ANALYTIC, HOLISTIC, AND INTEGRATED PROCESSING ON THE WISC-R AND SUBSEQUENT ARITHMETIC ACHIEVEMENT PREDICTION

PHILIP HENRY ROUTON

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An Abstract

Presented to

the Graduate Council of

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

Philip Henry Routon

July, 1981

ANALYTIC, HOLISTIC, AND INTEGRATED PROCESSING ON THE WISC-R AND SUBSEQUENT ARITHMETIC ACHIEVEMENT PREDICTION

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To the Graduate Council:

I am submitting herewith a Thesis written by Philip Henry Routon entitled "Analytic, Holistic, and Integrated Processing on the WISC-R and Subsequent Arithmetic Achievement Prediction." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

Elizabeth H. Hoskins
Major Professor

We have read this thesis and recommend its acceptance:

Linda Rudolph
Second Committee Member

Third Committee Member

Accepted for the Graduate Council:

William H. Ellis
Dean of the Graduate School

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A special note of thanks is given to my wife, Marsha, for her understanding, patience, and love. In addition, appreciation is extended to my parents, Mr. and Mrs. Joe Routon, and family for their encouragement and support.

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Chapter I

Introduction

Hemispheric Specialization

Cerebral hemisphere specialization refers to the purported ability of one cerebral hemisphere to be decidedly more proficient at a particular task than the other hemisphere. Interest in the specialization of cerebral functioning was greatly facilitated by the "split-brain" research of Roger Sperry and his associates (Sperry, 1968; Gazzaniga, 1975). A small sample of patients was studied who had their corpus callosa severed to eliminate the symptoms of severe epilepsy. Through this study it was possible to observe these patients' cerebral functioning at least partially disconnected. By severing a patient's corpus callosum, the communication between the two cerebral hemispheres was largely terminated. It had been more or less accepted for several years, through the study of patients with brain lesions (Reitan, 1955), that the left cerebral hemisphere was specialized for handling language-oriented material and the right hemisphere was specialized for handling spatial material.

In addition to the verbal vs. spatial differentiation

between the two hemispheres, Bogen (1969) later concluded that the left hemisphere was specialized for analytic, temporal, and digital operations, and that the right hemisphere was specialized for synthetic, holistic, analogic, and creative functions. He hypothesized further that the distinction between the hemispheres was dependent not on the stimuli presented, but on the methods for processing those stimuli. Even though the left hemisphere was credited with handling digital and numerical stimuli, Hartlage (1981) contended that mathematical "computation may involve either right or left cerebral hemisphere, depending on the complexity of the material and the specific neuropsychological abilities required" (p. 7).

Intelligence Tests and Hemispheric Processing

Wechsler (1958) was attempting to measure a person's global intelligence when he created his first scales, the Wechsler Bellevue Intelligence Scale (W-B) and the Wechsler Intelligence Scale for Children (WISC). The idea of attempting to measure global intelligence was carried over into the Wechsler Adult Intelligence Scale (WAIS) and the Wechsler Intelligence Scale for Children-Revised (WISC-R). In addition, he recognized that more information on subjects' abilities than merely a total, global score could be gathered in individual administration

of his scales. He stated,

> Although the primary purpose of an intelligence examination is to give a valid and reliable measure of the subject's global intellectual capacity, it is reasonable to expect that any well conceived intelligence scale will furnish its user with something more than an IQ or M.A. In point of fact, most intelligence examinations, when administered individually, make available a certain amount of data regarding the testee's mode of reaction, his special abilities or disabilities and, not infrequently, some indication of his personal traits. (p. 155)

The Wechsler Scales, the W-B, the WAIS, and the Wechsler Intelligence Scale for Children (WISC), as well as the revised WISC, the WISC-R, were constructed prior to the understanding of differential hemisphere processing. Though it might appear that the Verbal and Performance scales were attempts to measure left hemisphere functioning and right hemisphere functioning, respectively, this was not the original intention. Wechsler (1958) stated,

> One of the more useful features of the WAIS and W-B Scales is their dichotomy into Verbal and Performance subtests. This grouping was originally based not on the theory that there are different kinds of intelligence, but on the hypothesis that either through habit, training or endowment some individuals are able to deal better with objects than with words. (p. 159)

Even though the Verbal-Performance dichotomy was not originally intended for differentiating analytic, or left-brain, from holistic, or right-brain functioning, researchers have sometimes superimposed analytic and

holistic functioning on the Wechsler Verbal and Performance scales, respectively. The basis for this was research by Reitan (1955) in which patients with known left or right brain damage were administered the adult Wechsler scale. Reitan found lowered Verbal IQ's in patients with left hemisphere lesions and lowered Performance IQ's in patients with right hemisphere lesions.

