For example, Sattler (1984) (discussed below) and Sandoval et al. (1986) also found the ACID subtests to be lowest for their reading disabled and learning disabled samples, respectively. Prifitera & Dersh (1993) found three of the ACID subtests to be lowest for a learning disabled sample on the WISC-III. McCue et al. (1986) found that a sample of adults with learning disabilities scored one-half a standard deviation below their Full Scale IQ on the ACID subtests. Similarly, Kaufman's (1990) ACID computations of Salvia et al.'s (1988) college students with learning disabilities and Frauenheim and Heckerl's (1983) adults with dyslexia revealed an ACID score that was suppressed by one-half of a standard deviation and a full standard deviation below their mean Full Scale IQ's, respectively.

Sattler (1984) reviewed thirty studies of children with reading disorders and found, on the average, that the children's four lowest subtests were the ACID subtests. In Sattler's analysis the rank order of subtests from worst to best were: Information, Arithmetic, Digit Span, Coding, Vocabulary, Comprehension, Similarities, Object Assembly, Block Design, Picture Arrangement, and Picture Completion.

The WISC-III

The ACID profile results have become widely accepted and were included in the manual for the recently revised version of the WISC-R, the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) (Wechsler, 1991). The WISC-III, the most widely used test of its kind, is an individually administered cognitive ability test for children aged 6 to 16 years. The test consists of 11 core subtests and 2 optional subtests that are divided into two major categories. The subtests Information, Similarities, Arithmetic, Vocabulary, Comprehension, and the optional subtest Digit Span make up the Verbal Scale. The subtests Picture Completion, Coding, Picture Arrangement, Block Design, Object Assembly, and the optional subtests Symbol Search and Mazes make up the Performance Scale. The Verbal and Performance categories are further subdivided into two separate factors. The Verbal category is divided into the Verbal Comprehension (VC) and Freedom from Distractibility (FD) factors. The Performance category is divided into the Perceptual Organization (PO) and Processing Speed (PS) factors. Thus, the WISC-III has a four factor structure allowing the examiner to obtain four standard scores corresponding to these four factors (VC, PO, FD, & PS).

The WISC-III is used by practitioners when there is a need to have a measure of cognitive functioning. Furthermore, the WISC-III is the most frequently used intelligence test in pyschoeducational evaluation for educational planning and placement (Woody, LaVoie, & Epps, 1992). Additionally, the WISC-III can be used for diagnosis of exceptionality and in clinical and neuropsychological assessment (Wechsler, 1991).

Changes from the WISC-R to the WISC-III

The ACID studies previously discussed were based on the WISC-R, the predecessor of the WISC-III. While the two tests are similar, there have been several important changes on the WISC-III. The WISC-III includes a new subtest, Symbol Search, not found on previous Wechsler Scales. Symbol Search couples with Coding to form a fourth factor (Processing Speed), an addition that Kaufman (1994) calls, "... the most critical innovation in a Wechsler scale since the mid 1940's..." (p. 209). This allows the examiner to subdivide the Performance Scale into two meaningful components, Perceptual Organization (PO) and Processing Speed (PS). Also, the Symbol Search subtest seems to be highly related to clinical, personality, behavioral and neurological variables (Kaufman, 1994).

Other changes from the WISC-R to the WISC-III concern the Information subtest. The Information subtest has 30% new or highly modified items (Kaufman, 1994). Additionally, the Information subtest has changed positions in terms of order of administration from the first subtest administered to the second. As Kaufman (1994) suggests, this may have the effect of improving the Information subtest score of LD students relative to the WISC-R because of a "warm-up" effect. On the WISC-III the relatively non-threatening Picture Completion subtest is administered first. Pointing out the part missing in a picture is probably less threatening to students than asking them factual knowledge questions as with the Information subtest. Kaufman (1994) reasons that this warm-up period may benefit the Information score of children with learning disabilities more than that of normally achieving students. Probably because of these changes preliminary findings indicated that the Information subtest no longer tends to group with the other ACID subtests. For example, Reynolds and Ford (in press) found that the Information subtest on the WISC-III only loads .18 on the Freedom From Distractibility Factor (Arithmetic and Digit Span) in contrast to the WISC-R where Information loaded .41 on the FD factor (Kaufman, 1994). Kaufman (1994) refers to loadings of .40 and above as high.

The WISC-III and Children with Learning Disabilities

The WISC-III manual reports that a composite standard score (x=100, SD=15) derived from the ACID subtests was suppressed by a full standard deviation for a learning disabled sample (N=65) and approximately one-half a standard deviation for a reading disabled sample (N=34) (Wechsler, 1991). The WISC-III manual also reports the percentage of the learning disabled and reading disabled samples combined that displayed the full ACID profile (Wechsler, 1991). Results indicated that the percentage of the exceptional sample that displayed the full and partial ACID profiles was significantly greater than in the standardization sample. The full ACID profile was exhibited by 5.1% of the exceptional sample and by 1.1% of the standardization sample. Additionally, the WISC-III manual reports the percentage of individuals that displayed partial ACID profiles. A partial ACID profile occurs when any three scores on the ACID subtests are equal to or less than the lowest scaled score on any of the other subtests, not including Mazes or Symbol Search. The study showed that 20.2% of the exceptional sample displayed the partial ACID profile compared to 5.6% of the standardization sample. It should be noted, however, that children with special education needs were not excluded from the standardization sample and, thus, some of the 5.6% could have been learning disabled (Wechsler, 1991).

However, upon closer inspection, these preliminary findings, while lending support for the ACID profile, actually indicate that the WISC-III may produce different profiles with exceptional samples than the WISC-R. Kaufman (1994) has suggested that this is because of the changes in the WISC-III. For example, inspection of the mean subtest scaled scores of the combined reading and learning disabled sample reported in the WISC-III manual (Wechsler, 1991) reveals that Symbol Search instead of Information grouped with the other ACID subtests (Arithmetic, Coding, and Digit Span) as the lowest for the group. Information did not emerge as a weakness for the group.

Similarly, in a study with 99 subjects with learning disablilities Prifitera and Dersh (1993) did not find the four ACID subtests to be the lowest. They found that Symbol Search had, instead of Information, grouped with the other three ACID subtests (Arithmetic, Coding, & Digit Span) as the four lowest subtests. Information was the seventh lowest subtest.

Even though Information was not among the lowest subtests, Prifitera and Dersh (1993) still found the full and partial ACID profiles (as defined earlier) to be significantly more common in their sample of children with learning disabilities than in the general population. For example, the percentage of subjects in the LD and standardization sample that displayed the full ACID profile was 5.1% vs. 1.1%, respectively. For the partial ACID profile with 3 of 4 subtests for the LD and standardization sample it was 21.1% vs. 5.7%, respectively; with 2 of 4 subtests = 36.4% vs. 19.5%, respectively; and with 1 of 4 ACID subtests = 64.6% vs. 46.9%, respectively. However, these results appear to be primarily because of the contributions of Arithmetic, Coding, and Digit Span not because of Information (Kaufman, 1994). When computing the ACID profile percentages, Prifitera and Dersh (1993) did not include the Symbol Search subtest, which again was among the lowest four subtests for their sample of children with learning disabilities.