There has been considerable disagreement as to the utility of intelligence tests for localizing functions (Kaufman, 1979a). Nevertheless, this is a relatively new area of research, and the Wechsler Scales have appeared to be at least minimally useful in differentiating between the two types of processing (Reitan, 1955; Hartlage, 1981; Kaufman, 1979b). Hartlage (1981) held that the WISC-R was valuable as a neuropsychological instrument for school psychologists in part because the Verbal IQ was an estimate of the left hemisphere's level of functioning and the Performance IQ was an estimate of the right hemisphere's level of functioning.

Kaufman (1979b) questions the contention that the Verbal scale reflects only analytic processing and the Performance scale reflects only holistic processing. This analysis, he suggests, recognizes the content rather than the processes involved in the two scales. From inspection of the content of the two scales, one might

infer that since the Verbal scale contains verbal content and since the Performance scale contains nonverbal content, the scales should be expected to reflect analytic and holistic processing, respectively. Kaufman agrees that the Verbal scale of the WISC-R requires primarily analytic processing, but he contends that processing necessary for the Performance scale is not unique to the right hemisphere. Picture Arrangement on the WISC-R, he argues, requires temporal sequencing to solve the problems, and temporal sequencing is in the domain of the left hemisphere. In addition, performance on the Coding subtest is influenced by analytic and sequencing skills characteristic of the left hemisphere. Block Design is also seen as being highly influenced by the left hemisphere due to the analysis used to separate the designs into their component blocks.

Kaufman (1979b) has grouped the WISC-R subtests into those he believes require left brain processing, right brain processing, and integrated functioning, according to the processes called on rather than the content of the subtests. The left brain processing subtests, according to Kaufman, are Information, Similarities, Arithmetic, Vocabulary, Comprehension, and Digit Span. Those thought to reflect right brain processing are Picture Completion and Object Assembly.

The integrated functioning subtests are Picture Arrangement, Block Design, Coding, and Mazes.

Differential Processing and Mathematics Performance

Hartlage (1981), seeing math computation as involving both the right and left hemispheres, states that language-oriented problems, such as included in the WISC arithmetic subtest or in modern math problems with sequential logic, are more left brain oriented. In contrast, he states that visualization of the everyday two-dimensional problems involves more right brain functioning. As a result, the left hemisphere would more efficiently process information involving math concepts, language formulations, sequential logic, aural practice, or algebra. On the other hand, the right hemisphere would more efficiently process information involving computation, geometry, two-dimensional workbook problems, flash card multiplication tables, or similar visually oriented modes.

Wheatley (1977) also recognizes the importance of the right hemisphere's role in arithmetic. He states that "rule application is characteristic of left-hemisphere processing. The mulling over of a problem to determine an approach is more characteristic of right-hemisphere functioning" (pp. 37-38). He explains that instructors primarily show students how to work problems

and then have them practice the processes involved, thus neglecting right-hemisphere problem solving abilities.

Just as the right hemisphere appears important in beginning reading in order for children to recognize letters as gestalts (Pirozzolo, 1978), holistic processing may be crucial in the early learning of numerical symbols for later calculation and problem solving. Early arithmetic achievement then might be more proficiently predicted by sampling of holistic processing capabilities.

Purpose of the Study

The purpose of this study is to compare the utility of analytic, holistic, and integrated processing styles for predicting arithmetic achievement. The WISC-R was used to differentiate processing capabilities in the subjects utilizing Kaufman's categories (1979b). The subjects of the study were given the WISC-R three years ago while in kindergarten (Stokes, Note 1). Analytic, holistic, and integrated processing means were gathered from the WISC-R subtest scores of the twenty-five subjects. Correlations between each type of processing and arithmetic achievement were compared. Arithmetic achievement was represented by school marks, standardized group achievement test scores, and the individually administered KeyMath Diagnostic Arithmetic Test.

Hypotheses

The author of the present study hypothesizes that (1) analytic processing on the WISC-R will correlate significantly with arithmetic achievement, (2) holistic processing on the WISC-R will correlate significantly with arithmetic achievement, and (3) integrated processing on the WISC-R will correlate significantly with arithmetic achievement. In addition, the following will also be shown: (4) WISC-R holistic means will correlate significantly more highly with arithmetic grades in school than will either analytic or integrated means, (5) WISC-R holistic means will correlate significantly more highly with California Achievement Test mathematics scores than will either analytic or integrated means, and (6) WISC-R holistic means will correlate significantly more highly with KeyMath than will either analytic or integrated means.

Limitations of the Study

The sample of 25 students had a disproportionately large number of female subjects. Seventeen girls, as opposed to 8 boys, remained in the longitudinal study, originally consisting of 40 students.

Of the 12 possible subtest scores on the WISC-R that could be grouped according to Kaufman's processing categories, only 10 of the scores could be used. This

was because the two optional WISC-R subtests, Digit Span and Mazes, were not administered to the subjects as part of earlier research in the longitudinal study.

Chapter II

Method

The Sample

There were 25 subjects in the sample, which included 8 boys and 17 girls. All the subjects attended St. Bethlehem Elementary School, in the Clarksville-Montgomery County School System, in St. Bethlehem, Tennessee. Twenty-four of the subjects were in the third grade and one was in the second grade. They ranged in age from 8 years 7 months to 9 years 4 months, with the mean age being approximately 9 years 1 month.

The students in the sample are participants in a longitudinal study begun in 1978 during the spring semester and the summer of their kindergarten year. Signed parental consent was obtained to use data on their school performance in a longitudinal study conducted by two faculty members and graduate students of the Psychology Department at Austin Peay State University, Clarksville, Tennessee. The original sample contained all the students from two kindergarten classes at St. Bethlehem Elementary School. The initial sample consisted of 40 students; however, due to students having transferred to other schools, only 25

were involved in this study. Parental permission had been obtained at the beginning of the developmental study with the understanding that the parents would be notified prior to additional contact with the students. A copy of the parent notification form for the present study is in the Appendix.

School Grades in Arithmetic

School grades in arithmetic were secured from the school's cumulative records for each subject in the sample. The grades were total arithmetic grades from the 1978-79, 1979-80, and 1980-81 school years. To convert the grades to numerical grades which could be correlated with the different types of processing styles, they were assigned the following values: A=4, B=3, C=2, D=1, and F=0.

Instruments Administered

During their first grade year in the spring of 1979, the students were administered the Wechsler Intelligence Scale for Children-Revised by a graduate student in the Psychology Department (Watts, 1979). In March of 1981 during their fourth year in school, the subjects were administered the California Achievement Test (CAT) by their classroom teachers as part of the regular school evaluation program. During May of the same year

the investigator administered the KeyMath Diagnostic Arithmetic Test to the 25 subjects remaining from the original sample.

Description of the Instruments

The WISC-R (Wechsler, 1974) is designed for individual administration to students 6 through 16 years old. The instrument is divided into two scales, the Verbal scale and the Performance scale. The Verbal scale is further divided into six subtests: Information, Similarities, Arithmetic, Vocabulary, Comprehension, and Digit Span (optional). The Performance scale is also divided into six subtests: Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding, and Mazes (optional). Scores from the test include a Full Scale IQ score, a Verbal IQ score, a Performance IQ score, and subtest scaled scores on each of the subtests. The optional subtests are not used in computing the IQ scores.

Part of the group-administered California Achievement Test is devoted to the assessment of mathematics achievement. Only the scores on the mathematics section of the CAT are used for this study. The two subtests involved are Computation, and Concepts and Applications. Both subtests are timed, and the scores from each are used to compute a Total Math

score for the student.

The KeyMath has been highly recommended for diagnosing mathematical skills in exceptional children (Greenstein and Strain, 1977; Goodstein, Kahn, and Cawley, 1976). Bannatyne (1973) states that "diagnostically it is very useful because deficit areas are delineated in considerable detail; this enables the teacher to write equally precise remedial prescriptions" (p. 131). Because distinct skill areas are sampled by the KeyMath, and because it yields a total score, it was chosen as the primary test for correlating with analytic, or left-brain, vs. holistic, or right-brain, processing on the WISC-R. In addition, the KeyMath has been shown to have a significant positive relationship with the arithmetic portion of the California Achievement Test (Tinney, 1975) administered to children with learning disabilities.