Because Prifitera and Dersh (1993) found Symbol Search to be among the lowest four subtests they decided to examine this subtest along with the ACID profile (the ACIDS profile). The ACIDS profile was said to occur when the scores on the subtests Arithmetic, Coding, Information, Digit Span, and Symbol Search were equal to or less than the lowest scaled scores on any of the remaining subtests, not including Mazes. The ACIDS profile occurred with greater frequency in a LD sample than the ACID profile. However, the ACIDS profile also occurred more frequently than the ACID profile in the standardization sample. Nevertheless, the ACIDS profile was also significantly more common in their LD sample than in the standardization sample. For example, the percentage of subjects in the LD and standardization sample that displayed the full ACIDS profile was 4.0% vs. .6%, respectively. For the partial ACIDS profile with 4 of 5 subtests for the LD and standardization sample it was 14.1% vs. 3.1%, respectively; with 3 of 5 subtests = 28.3% vs. 10.9%, respectively; with 2 of 5 subtests = 48.5% vs. 26.9%, respectively; with 1 of 5 subtests = 70.7% vs. 52.2%, respectively. The authors state that their results should be replicated to assess their robustness.

Based on these studies (e.g. Prifitera & Dersh, 1993; Wechsler, 1991) that show Symbol Search replacing Information in the ACID quartet, Kaufman (1994) recommends that practitioners abandon the use of the ACID profile. Instead, he advocates the use of the SCAD profile (Symbol Search, Coding, Arithmetic, and Digit Span) to aid in the detection of exceptionality.

However, a more recent study (S.B. Ward, T.J. Ward, Hatt, Young, & Moller, 1995) suggests that Kaufman's recommendation may have been premature. In a follow up to Prifitera and Dersh (1993), Ward, et al. (1995) studied the prevalence and utility of the ACID and ACIDS profiles in a learning disabled population. In contrast to Prifitera and Dersh (1993) and Wechsler (1991) this study found the Information subtest to be among the four lowest subtests, but found the Symbol Search subtest to be among the four highest subtests in their relatively large (N = 382) LD sample. Two other ACID/SCAD subtests, Arithmetic, and Digit Span were also among the lowest four subtests. Coding, the remaining ACID/SCAD subtest, was the 7th lowest subtest. Vocabulary was also among the lowest four subtests.

Ward et al. (1995) found the full ACID profile to be more prevalent in their LD sample than in the general population. The incidence of the full ACID profile found by Ward et al. (1995) was similar to the incidence found by Prifitera and Dersh (1993) (4.7% vs. 5.1%, respectively). However, Ward et al. (1995) did not find the full ACIDS profile to be more common in their LD sample than in the general population. The ACIDS profile only occurred in .6% of Ward et al.'s LD sample compared to 4% in Prifitera and Dersh's (1993) LD sample.

<u>Learning Disability Subtyping Research</u>

The above studies looked at the Wechsler Scale profiles of students with learning disabilities as one homongenous group. However, there is agreement that students with learning disabilities represent a diverse group with a variety of cognitive and academic problems (Shafrir & Siegel, 1994). Clustering these problems into several distinct relatively homogenous subgroups, called subtyping, has been attempted by many researchers (Johnson & Myklebust, 1967; Bonder, 1973; Lyon, Stewart & Freeman, 1982; Forness, 1990). In fact, over 100 of these studies have been conducted since 1963 (Learner, 1993). This research has proved useful in identifying more homogenous learning disabled groups for which more specific remediation methods can be implemented. At the present time, however, the precise nature of the different subgroups of learning disabilities remains unclear (Lerner, 1993).

Students with Learning Disabilities in Reading and Math

Several different learning disability subtypes have been identified (Johnson & Myklebust, 1967; Boder, 1973; Lyon, Stewart & Freeman, 1982; Siegel & Heaven, 1986). Two of these particular subtypes that appear to have different patterns of assets and deficits are students with a learning disability in reading (LD-R) or mathematics (LD-M). For example, Fletcher, (1985) reports that LD-M students have deficits in visual-spatial skills while LD-R students have intact visual-spatial problem solving skills. Shafrir and Siegel (1994) report that LD-M students have deficits in eye-hand coordination, short term memory (with non-verbal stimuli presented visually), and visual-spatial skills. LD-R students are reported to have deficits in language/vocabulary, and short term memory (with verbal stimuli). In addition, their LD-R group scored significantly lower than the LD-M group on the WISC-R Digit Span subtest, a measure of auditory short-term memory (8.5 & 9.6, respectively). Shafrir and Siegel (1994) also studied a separate combined reading and math disabled group (LD-R+M). As would be expected, this group had the deficits of both groups and performed relatively poorly on the WISC-R Digit Span subtest (7.6).

Rourke (1993) discussed the differences between two subtypes of children with learning disabilities from a neuropsychological perspective. Rourke (1993) states that one group (group 1) had relatively dysfunctional systems in the left hemisphere of the brain, while the other group (group 2) had relatively dysfunctional systems in the right hemisphere. Rourke (1993) found that group 1 students obtained a Performance IQ that was significantly better than their Verbal IQ while group 2 displayed the opposite pattern. Additionally, Rourke (1993) reports that group 1 had deficits in auditory attention, auditory perception, verbal attention, auditory memory, verbal memory, and very poor reading and spelling skills and impaired, but significantly better arithmetic skills. Group 2 had deficits in visual perception, visual attention, tactile attention, tactile memory, visual attention, general psychomotor incoordination, and learning difficulties in arithmetic, but advanced levels of reading and spelling. Thus, theses two subtypes with their different patterns of cognitive deficits can be distinguished by their relatively different performance in reading and math. Similarly, Snow (1992) reports that LD-M students have slow motor speed. Thus, it appears that students that are learning disabled in reading (LD-R), math (LD-M), or reading and math (LD-R+M) achievement areas are three distinct subgroups of learning disabled children each with their own unique pattern of skills and deficits. Reading disabled students have deficits in the linguistic, verbal, and auditory areas, math disabled students have deficits in the visual/perceptual and visual-motor areas and students with learning disabilities in reading and math have the deficits of both groups.

<u>LD-R, LD-M, and LD-R+M students and the WISC-III</u>

LD-M students have deficits in many of the skills that the Processing Speed portion of the SCAD profile (Symbol Search & Coding) measures. For example, the Symbol Search subtest measures the following skills: visual short term memory, spatial visualization, speed of mental processing, speed of visual search, and visual-motor coordination. Additionally, Symbol Search is subject to the influence visual-perceptual problems. Similarly, the Coding subtest measures the following skills: sequential processing, facility with numbers, visual short-term memory, visual sequencing, visual-motor coordination, and psychomotor speed (Kaufman, 1994). Thus, in light of the similarity between LD-M student's deficits and what the Symbol Search and Coding subtests measure, LD-M students should perform worse than LD-R students on the Symbol Search and Coding subtests.

LD-R students have deficits in some of the skills that the Freedom from Distractibility portion (Arithmetic and Digit Span) of the ACID/SCAD profile measures. For example, the Arithmetic subtest on the WISC-III measures, among others, the following skills: memory for symbolic stimuli, sequential processing, auditory short term memory, and acquired knowledge (Kaufman, 1994). In Sattler's inspection of thirty studies of reading disordered children, Arithmetic was one of the two lowest subtests, second only to the Information subtest.