The KeyMath (Connolly, Natchman, and Pritchett, 1971) was designed for individual administration to students in kindergarten through grade six. Subtests are divided into three major areas as follows: (1) Content (numeration, fractions, geometry, and symbols), (2) Operations (addition, subtraction, multiplication, division, mental computation, and numerical reasoning), and (3) Applications (word problems, missing elements, money, measurement, and time). The Content area samples

basic mathematics knowledge and concepts prerequisite to operations and applications. The Operations area samples proficiency with the four primary operations in mathematics in addition to mental computation and numerical reasoning. The Applications area samples the utilizing of math concepts and operations to solve problems.

Numerations includes concepts essential to an understanding of the number system and its functional application. Fractions samples an understanding of parts and their symbolic representations. The subtest Fractions, even though its items could have been included in numerations, was given subtest status due to the frequency of students who generally have difficulty with skills in using fractions. Geometry and symbols involves recognition of geometric shapes and operational symbols. Addition, subtraction, multiplication, and division involve some regrouping and are the only subtests requiring the student to write. Mental computation involves memory and numerical facility and the manipulation of increasing numbers of simple operations. Numerical reasoning requires solving problems with a missing number fact, providing the student with an opportunity to demonstrate reasoning ability and understanding of computational processes. Word problems requires the

student to solve examiner-read problems in which there are both essential and unneeded details. Missing elements is comprised of problems which require logical thinking to decide what missing information is needed to solve each problem. The money, measurement, and time subtests require recognition of units and the solution of problems with the units characteristic of the special type of problems in money, measurement, and time.

The KeyMath is not timed, and, since it does not demand that the student read, there is less chance that a child with reading difficulties will be penalized in the math performance due to reading skills. Most of the items on the test are open-ended and not multiple choice as in many standardized measures of arithmetic achievement. The KeyMath was initially intended for diagnostic assessment; therefore, the scores are merely estimates of skills in the different areas.

Administration and Scoring

The WISC-R subtest scores were calculated in the recommended manner to evaluate analytic processing, holistic processing, and integrated processing as recommended by Kaufman (1979b). Analytic processing was represented by calculating the mean of the five following Verbal subtests on the WISC-R: Information, Similarities, Arithmetic, Vocabulary, and Comprehension.

Digit Span, an optional Verbal subtest, was not administered to the subjects earlier in the longitudinal study. Holistic processing was represented by calculating the mean of the Picture Completion and Object Assembly subtests of the WISC-R Performance scale. Integrated processing was represented by calculating the mean of the Picture Arrangement, Block Design, and Coding subtests of the WISC-R Performance scale. Mazes, an optional Performance subtest, was not included when the subjects were administered the WISC-R.

The mean for analytic processing was calculated from 5 subtest scores, the mean for holistic processing was calculated from 2 subtest scores, and the mean for integrated processing was calculated from 3 subtest scores on the WISC-R. As a result, the data representing analytic processing may be more stable samples, since holistic or integrated processing means are more likely to have been influenced by single, deviant subtest scores. The scaled score on each subtest was used for calculating the subtest means.

The California Achievement Tests were administered by the students' regular teachers in the classroom. The tests were scored by computer for the school system. The scaled scores were used as data from the math portions of the CAT.

The KeyMath was individually administered to each of the 25 subjects and hand-scored by the present author in accordance with the appropriate procedure (Connolly, Natchman, and Pritchett, 1971). Approximately 45 minutes was required for the administration of each test. Raw scores from the subtests, areas, and total test were used as KeyMath data.

Chapter III

Results

Scores from the first grade administration of the WISC-R to the 25 subjects yielded a Full Scale IQ score $\underline{M}$ = 104.96, $\underline{SD}$ = 13.72. Scores from the third grade administration of the KeyMath to the same students yielded a total raw score $\underline{M}$ = 122.72, $\underline{SD}$ = 19.44

Pearson product moment correlations[1] were computed between the processing styles on the WISC-R. There were significant positive correlations in each case, as shows in Table 1. Significance of differences between correlations were computed at the $\underline{p} < .05$ level using a z-test.

Table 1

Correlations Between WISC-R Subtests Reflecting Analytic, Holistic, and Integrated Processing

Process Type	1.	2.	3.
1. Analytic	---	.71*	.66*
2. Holistic		---	.56*
3. Integrated			---

Note. $\underline{N}$ = 25. *$\underline{p} < .05$

Analytic processing correlated more highly than did holistic or integrated processing with school marks in arithmetic for first and second grades. However, integrated processing correlated slightly higher with third grade arithmetic grades than did either analytic or holistic processing on the WISC-R as presented in Table 2.