Digit Span, the other half of the Freedom from Distractibility factor, measures the skills of sequential processing and auditory short term memory. Thus, noting the similarities between LD-R students deficits and the skills measured by the Arithmetic and Digit Span subtests, LD-R students should perform worse on these two subtests than their LD-M counterparts. Shafrir and Siegel's (1994) finding that a LD-R sample performed significantly worse on the Digit Span subtest than a LD-M sample partially supports this hypothesis.

The Information subtest on the WISC-III measures the skills of memory for semantic stimuli, and range of general factual knowledge. Additionally, it is subject to the influence of outside reading (Kaufman, 1994). This would imply that this subtest would be affected more negatively in a LD-R group than in a LD-M group. Thus, the ACID profile, should be more common in a LD-R group than the SCAD profile, but the SCAD profile should be more common in a LD-M group than the ACID profile. These results are expected because the ACID profile contains three verbal subtests that appear to be closely related to LD-R student's deficits and contains only one performance subtest. The SCAD profile, on the other hand, contains two performance subtests that appear to be closely related to LD-M student's deficits. Therefore, the three verbal subtests of the ACID profile should be relative weaknesses for a LD-R group while the two performance subtests of the SCAD profile should be relative weaknesses for a LD-M group.

Children with learning disabilities in both reading and math areas (LD-R+M) have deficits of both the LD-R and the LD-M groups. For example, Shafrir and Siegel (1994) found that a combined LD-R and LD-M group performed worse than either a LD-R only or a LD-M only group on a variety of cognitive and achievement measures. These cognitive measures in Shafrir and Siegel (1994) reflect many of the skills measured by the SCAD and ACID subtests (e.g. visual-spatial skills, eye-hand coordination, visual short term memory and auditory short term memory). Thus, LD-R+M students should perform worse on the ACID and SCAD subtests than either LD-R or LD-M students.

The Purpose of this Study

The purpose of the study reported here is two-fold. The first purpose is to see if the preliminary results from the studies on the WISC-III may be replicated (e.g. Wechsler, 1991; Prifitera & Dersh, 1993). That is, will Symbol Search but not Information, be among the lowest four subtests for a learning disabled sample resulting in the SCAD index being significantly lower than the ACID index for this sample? This research question will be answered by examining learning disabled children's profiles on the WISC-III. Because of the changes from the WISC-R to the WISC-III, Symbol Search is expected to replace Information as one of the four lowest subtests on the WISC-III for a sample of children with learning disabilities. Thus, the LD sample is expected to perform lower on the SCAD index than on the ACID index.

The second purpose of the current study is to compare the WISC-III profiles of three different subgroups of learning disabled students (LD-R, LD-M, and LD-R+M). None of the studies on the ACID profile with the WISC-R or WISC-III reported above directly examined profile differences with different subgroups of children with learning disabilities. Different patterns for these subgroups may be discovered, especially in light of the reported differences between the subtypes. Thus, the question to be answered is: do different subtypes (LD-R, LD-M, LD-R+M) of learning disabled students perform differently on the WISC-III ACID and SCAD subtests? It was expected that there would, in fact, be overall differences among these learning disabled subtypes on both the WISC-III ACID and SCAD subtests. These results were expected because the Information subtest of the ACID grouping was expected to be a weakness for LD-R students, but the Symbol Search subtest of the SCAD grouping was expected to be a weakness for LD-M students. LD-R students were expected to perform relatively poorly on the Information subtest because this is what previous research has shown (e.g. Sattler, 1994) and Kaufman (1994) says that the Information subtest is subject to the influence of outside reading. The Symbol Search subtest is expected to be relatively low for LD-M students because it measures visual-spatial skills (Kaufman, 1994) which have been shown to be a weakness for LD-M students (Fletcher, 1985). Additionally, the LD-R+M group was expected to perform lower on the ACID and SCAD indexes than the LD-R or LD-M group. These results were expected because LD-R+M students have been shown to perform worse on cognitive and achievement measures that reflect many of the skills measured by the ACID and SCAD subtests (Shafrir & Siegel 1994).

Another comparison of interest to the current researcher is between the ACID and SCAD subtests for each subgroup. That is, will there be a significant difference between the ACID and SCAD indexes for each separate group (LD-R, LD-M, & LD-R+M)? It was expected that the ACID index would be significantly lower than the SCAD index for the LD-R group. For the LD-M group it was expected that the SCAD index would be significantly lower than the ACID index. These results were expected because the Information subtest was expected to be a weakness for the LD-R group, but not the LD-M group.

Another subgroup comparison involved the FD portion and the PS portion of the SCAD index. The question to be answered is, are there differences between the FD and PS indexes for the different subgroups of learning disabled students? It was expected that the LD-R group would perform significantly lower on the FD portion than on the PS portion of the SCAD index because the Arithmetic and Digit Span subtests (FD) were expected to be weaknesses for the LD-R group. The Arithmetic subtest was expected to be a weakness for LD-R students because this subtest has been found to be particularly low for LD-R students (e.g Sattler, 1988) and it measures the skill of auditory short-term memory which has been found to be a weakness for LD-R students. In contrast, the LD-M group was expected to perform significantly lower on the PS index than on the FD index because the Coding and Symbol Search subtests were expected to be weaknesses for the LD-M group.

Another research question addressing the replicability of the preliminary WISC-III findings is, will a sample of children with learning disabilities display greater percentages of full and partial SCAD profiles than full and partial ACID profiles? This research question will be answered by examining learning disabled children's profiles on the WISC-III. Because the Symbol Search subtest but not the Information subtest is expected to be among the lowest four subtests for a sample of children with learning disabilities the LD sample is expected to display greater percentages of full and partial SCAD profiles than full and partial ACID profiles.

A final subgroup comparison concerns the ACID and SCAD profiles. The question to be answered is, do different subgroups of learning disabled students (LD-R, LD-M, & LD-R+M) display different frequencies of the ACID and SCAD profiles? It was expected that there would be differences among the groups for the frequencies of the ACID and SCAD profiles. The LD-R+M group in particular was expected to display greater frequencies of full and partial ACID and SCAD profiles than either the LD-R or the LD-M group. These results are expected because once again, LD-R+M students have been shown to perform worse on cognitive and achievement measures that reflect many of the skills measured by the ACID and SCAD subtests (Shafir & Siegel 1994).

Method

Participants

The sample used in this study consisted of 171 children with learning disabilities aged 6 to 16 (Mean age = 11 years and 10 months). Because the internal consistency reliabilities do not dramatically change with age on the WISC-III (Sattler, 1992) and because the ACID profile has been consistently found across a large age range (with children and adults) no further breakdown of age is needed.

The participants in this study were students with learning disabilities that have been given the WISC-III in several school systems in the Midwest. The data were gathered from files in fourteen Midwestern school systems. The children were previously verified by multidisciplinary teams as having a learning disability. Verification was based primarily on IQ and achievement scores according to state guidelines. The child's Full Scale IQ score had to be above the -1 standard deviation level on an individually administered test of intelligence. For those children who had a greater than or equal to 1 standard deviation difference between their verbal and performance IQ's the higher score was used as the index of cognitive ability. Additionally, the child's score in one or more achievement areas had to be at least 1.3 standard deviations below the child's measured intellectual ability. Finally, the child's achievement score had to be at or below a standard score of 90. Like the IQ scores the achievement scores were standard scores (X=100, SD=15). In the state there is some leeway allowed in the verification guidelines for learning disabled students. For example, a multidisciplinary team could verify a student as having a learning disability even though they do not meet the verification criteria. However, only students that meet the exact verification criteria were used in the current study. Also, students that were identified as having ADHD, Behavioral Disorders, or Speech/Language Impairments in addition to learning disabilities were excluded from the current study. However, this may not have ruled out all students with these disorders because some students may not have been correctly identified as having these disorders.

The sample was divided into three separate groups based on their primary areas of disability. All three groups had been verified as learning disabled based on discrepancies between the WISC-III and achievement scores on several achievement tests. The achievement tests included, but were not limited to, the Wechsler Individual Achievement Test, the Diagnostic Achievement Battery-Two, the Peabody Individual Achievement Test, and the Kaufman Test of Educational Achievement. One group were students who were verified as learning disabled in the area of reading only (LD-R) (Basic Reading and/or Reading

Comprehension). Although the two basic component skills of reading (Basic Reading and Reading Comprehension) may be independent from one another (Aaron & Joshi, 1992) they tend to be highly correlated. For example, the average correlation between Basic Reading and Reading Comprehension over the age range of 6-16 reported in the manual for the Wechsler Individual Achievement Test (WIAT) (Wechsler, 1992) is .72.

The second group consisted of students that were verified as having a learning disability in the area of math only (Math Reasoning and/or Numerical Operations). Relatively high average correlations between the math areas (Math Reasoning and Numerical Operations) are also evident (e.g. the average correlation between Math Reasoning and Numerical Operations for the age range of 6-16 years reported in the WIAT manual is .73). These high correlations justify the use of either reading area or either math area to consider a child as having a learning disability in reading or math respectively.

The third group consisted of children that had been verified as learning disabled in reading and math (LD-R+M) (Basic Reading and/or Reading Comprehension, and Mathematics Reasoning and/or Numerical Operations). Table I summarizes the demographic information for each sample.

Table I

Demographics on Samples

	Sample			
	LD-Total (N=171)	LD-R (N=30)	LD-M (N=30)	LD-R+M (N=30)
Mean Age (yrs.-mos.)	11-10	12-0	11-7	12-4
Male	67.3%	70.0%	67.0%	67.0%
Female	32.7%	30.0%	33.0%	33.0%
Caucasian	91.2%	96.7%	96.7%	100.0%

Procedure

The current study used two different methods of examining performance on the ACID and SCAD subtests, the index score method and the profile method. The index score is a standard score (X=100, SD=15) that is computed from the four subtest scaled scores (X=10, SD=3) from ACID or SCAD. The mean standard scores for the samples were computed and compared. The profile method involved computing and then comparing the percentages of the samples that displayed full and partial ACID and SCAD profiles.

ACID vs. SCAD Index. To answer the first research question the mean WISC-III subtest scores for the total LD sample were calculated and rank-ordered from lowest to highest. Because the ACID and SCAD indexes have the same subtests in common except for the Information subtest and the Symbol Search subtest, respectively, the relative rankings of the Information and Symbol Search subtests were compared to help explain the ACID and SCAD index findings. Additionally, to answer the first research question the ACID and SCAD index scores were calculated and compared. The ACID score was calculated by applying a formula (ACID standard score = 1.6X + 36) based on the intercorrelations among the four ACID subtests (Wechsler, 1991, Table C.2) using a linear equating procedure (Tellegen & Briggs, 1967). The SCAD score was also calculated by applying a formula (SCAD standard score = 1.74X + 30.4) based on the intercorrelations among the four SCAD subtests (Wechsler, 1991, Table C.2) using a linear equating procedure (Tellegen & Briggs, 1967). This comparative analysis was accomplished by performing a t-test.

ACID vs. SCAD Index for Subgroups. The ACID and SCAD index scores for each subgroup (LD-R, LD-M, & LD-R+M) were calculated and compared to see if the groups differed on these indexes. This comparative analysis was accomplished by performing a 3X2 analysis of variance. Also, planned multiple comparisons utilizing t-tests were performed to see if the ACID and SCAD indexes differed for each group.

FD vs. PS Index for Subgroups. The last analysis addressing the index scores involved comparing the Freedom From Distractibility (Arithmetic & Digit Span) and Processing Speed (Coding & Symbol Search) standard scores for each group (LD-R, LD-M, & LD-R+M). This helped delineate how the three groups differed on the SCAD profile. This was accomplished by performing another 2x3 analysis of variance. Once again, planned multiple comparison tests (t-tests) were performed to compare the Freedom From Distractibility and Processing Speed scores for each group.

ACID vs. SCAD Profiles. The first analysis using the profile method involved calculating the percentages of children that displayed the full and partial ACID and SCAD profiles. As previously stated, participants were considered positive for the full ACID and SCAD profiles when their scaled scores on the all four of the ACID or SCAD profiles were equal to or less than the lowest scaled score on any one of the remaining subtests, excluding Symbol Search and Mazes for the ACID profile and Mazes for the SCAD profile (Prifitera & Dersh, 1993). Subjects were considered positive for the partial ACID and SCAD profiles when three of the four ACID or SCAD subtests were equal to or less than the lowest scaled score on any of the remaining subtests (excluding mazes). As in previous studies (e.g. Prifitera & Dersh, 1993; Wechsler, 1991) this procedure was also followed for examining partial ACID and SCAD profiles with one and two subtests. These percentages were then compared by using a chi-square analysis.

ACID vs. SCAD Profiles for Subgroups. The other analysis using the profile method involved calculating the percentages of children in each subgroup (LD-R, LD-M, LD-R+M) that displayed the full and partial ACID and SCAD profiles. The group percentages were compared by using a chi-square analysis.

Results

Table II presents the mean WISC-III composite scores for the total sample and the subgroups. All groups displayed similar Full Scale IQ's, F (2,87) = .0256, MS = 82.03, p = .9747. Table III presents the mean WISC-III subtest scores for the total sample and the subgroups ranked from highest to lowest. The lowest subtests for the total sample were Arithmetic, Digit Span, Vocabulary, and Comprehension. The remaining two ACID subtests Information and Coding, were the fifth and sixth lowest, respectively. Symbol Search was the ninth lowest subtest for the total sample.

ACID vs. SCAD Index

Table IV presents the ACID and SCAD standard scores for the total sample and each subgroup. The ACID and SCAD standard scores for the total sample were compared by using a t-test. This effect was found to be significant but in the opposite direction predicted. It was predicted that the SCAD score would be significantly lower than the ACID score. However, the ACID score (M = 85.66, SD = 10.063) was significantly lower than the SCAD score (M = 88.55, SD = 12.103), t (340) = -2.40, p = .017. This is explained by the mean subtest scores of Information and Symbol Search. Information was one of the lowest subtest scores and Symbol Search was one of the highest.