Table 2

Correlations Between Analytic, Holistic, and Integrated Processing on the WISC-R, and Arithmetic Grades in School

Variable	Analytic	Holistic	Integrated
First Grade	.41	.35	.33
Second Grade	.63*	.44*	.52*
Third Grade	.40*	.43*	.45*

Note. $N = 25$.

*$p < .05$

Analytic processing correlated more highly with CAT Total Math scores and Concepts and Applications scores than did either holistic or integrated processing. All correlations with California Achievement Test scores were at the $p < .05$ level of significance, as presented

in Table 3. Integrated processing correlated more highly with CAT Computations than did either analytic or holistic processing.

Table 3

Correlations Between Analytic, Holistic, and Integrated Processing on the WISC-R, and CAT Math Scores

Variable	Analytic	Holistic	Integrated
Total Math	.65*	.52*	.58*
Computations	.55*	.49*	.60*
Concepts and Applications	.69	.50*	.50*

Note. $N = 25$.

*$p < .05$

Correlations were also computed between the three types of processing and KeyMath area scores. Holistic processing did not correlate higher with each of the three areas of the KeyMath than either analytic or integrated processing as shown in Table 4. Total KeyMath scores also did not correlate higher with holistic than with either analytic or integrated processing on the WISC-R.

Table 4

Correlations Between Analytic, Holistic, and Integrated Processing on the WISC-R, and KeyMath Area Scores

Variable	Analytic	Holistic	Integrated
Total Test	.70**	.52**	.58**
Content	.53*	.44*	.45*
Operations	.68**	.53**	.51**
Applications	.66*	.45*	.59*

Note. $N = 25$.

*$p < .05$

**$p < .01$

Arithmetic achievement was assessed with 10 types of scores: arithmetic grades from each of three years in school; CAT Total Math, CAT Computation, and CAT Concepts and Applications scores; and KeyMath total and area scores. Of the ten types of arithmetic achievement scores, analytic, holistic, and integrated processing on the WISC-R correlated significantly, $p < .05$, with nine types of scores. The exception was with first grade arithmetic scores with which none of the processes showed a significant correlation. As a result, Hypothesis 1, Hypothesis 2, and Hypothesis 3 were accepted.

Hypothesis 4 stated that WISC-R holistic means

correlated significantly more highly with arithmetic grades in school than do either analytic or integrated means. First grade arithmetic scores did not correlate significantly with either of the three processing styles. Second grade arithmetic scores correlated significantly, $p < .05$, with all three processing types. Analytic processing correlated most highly with second grade arithmetic grades, followed by integrated and then holistic processing. Third grade arithmetic scores correlated significantly, $p < .05$, with all three processing types. Integrated processing correlated most highly with third grade arithmetic grades, followed by holistic and then analytic processing. Though the correlations were significant, the differences between the correlations were not. Hypothesis 4 was rejected.

Hypothesis 5 stated that WISC-R holistic means correlate significantly more highly with CAT mathematics scores than do either analytic or integrated means. Though all the correlations between processing styles and CAT scores were positive and significant, $p < .05$, analytic processing correlated most highly with CAT Total Math and CAT Concepts and Applications scores, and integrated processing correlated most highly with

CAT Computations scores. Hypothesis 5 was rejected.

Hypothesis 6 stated that WISC-R holistic means correlate significantly more highly with KeyMath scores than do either analytic or integrated means. The different types of processing correlated significantly at the $p < .01$ level with KeyMath total scores and with KeyMath Operations scores, and at the $p < .05$ level with KeyMath Content and KeyMath Applications scores. With each type of KeyMath total and area scores analytic processing correlated most highly. As a result of analytic processing correlating more highly with KeyMath scores than either holistic or integrated processing, Hypothesis 6 was rejected.

KeyMath total scores correlated more highly with arithmetic grades in first grade than did CAT Total Math scores. However, CAT Total Math scores correlated more highly with arithmetic marks in second and third grades. These correlations are presented in Table 5. Correlations between the two total test scores and arithmetic grades were at the $p < .001$ level of significance.

Table 5

Correlations of Total KeyMath and CAT Scores With School Grades in Arithmetic

Variable	KeyMath	CAT
First Grade	.70*	.67*
Second Grade	.71*	.83*
Third Grade	.67*	.74*

Note. $N = 25$.