Table II

Mean Standard Scores for Samples

	Sample			
	Total Sample (N=171)	LD-R (N=30)	LD-M (N=30)	LD-R+M (N=30)
VIQ	89.76	90.53	87.80	87.27
PIQ	99.78	97.87	96.80	97.67
FSIQ	93.25	92.76	92.87	93.27
VC Index	92.35	90.93	95.17	88.90
PO Index	101.30	98.63	97.57	102.67

Note. VIQ=Verbal IQ, PIQ=Performance IQ, FSIQ=Full Scale IQ, VC=Verbal Comprehension, PO=Perceptual Organization.

Table III

Rank-ordered mean subtest scores from highest to lowest for samples

Sample

	Total Sample (N=171)	LD-R (N=30)	LD-M (N=30)	LD-R+M (N=30)
12	PA(10.66)	PA(10.53)	PC(10.07)	PC(11.03)
11	PC(10.14)	SS (9.83)	OA (9.93)	PA(10.83)
10	OA (9.91)	OA (9.73)	PA (9.63)	OA(10.23)
9	SS (9.72)	PC (9.5)	I (9.47)	SS (9.37)
8	BD (9.10)	BD (8.97)	SS (9.4)	BD (8.47)
7	S (8.75)	S (8.87)	V (8.83)	S (8.43)
6	C (8.61)	C (8.63)	S (8.80)	C (8.27)
5	I (8.44)	CO (8.6)	C (8.53)	I (8.13)
4	CO (8.33)	I (8.4)	CO (8.5)	V (7.53)
3	V (8.03)	A (8.17)	BD (8.29)	DS (7.5)
2	DS (7.64)	V (7.53)	DS (7.9)	CO (7.27)
1	A (7.28)	DS (7.43)	A (6.13)	A (6.93)

Note. PC=Picture Completion, PA=Picture Arangement, OA=Object Assembly, SS=Symbol Search, BD=Block Design, S=Similarities, C=Coding, I=Information, CO=Comprehension, V=Vocabulary, DS=Digit Span, A=Arithmetic.

Table IV

FD & PS Index and ACID and SCAD Standard Scores for Total Sample and Subgroups

Sample

	Total Sample (N=171)	LD-R (N=30)	LD-M (N=30)	LD-R+M (N=30)
FD Index	87.41	89.30	85.00	85.23
PS Index	96.71	97.90	95.70	94.90
ACID Index	85.66	88.00	87.23	84.50
SCAD Index	88.54	90.87	86.33	86.50

ACID vs. SCAD Index for Subgroups

Table IV presents the mean ACID and SCAD index scores for the total sample and the subgroups. The ACID and SCAD standard scores for each group were compared by using a 3X2 mixed analysis of variance with group (LD-R, LD-M, or LD-R+M) as the between subjects variable, and index score (ACID or SCAD) as the within-subjects variable. Neither of the main effects for group, F (2,116) = 2.27, MS = 214.41, p =.108, or index score, F (1,58) = .65, MS = 78.67, p = .424, were significant, nor was the interaction effect of group x index score, F (2,116) = .55, MS = 58.37, p = .579. Planned multiple comparison tests revealed that the ACID and SCAD index scores did not significantly differ for the LD-R group, t (58) = -1.30, p = .198, the LD-M group, t (58) = .30, p = .766, or the LD-R+M group, t (58) = -.69, p = .493.

FD vs. PS Index for Subgroups

Table IV presents the mean FD and PS index scores for the total sample and the subgroups. The FD and PS index scores for each group were compared by using a 3x2 mixed analysis of variance with sample (LD-R, LD-M, LD-R+M) as the between-subjects variable and index score (FD or PS) as the within-subjects variable. The main effect for index score was significant F (1,58) = 22.81, MS = 4156.81, p = .000, indicating that there was a significant difference between the FD and PS indexes. However, the main effect for group was not significant, F (2,116) = 1.67, MS = 226.07, p = .192, nor was the interaction effect of group x index score, F (2,116) = .19, MS = 26.01, p = .825. Planned multiple comparison tests (t-tests) revealed that the FD index was significantly lower than the PS index for the LD-R group, t (58) = -2.84, p = .006, the LD-M group, t (58) = -3.24, p = .002, and the LD-R+M group, t (58) = -3.00, p = .004. The mean subtest scores explain why these results occurred. Among the groups, both Arithmetic and Digit Span (FD index) ranked from the lowest to the third lowest subtests. Coding was also relatively low for the groups ranging from the fifth to the sixth lowest subtest. However, Symbol Search, the other half of the PS index, ranged from the eighth lowest to the eleventh lowest subtest for the three groups. For the total LD sample Symbol Search ranked as only the ninth lowest (fourth highest) subtest.

<u>ACID vs. SCAD Profiles</u>

The percentage of the total sample that displayed full and partial ACID profiles is presented in Table V and the percentage of the total sample that displayed full and partial SCAD profiles is presented in Table VI. The results indicated that the percentage of the total sample of students with learning disabilities that displayed the full ACID profile did not differ from the percentage of the total sample that displayed the full SCAD profile,

Table V

Cummulative Percentages of Samples at Various Levels of the ACID Profile

	Sample			
Number of ACID subtests	Total Sample (N=171)	LD-R (N=30)	LD-M (N=30)	LD-R+M (N=30)
4	2.3	0.0	3.3	0.0
3	18.1	6.7	26.7	13.3
2	44.4	30.0	60.0	33.3
1	62.6	53.3	70.0	63.3

Table VI

Cummulative Percentages of the Samples at Various Levels of the SCAD Profile

	Sample			
Number of SCAD subtests	Total Sample (N=171)	LD-R (N=30)	LD-M (N=30)	LD-M+R (N=30)
4	3.5	0.0	6.7	0.0
3	17.0	10.0	30.0	6.7
2	37.4	26.7	60.0	33.3
1	57.3	43.3	73.3	60.0

$\chi^2(1, N = 171) = .23$, $p > .05$. The percentages of the sample that displayed the partial ACID and SCAD profiles with 3, 2, and 1 subtests, were also statistically similar, $\chi^2(1, N = 171) = .60$, $p > .05$, $\chi^2(1, N = 171) = .034$, $p > .05$, $\chi^2(1, N = 171)$, $= .24$, $p > .05$, respectively.

ACID vs. SCAD Profiles for Subgroups

Table V presents the percentage of each subgroup that displayed full and partial ACID profiles and Table VI presents the percentage of each subgroup that displayed full and partial SCAD profiles. A greater percentage of the LD-M group displayed the full ACID profile than the LD-R group or the LD-R+M group, $\chi^2(2, N = 90) = 6.6$, $p < .05$. The LD-M group also displayed greater percentages of partial ACID profiles with 3 and 2 subtests $\chi^2(2, N = 90) = 13.4$, $p < .05$, $\chi^2(2, N = 90) = 13.16$, $p < .05$, respectively. However, with 1 subtest the partial ACID profiles were similar among the groups, $\chi^2(2, N = 90) = 2.19$, $p > .05$. As with the ACID profile, a greater percentage of the LD-M group displayed the full SCAD profile than the LD-R group or the LD-R+M group $\chi^2(2, N = 90) = 7.56$, $p < .05$. The LD-M group also displayed greater percentages of partial SCAD profiles with 3 and 1 subtest than the LD-R or LD-R+M groups, $\chi^2(2, N = 90) = 7.967$, $p < .05$, $\chi^2(2, N = 90) = 7.56$, $p < .05$, repectively. However, all three groups displayed similar percentages of partial SCAD profiles with 2 subtests, $\chi^2(2, N = 90)$

$= 5.54$, $p > .05$.

Discussion

This study examined the performance of a heterogeneous LD sample and three LD subtypes on the WISC-III ACID and SCAD subtests. The findings of this study provide supporting evidence for the relatively poor performance of LD children on the Information subtest and, hence, the ACID Index relative to the Symbol Search subtest and, consequently, the SCAD index. The findings of this study also provide supporting evidence for the incongruent performance of three LD subtypes on the WISC-III ACID and SCAD subtests. Although there was not a significant difference among the LD-R, LD-M, and LD-R+M groups on the ACID and SCAD indexes this may have been because of the limited statistical power resulting from the small sample sizes. The LD-M group displayed greater percentages of the ACID and SCAD profiles than the other two groups. There were also differences among the subgroups for the Arithmetic and Information subtests. Although some of the findings in the current study were unanticipated and it was not without limitations, the current study's findings have significant implications for school psychologists and researchers.

ACID vs. SCAD Index

The data showed that the LD sample performed significantly lower on the ACID index than the SCAD index. Thus, it appears that Kaufman's (1994) recommendation to abandon the ACID profile in favor of the SCAD profile may have been premature. The scaled score obtained by the learning disabled sample on the Symbol Search subtest was near the average obtained by children in the WISC-III standardization sample (Wechsler, 1991) which suggests that the Symbol Search subtest does not discriminate between children with learning disabilities and children without learning disabilities. In contrast, the Information subtest scaled score of the ACID profile was one-half a standard deviation lower than obtained on the WISC-III standardization sample (Wechsler, 1991). These results suggest that the Information subtest is better than the Symbol Search subtest at discriminating between children with and without learning disabilities.

These results are not consistent with the preliminary findings of Prifitera and Dersh (1993) who found Symbol Search to be among the lowest and Information to be the sixth lowest mean subtest score for a learning disabled sample. However, these results are consistent with the more recent study by Ward et al. (1995) who found Information to be the third lowest and Symbol Search the ninth lowest subtest for a LD sample.

Differences among the samples in Prifitera and Dersh, Ward et al. (1995), and the current study may help to explain the discrepant findings. For example, the Full Scale and Verbal scores in Prifitera and Dersh (1993) were higher than in Ward et al. (1995) and the current study. One would expect a higher Information subtest to occur with higher verbal ability as occurred in Prifitera and Dersh (1993).

Another demographic difference in the participants in these studies was that the sample in the current study included twice the number of children with a learning disability in reading than did Prifitera and Dersh (1993). The Information subtest in the current study was found to be a weakness for the LD-R group relative to the LD-M group. Additionally, the Information subtest has been found to be among the lowest four subtests for reading disabled samples in previous research (e.g. Sattler, 1988). Thus, the large percentage of LD-R children in the current study, relative to Prifitera and Dersh's (1993) sample, may have been responsible for the relatively low Information subtest performance by the sample in the current study. Ward et al. (1995) did not report the percentage of LD-R children in their sample, but perhaps, like the current study's sample, it consisted of a relatively high percentage of LD-R children resulting in a relatively low Information subtest score.

ACID vs. SCAD Index for Subgroups

The current research also tested the research question of whether certain subtypes of learning disabled children (LD-R LD-M, & LD-R+M) perform differently from each other on the WISC-III ACID and SCAD indexes. The results showed that the LD-M group was the only group who performed lower on the SCAD index than on the ACID index. This may have been because the Symbol Search subtest of the SCAD index measured the hypothesized visual-spatial weakness of the LD-M group (Fletcher, 1985). Additional evidence of this visual-spatial weakness for LD-M students in this study can be seen in their performance on the Block Design subtest. Block Design, which is a measure of visual-spatial skills (Kaufman, 1994), was the third lowest subtest for the LD-M group, but was the eighth lowest subtest for the LD-R and LD-R+M groups.

The index score results may have not resulted in significance because of the small sample sizes of the subgroups (N=30). These small subject numbers were used because it was difficult to locate subjects that were learning disabled in just one particular area. These small subject numbers limited the power of the statistical analyses employed. The ACID standard score of the LD-R+M group differed from the other two groups by approximately three standard score points and the SCAD standard score of the LD-R group differed from the other two groups by more than four points. It is possible that these would be significant differences with larger sample sizes and, hence, greater statistical power. For example, some of these group differences were larger than the significant difference between ACID and SCAD indexes for the much larger total sample.

FD vs. PS Index for Subgroups

The final index score comparison indicated that there were no significant differences among the subgroups on either the FD index or the PS indexes. However, the FD index was found to be significantly lower than the PS index for all three subgroups. These results occurred because of the relatively high Symbol Search score for the groups. Even when combined with the relatively low score occurring on the Coding subtest to form the PS index, the duo of Symbol Search and Coding was not a weakness for the learning disabled subgroups. For example, the PS index was higher than the FSIQ for the three groups and the total sample indicating that the mean of these two subtests together was higher than the mean of all twelve subtests. These results are consistent with Ward et al. (1995), but contrast with Prifitera and Dersh (1993) who found Symbol Search to be the fourth lowest subtest for a sample of learning disabled children. However, the current study and Ward et al. (1995) used considerably larger sample sizes than Prifitera and Dersh (1993) indicating that Prifitera and Dersh's (1993) preliminary Symbol Search findings were probably spurious.

ACID vs. SCAD Profiles

While there was a significant difference between the

ACID and SCAD indexes for the LD sample, comparison of the ACID and SCAD profiles yielded different results. The percentages of the total LD sample that displayed the ACID and SCAD profiles were not significantly different. The ACID and SCAD profile findings may be discrepant from the ACID and SCAD index findings because the profile method utilizes nominal data, but the index method uses interval data. Because the units of a nominal scale are categories (a given subject either displayed the ACID/SCAD profile or not) all subjects displaying the various levels of the ACID/SCAD profiles are viewed as being equivalent. Thus, there is no magnitude of relationship among subjects displaying the ACID/SCAD profiles. However, the index method, by using interval data, takes the magnitude of relationships among the subjects into account. For example, using the profile method one student may display the full SCAD profile but only a partial ACID profile with three subtests and the Symbol Search subtest (of the SCAD profile) may only differ from the Information subtest (of the ACID profile) by one standard score point. On the other hand, another student may display a full SCAD profile but only a partial ACID profile with three subtests, and the Information score could differ from the Symbol Search score by several standard score points. The profile method would view these two subjects as identical, but the index method would account for the magnitude differences between these two subjects. Thus, previous research using the index method (e.g. McCue, Shelly, & Goldstein, 1986; Kaufman, 1990; Kavale and Forness, 1984; Wechsler, 1991) may not be directly comparable to previous research utilizing the profile method (e.g. Wechsler, 1991; Prifitera & Dersh, 1993; Ward et al., 1995).