*$p < .001$

Chapter IV

Discussion

Analytic, holistic, and integrated processing means on the WISC-R correlated significantly with each other. This could have several implications. One possible implication is that there is more overlapping of processing types than has been suggested. Another possible implication is that the WISC-R may not clearly differentiate between left- and right-brain functioning. Wechsler (1958) had not intended for his scales to differentiate processing styles. His dichotomy between Verbal and Performance scales was based on the fact that some people perform verbally better than manually, and vice versa. All subtests on the WISC-R have verbal instructions, and these may be inappropriate for right hemisphere processing assessment. The right hemisphere's processing style may only be able to be tapped by clearly and totally nonverbal means (Golden, Note 2).

Analytic, holistic, and integrated processing on the WISC-R did yield significant correlations with arithmetic achievement. The correlations with analytic processing, though appearing to be greater than correlations with holistic and integrated processing,

were not significantly greater. It was not the intention of this study to find a cause-and-effect relationship, but rather to use scores from widely used psycho-educational tests superimposed on more current research and speculation of hemispheric functioning. It is possible that the left hemisphere has a more active role in elementary mathematics than the right hemisphere. Another possibility is that the WISC-R is inadequate in differentiating left from right processing. The author was unable to locate a research basis for either Kaufman's (1979) categorizing subtests according to hemispheric function, or specific research forming the basis for Hartlage's (1981) claim that computational processes can be differentially categorized into left and right processing on the basis of math skills required. In addition, many researchers (Bogen, 1969; Hartlage, 1981) may have been assuming dominance of one hemisphere over the other for cognitive functions when there may be a very complex integration between the two hemispheres for those particular cognitive functions.

The group administered CAT math sections' scores were found to correlate as highly with arithmetic grades in scool as scores on the individually administered KeyMath, with this group of children. It must be remembered that the age range of students, though, was

very limited, due to their selection being based on their participation in the longitudinal study. In addition, there were twice as many girls as boys in the sample; therefore, the sample was not truly representative of a normal student population.

The KeyMath Addition subtest scores yielded very low correlations with the different categories of cerebral functioning. The subtraction, multiplication, and division subtest scores, on the other hand, did correlate at least moderately with different processing categories. The reason for this may be that addition for this age group of children has been more or less mastered. This would appear reasonable since addition is the fundamental process in mathematics on which almost all of the subsequent operations and applications must build. Another possible explanation could be that the addition problems on the KeyMath do not adequately discriminate among students' skills in addition. This argument could be sustained by the fact that one raw score point on the addition subtest was equivalent to one standard deviation of the Addition subtest scores for this sample.

Despite some inadequacies in the methodology of this study, it appears to agree with the findings of early split-brain researchers. These researchers, such

as Bogen (1969), held that the left hemisphere was more suited for numerical manipulations and computations than the right hemisphere.

The need for precise instruments for assessing analytic and holistic processing is only surpassed by the need for more scientific instruments. The fact that left- and right-brain processing on the WISC-R correlated so highly indicates that Kaufman's groupings may not even accurately differentiate left from right processing. Due to the paucity of research data at this time, it may merely be appropriate to advise educators to continue to recognize and attempt to develop those different cognitive styles which have been associated with analytic, holistic, and integrated processing.

Recommendations for Future Research

There is a need for a research basis for differentiating processing styles on the WISC-R, if the WISC-R is to be used as the only instrument in a battery of tests for assessing right- vs. left-brain functioning. In this study the WISC-R was shown to be a very valid predictor of arithmetic achievement. Not only did IQ scores on the WISC-R correlate significantly with arithmetic achievement, but also the various

subtest groupings correlated significantly with arithmetic achievement.

Other longitudinal studies could see how well the WISC-R predicts performance in other subject areas across different numbers of years. It would also be interesting to see how the different processing means differed if the same subjects in this study were again administered the WISC-R.

REFERENCE NOTES

1. Stokes, E. H. Personal communication, March 1981.

2. Golden, A. J. Personal communication, July 1981.

REFERENCES

Bannatyne, A. "Review of the KeyMath Diagnostic Arithmetic Test." Journal of Learning Disabilities, 1973, 6, 131-132.

Bogen, J. E. "The other side of the brain: parts I, II, and III." Bulletin of the Los Angeles Neurological Society, 1969, 34, 73-105; 135-162; 191-203.