The current study suggests that the index method may be more sensitive to differences between the ACID and SCAD subtests than the profile method. For example, the Information subtest (of the the ACID grouping) was the fifth lowest subtest for the total LD sample, but the Symbol Search subtest (of the SCAD grouping) was only the ninth lowest subtest. This difference appeared in the ACID vs. SCAD index comparison, but not in the ACID vs. SCAD profile comparison. For example, there was a significant difference between the ACID and SCAD indexes, but there was not a significant difference between the ACID and SCAD profiles.

The percentage of the total LD sample in the current study that displayed the full ACID profile was lower than in previous research on the WISC-III. For example, in Wechsler (1991), Prifitera and Dersh (1993), and Ward et al. (1995) the percentage of LD samples that displayed full ACID profiles was 5.1%, 5.1%, and 4.7%, respectively. However, the percentages of the total LD sample that displayed the partial ACID profile with three, two, and one subtests were consistent with previous research (e.g.

Wechsler, 1991; Prifitera & Dersh, 1993).

ACID vs. SCAD Profiles for Subgroups

Another research question tested in the current study involved comparing the ACID and SCAD profiles for the three subgroups. Results indicated that the LD-M group did, in fact, display greater percentages of partial ACID profiles than the LD-R or LD-R+M groups. Similarly, the LD-M group displayed greater percentages of full and partial SCAD profiles than the LD-R or LD-R+M groups. This probably occurred because the Arithmetic subtest was especially low for the LD-M group reflecting their deficient mathematical abilities (see discussion of subtest differences below). However, the results also showed similar percentages for each group between the ACID and SCAD profiles.

These ACID and SCAD profile results for the subgroups may be different than the ACID and SCAD index results because of the difference between the profile and index methods, as discussed above. Additionally, the small subgroup sample sizes may have caused the index differences to be non-significant.

Subtest Differences for Subgroups

Differences existed among the groups for some of the ACID subtests. For example, the Arithmetic subtest was nearly two-thirds of a standard deviation lower for the LD-M group than for the LD-R group. While this finding may seem intuitively obvious, the Arithmetic subtest is different from arithmetic subtests on achievement batteries because it does not measure the mathematics curriculum in a content valid way (Kaufman, 1994). For example, the WISC-III Arithmetic subtest directly excludes mathematics skills such as the use of charts and graphs. Also, there is a stringent time requirement on the Arithmetic subtest questions which does not generalize to most classroom mathematics situations. Kaufman (1994) states that scores on the WISC-III Arithmetic subtest can be very different from achievement in mathematics. Nevertheless, the current study suggests that students with learning disabilities in math perform relatively lower on the WISC-III Arithmetic subtest than students with learning disabilities in reading. Even though the Arithmetic subtest does not measure mathematics achievement per se it does require some skills that are probably weaknesses for LD-M students relative to LD-R students (e.g. computational skill, and facility with numbers).

There were also differences among the groups on the Information subtest. Information was not a weakness for the LD-M group as it was for the LD-R and LD-R+M groups. For the LD-M group Information was the ninth lowest subtest, but for the LD-R group and the LD-R+M group it was the fourth and fifth lowest subtest, respectively. The Information subtest of the ACID profile was actually higher than Symbol Search of the SCAD profile for the LD-M group. This resulted in the LD-M group being the only group for which the SCAD index was lower than the ACID index.

Vocabulary was found to be the third lowest subtest for the total sample. Although the Vocabulary subtest occurred slightly lower than anticipated, this finding is relatively consistent with previous research on the WISC-R and the WISC-III. For example, in Kavale and Forness's (1984) meta-analytic examination of 94 WISC and WISC-R studies with learning disabled samples Vocabulary was the fifth lowest subtest. Similarly, in Sattler's (1984) review of 30 studies of reading disordered student's performance on the WISC-R, Vocabulary was found to be the fifth lowest subtest. The findings in the current study and those of previous research indicate that on the WISC-III, Vocabulary has been found to be slightly lower for LD samples than on the WISC-R. For example, Prifitera and Dersh (1993) found Vocabulary to be the fifth lowest subtest for a LD sample. Ward et al. (1995), with a larger sample size, found Vocabulary to be the fourth lowest subtest for their LD sample. Perhaps the changes in the Vocabulary subtest from the WISC-R to the WISC-III have caused it to become more of a weakness for learning disabled children. For example, the WISC-III Vocabulary subtest includes 11 new items not found on the WISC-R (Wechsler, 1991).

Another unanticipated finding in the current study was the fact that the Comprehension subtest was the fourth lowest subtest for the total LD sample. This finding was particularly unexpected because past research indicates that Comprehension often emerges as a "diamond in the rough" among the Verbal subtests for LD students. For example, the relatively low Comprehension findings in the current study are not consistent with previous research on the WISC, WISC-R or WISC-III (e.g. Kavale & Forness, 1984; Prifitera & Dersh, 1993; Ward et al., 1995). For example, Kavale and Forness's (1984) LD WISC and WISC-R meta-analysis found Comprehension to be the eighth lowest subtest. On the WISC-III Prifitera and Dersh (1993) and Ward et al. (1995) found Comprehension to be the sixth lowest and the eleventh lowest subtest for their LD samples, respectively.

<u>Implications for School Psychologists</u>

The results of this study have implications for school psychologists using the WISC-III in evaluations of children with learning disabilities. While the SCAD profile was a weakness for the learning disabled sample, these results are primarily because of the Coding, Arithmetic, and Digit Span subtests and not because of the Symbol Search subtest. The ACID index, which includes the same subtests with Information instead of Symbol Search was found to be significantly lower than the SCAD index for a learning disabled sample. Thus, the ACID grouping should not be abandoned in favor of the SCAD grouping to aid in the detection of learning disabilities. In fact, it is recommended that examiners continue to utilize the ACID grouping, pending future research that suggests otherwise. When using the ACID profile, however, examiners need to keep in mind the difference between LD-R and LD-M students on the Arithmetic and Information subtests. The current study's findings suggest that examiners should expect the Information subtest to be among the lowest subtests for LD-R students but not LD-M students. Additionally, examiners should expect the Arithmetic subtest to be especially low for LD-M students.

Examiners should also expect differences between the subgroups for non-ACID subtests. For example, examiners should expect the Vocabulary subtest to be lower for students with learning disabilities in reading than for students with learning disabilities in math because in the current study the Vocabulary subtest was a particular weakness for the LD-R group (second lowest), but not the LD-M group (seventh lowest). Additionally, if the current study's results are found to be robust, examiners should expect the Comprehension subtest to be relatively low for students with learning disabilities in reading, math, and especially, students with learning disabilities in reading and math. For example, in the current study the Comprehension subtest was the fifth, fourth, and the second lowest subtest for the LD-R, LD-M and LD-R+M groups, respectively.

A final subtest where examiners should expect differences among students with learning disabilities in reading (LD-R), math (LD-R+M) and reading and math (LD-R+M) is on the Block Design subtest. In the current study the Block Design subtest was particularly low for the LD-M group (third lowest), but not for the LD-R and LD-R+M groups (eighth lowest).