Connolly, A. J., Nachtman, W., and Pritchett, E. M. Manual for the KeyMath Diagnostic Arithmetic Test. Circle Pines, Minnesota: American Guidance Service, 1971.

Gazzaniga, M. S. "Review of the split brain." UCLA Educator, 1975, 17, 9-12.

Goodstein, H. A., Kahn, H., and Cawley, J. F. "The achievement of educable mentally retarded children on the KeyMath Diagnostic Arithmetic Test." The Journal of Special Education, 1976, 10, 61-70.

Greenstein, J., and Strain, P. S. "The utility of the KeyMath Diagnostic Arithmetic Test for adolescent learning disabled students." Psychology in the Schools, 1977, 14, 275-282.

Hartlage, L. C. "Neuropsychological Assessment Techniques." Chapter from Handbook of School Psychology (C. Reynolds and J. Gutkin, Editors). New York: Wiley, 1981.

Kaufman, A. S. "Cerebral specialization and intelligence testing." Journal of Research and Development in Education, 1979(a), 12, 96-107.

Kaufman, A. S. Intelligent Testing with the WISC-R. New York: Wiley, 1979(b).

Pirozzolo, F. J. "Cerebral asymmetries and reading acquisition." Academic Therapy, 1978, 13, 261-266.

Reitan, R. M. "Certain differential effects of left and right cerebral lesions in human adults." Journal of Comparative and Physiological Psychology, 1955, 48, 474-477.

Sperry, R. W. "Hemisphere deconnection and unity in conscious awareness." American Psychologist, 1968, 23, 723-733.

Tinney, F. A. "A comparison of the KeyMath Diagnostic Arithmetic Test and the California Arithmetic Test used with learning disabled students." Journal of Learning Disabilities, 1975, 8, 313-315.

Watts, P. A. Relationships of the McCarthy Scales of Children's Abilities and the Wechsler Intelligence Scale for Children-Revised. Unpublished masters thesis, Austin Peay State University, 1979.

Wechsler, D. The Measurement and Appraisal of Adult Intelligence. Baltimore: Williams and Wilkins, 1958.

Wechsler, D. Wechsler Intelligence Scale for Children-Revised. New York: The Psychological Corporation, 1974.

Wheatley, G. H. "The right hemisphere's role in problem solving." Arithmetic Teacher, 1977, 25, 36-39.

FOOTNOTES

[1]Pearson product moment correlation coefficients were obtained using a pre-programmed computer package called PSYSTAT-An Interactive Statistics Package for the VAX-11. PSYSTAT was prepared by Garland E. Blair, Psychology Department, Austin Peay State University, Clarksville, TN.

Appendix A

AUSTIN PEAY STATE UNIVERSITY

Clarksville, Tennessee 370

DEPARTMENT of Psychology

615 648-72

April 16, 1981

TO: Parents of Third Grade Children in McCarthy-WISC-R Study at St. Bethlehem Elementary School

FROM: Elizabeth H. Stokes, APSU Elizabeth H. Stokes

Evelyn Bell

We appreciate your cooperation in allowing your child to take part in the study of the McCarthy Scales of Children's Abilities during his/her kindergarten year, and of its correlation with the Wechsler Intelligence Scale for Children - Revised during the first grade year. As you remember, we asked for permission for your child tc be in the study so we could follow him through the next few years of school.

The time has come for the next stage of the study, which will consist of two phases. One phase will not require the children's direct participation. A graduate student will re-score parts of the kindergarten McCarthy Scales according to three short forms of the test. These short forms will be compared with the children's grades and California Achievement Test scores to see which is the best predictor of achievement. This information could be very helpful in future screenings of kindergarten children to find areas of need for special help.

In another phase, a graduate student will administer the Bender-Gestalt, a brief check of eye-hand coordination; and a simple drawing test, tc compare with earlier scores on the same measures, and with achievement in reading. These exercises are enjoyable, and together take about 10-15 minutes for most children.

As before, the children's results will be looked at as part of a group study. No individual will be identified. Such a study is valuable in finding out which of these are most useful. We thank you again for your help and for your child's help.

Please call me at 648-7233 or Mrs. Bell at 645-4449 if you have any questions or objections. Otherwise, we will assume that you are willing for us to continue working with your child's test results, and to obtain grades and CAT scores from the cumulative record for use as group data in the study.