Even though the Symbol Search subtest may not be useful in the detection of learning disabilities, this optional subtest should still be given because it can provide useful information. Symbol Search when combined with Coding to form the Processing Speed factor allows the examiner to subdivide the Performance Scale into two meaningful and reliable categories (the Perceptual Organization Factor and the Processing Speed Factor). This permits a more systematic evaluation of a student's nonverbal abilities. For example, a student may perform significantly better or worse on the Processing Speed Factor than on the Perceptual Organization Factor. This would suggest that the full Performance IQ would not reflect a unitary construct for that student. In this case the Perceptual Organization Factor would be a better measure of that student's nonverbal abilities (Kaufman, 1994).

The Processing Speed Factor can also provide important behavioral information about the student's motivation during the evaluation. As Kaufman (1994) states, "Copying symbols is about as interesting in (i.e. [sic]) standing on (i.e. [sic]) a long move line [Coding], and scanning symbols is almost as mindless [Symbol Search]" (p. 210). Thus, the Coding and Symbol Search subtests are more vulnerable to lack of effort during the evaluation than the other WISC-III subtests. Therefore, a low Processing Speed score can provide supporting evidence when the examiner suspects that the student is giving minimal effort during the evaluation (Kaufman, 1994).

The Processing Speed factor also provides important information about the student's learning style that can be directly translated to educational recommendations (Kaufman, 1994). For example, a student with a low Processing Speed score which is determined to not be the result of poor motivation leads to educational recommendations such as allowing the student more time to complete tasks, or limiting the length of assignments.

Of course, examiners should not rely solely on the WISC-III in diagnosing learning disabilities. The assessment also needs to include an individually administered test of educational achievement and other information obtained from such sources as behavioral observations, behavioral rating scales, and teacher reports. Poor performance on the ACID subtests should only be used as supporting evidence for a diagnosis of learning disabilities.

The ACID grouping may be particularly useful in cases where the learning disabilities are not obvious. It is ultimately the multidisciplinary team's decision to verify a student as having learning disabilities. In some cases this decision is not clear-cut. For example, a student may have an IQ-achievement discrepancy that nearly, but not quite, meets the criteria for learning disabilities verification. In contrast, a student may meet the LD verification criteria on one achievement measure but not on another achievement measure. In these borderline cases looking at the ACID subtests may be helpful in determining verification because poor performance on the ACID subtests suggests some underlying cognitive deficits that are more likely to occur in students with learning disabilities than in the general population.

Limitations of the Current Study

Due to the nature of the diagnosis of LD it is difficult to make comparisons among LD subtypes. One reason is because the diagnosis of learning disabilities in a particular area does not account for the level of severity of the disability. For example, the LD-R group in this study could have had an average of a forty point discrepancy between their ability and achievement, but the LD-M group may have had only an average of a twenty point discrepancy.

In this scenario the LD-M group would be more severely disabled and would probably perform worse on the ACID and SCAD subtests. This is unlikely because of the nature of group data (e.g. the discrepancies probably average out to be similar). It is also unlikely in the current study because all three groups displayed statistically similar Full Scale IQ's. One would suspect a more severely disabled group to display greater overall cognitive impairment as reflected in the Full Scale IQ.

Another difficulty in comparing different LD groups that is related to the nature of the LD diagnosis has to do with the variety of achievement measures utilized in this study. Although all of the achievement measures used in the current study are considered to be well-developed and well-normed (Sattler, 1988) the correlations among the achievement tests, of course, are not perfect. Thus, a student may be classified as being learning disabled using one particular instrument, but may not have met the verification criteria using a different instrument. In hindsight, it would have been beneficial to record the achievement scores for each student during the data collection.

The failure to directly rule out other disabilities was also a limitation of this study. For example, although no students that were identified as having ADHD were included in this study, there may have been some unidentified students with the disorder inadvertently included. This caveat also applies to students with Behavior Disorders and Speech/Language Impairments.

No attempt was made in this study to compare the incidence of the ACID and SCAD profiles with the incidence that occurs in the normal population. However, the current results of the incidence of these profiles for a LD sample were consistent with previous research (e.g. Wechsler, 1991; Prifitera & Dersh, 1993; Ward et al., 1995) and thus, can be assumed to significantly differ from the normal population as they did in these previous studies.

Additionally, no attempt was made in the current study to compute conditional probabilities and incremental gains of the ACID/SCAD profiles to determine the utility of these profiles for differential diagnosis. These computations are readily available elsewhere (e.g. Prifitera & Dersh, 1993; Ward et al., 1995).

A final limitation was that the participants in this study were predominantly Caucasian and were all from the Midwest. Thus, the results may not generalize to other populations.

Suggestions for Future Research

Future researchers investigating the WISC-III should be aware of differences between groups of students with learning disabilities in reading and math on the ACID subtests. For example, the current study suggests that the Information subtest is not a weakness for LD-M students as it is for LD-R students and the Arithmetic subtest is considerably lower for LD-M students than LD-R students. In addition, LD-M students displayed greater percentages of the ACID and SCAD profiles than LD-R students. The differences between these subtypes of learning disabilities on the ACID subtests and profiles may account for some of the variability in research on the ACID profile with homogenous samples of learning disabled students. That is, some samples may have included different ratios of LD-R and LD-M students. It would behoove the prudent researcher to, at the minimum, report the percentage of various learning disabled subtypes in their LD samples. Although many of the comparisons among the groups were not significant this may have been because of the small sample sizes in the subgroups. Therefore, future research studies will want to examine the WISC-III performance of these LD subgroups with larger sample sizes.

The group method of calculating index standard scores may lead to different results and, therefore, different conclusions than the traditional profile method. Thus, future researchers should not make comparisons with previous research using the alternate method. Also, since the methods may lead to different results, researchers may want to include both methods and perhaps even directly compare the index and the profile method in their study.

Future research with the WISC-III and learning disabled samples should investigate or at least be alert to the possibility that Vocabulary is a relative weakness for LD children on the WISC-III. Also, further research with LD samples on the WISC-III should help determine if the Comprehension findings in the current study were spurious. Comprehension was particularly low for the LD-R+M group. Perhaps children with more pervasive learning disabilities have greater weaknesses in some of the skills measured by the Comprehension subtest such as demonstration of practical information, evaluation of past experiences and/or knowledge of conventional standards of behavior (Kaufman, 1994). Thus, future researchers may want to examine the Comprehension subtest performance of groups of children with learning disabilities in more than one area.

Summary and Conclusions

The findings of the present study provide supporting evidence for the relatively poor performance of LD children on the Information subtest, and, hence, the ACID index relative to the Symbol Search subtest, and, consequently, the SCAD index. However, for the ACID and SCAD profiles, the sample of children with learning disabilities in the current study performed equally poorly. These findings are consistent with a recent study (Ward et al., 1995), but contrast with preliminary studies on the WISC-III (Prifitera & Dersh, 1993). Thus, the present study calls into question Kaufman's recommendations to abandon the ACID profile in favor of the SCAD profile.

The current study's findings also provide evidence for the different performance of subgroups of children with learning disabilities in reading and math on the ACID/SCAD subtests and profiles. In the current study the Arithmetic subtest was low for the LD-M group relative to the LD-R group. Additionally, the Information subtest was low for the LD-R group relative to the LD-M group. Also, the LD-M group displayed greater frequencies of the ACID and SCAD profiles than the LD-R group. Future researchers should further examine the performance of LD subgroups on the WISC-III ACID and SCAD subtests, preferably with larger sample sizes, to assess the current study's robustness.

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