Apparently the only empirical evidence of this overlap is the correlation of .77 on twelfth grade pupils' scores between the Watson-Glaser Test of Critical Thinking, and the Martin Reading Comprehension Test, which Glaser (1941) described as a test of critical reading.

The objectives of this study were to determine empirically the phenotypic interrelationships and factor structure of critical reading tests and subtests from which genotypic inferences could be made about the definitions of critical reading, critical thinking, and also the relationship between critical reading and critical thinking.

This study reports the primary statistical analysis of a fifth grade critical reading data collection, half of a research program examining empirically the definition of critical reading. The other half is a twelfth grade data collection.

PROCEDURE

The subjects (Ss) were 50 typical fifth grade pupils at Ballast Point Elementary School, Tampa, Florida. Most pupils were white and of lower or middle socio-economic class.

Two cooperatively developed critical reading tests, the Intermediate Reading Test - Science (CR SCI) (Maney, 1958), and the Intermediate Reading Test - Social Studies (CR SS) (Sochor, 1958), and one critical thinking test, the Cornell Critical Thinking Test Form X (CT) (Ennis and Millman, 1961) were administered in December, 1969. The Ss had already taken the California Test of Mental Maturity Level 2 Short Form

(CTMM) (California Test Bureau, 1964) and the Metropolitan Achievement Tests Intermediate Level Form Am (METRO) (Durost, et al., 1959).

The following tests and subtests were used:

Intermediate Reading Test - Science (CR SCI) total test

Literal Reading (LR) subtest

Critical Reading (CR) subtest

Intermediate Reading Test - Social Studies (CR SS) total test

Literal Reading (LR) subtest

Critical Reading (CR) subtest

Cornell Critical Thinking Test Form X (CT) total test

Induction (IND) subtest

Reliability (REL) subtest

Deduction (DED) subtest

Finding Assumptions (FIND ASSUMP) subtest

California Test of Mental Maturity (CTMM)

Language (LANG) subtest

Non-Language (NON-LANG) subtest

Metropolitan Achievement Tests (METRO)

Word Knowledge (WORD) subtest

Reading (READING) subtest

Spelling (SPELLING) subtest

Language Study Skills (LANG SKILLS) subtest

Arithmetic Computation (ARITH COMP) subtest

Arithmetic Problem Solving (ARITH PROB SOLV) subtest

Social Studies Study Skills (SS SKILLS) subtest

CR SCI CR and CR SS CR purportedly measure commonly 12 specific critical reading skills. In addition CR SCI CR purportedly measures two additional and CR SS CR one additional critical reading skill.

The CTMM and METRO scores were stanines.

Pearson product moment correlations were calculated to determine the subtest score matrix, and the total test score matrix, independently. Principal components factor analysis and Kaiser Varimax rotation of all factors with eigenvalues in excess of one were conducted for the subtest score matrix, and the total test score matrix, independently.

RESULTS

Table 1 indicates the intercorrelations for the 17 subtests. Ns ranged from 34 to 49 for the different correlations as not all students took all subtests. Ns, means, and standard deviations are not presented herein but are available upon request.

Correlations of .34 and .44 are significant at the .05 and .01 levels respectively for a sample of 34, the smallest sample. The critical correlation between CR SCI CR and CR SS CR is .63.

CR SCI CR, CR SS LR, CR SS CR, CT DED, CTMM LANG, CTMM NON-LANG, METRO WORD, METRO READING, and METRO SS SKILLS generally intercorrelated around .50 and apparently represent considerable common variance. Another, probably separate, cluster of slightly higher correlations is composed of METRO ARITH COMP, METRO ARITH PROB SOLV, and METRO SPELLING.

Table 1

Subtests' Intercorrelations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	CR SCI LIT																	
2	CR SCI CR	.22																
3	CR SS LIT	.45	.55															
4	CR SS CR	.32	.63	.74														
5	CT IND	.08	.31	.42	.32													
6	CR REL	.06	.35	.46	.47	.48												
7	CT DED	.28	.65	.56	.48	.31	.34											
8	CT FIND ASSUMP	.06	.40	.12	.29	.31	.33	.24										
9	CTMM LANG	.41	.44	.64	.46	.43	.11	.44	.15									
10	CTMM NON-LANG	.38	.47	.61	.54	.40	.29	.40	.14	.67								
11	METRO WORD	.30	.44	.52	.59	.38	.33	.42	.28	.52	.46							
12	METRO READING	.25	.56	.67	.67	.42	.52	.48	.29	.60	.58	.61						
13	METRO SPELLING	.14	.44	.27	.21	.33	.32	.44	.33	.45	.35	.40	.42					
14	METRO LANG SKILLS	.02	.48	.41	.38	.25	.23	.52	.14	.40	.47	.44	.39	.32				
15	METRO ARITH COMP	.19	.29	.29	.31	.25	.32	.43	.23	.29	.36	.36	.28	.48	.56			
16	METRO ARITH PROB SOLV	.14	.35	.30	.33	.35	.25	.47	.37	.33	.39	.44	.42	.62	.45	.70		
17	METRO SS SKILLS	.23	.65	.50	.57	.53	.47	.62	.25	.46	.50	.53	.65	.63	.49	.54	.59	

It should be noted that these three subtests also correlate .54 or higher with METRO SS SKILLS but generally not nearly as high as with the other subtests with which METRO SS SKILLS clusters. It should also be noted that CR SCI LIT correlated .45 with CR SS LIT but lower with all other variables. This is probably a function of its low reliability (OE = .29, KR = .24).

Table 2 indicates the subtests' means, standard deviations, unrotated and rotated factor loadings, % s of variance accounted for by each factor, and eigenvalues.

N was 32 for the factor analysis and rotation. The analysis indicated a general factor accounting for 46% of the variance with moderate to strong loadings from all variables except CR SCI LIT which loaded .38, and CT FIND ASSUMP which loaded .36. These two variables, and CR SS LIT, METRO SPELLING, METRO ARITH COMP, and METRO ARITH PROB SOLV all loaded in excess of .40 on Factor II. Factor III had loadings of .57 from CT REL, .48 from CT FIND ASSUMP, and four other loadings ca. .35 each. Factor IV had loadings of -.60 from CT IND, .43 from METRO LANG SKILLS, .41 from CR SCI CR, and -.35 from CR SCI LIT.

Rotation broke down the general factor into four group factors. The major group factor, accounting for 38% of the variance, consisted essentially of CR SCI CR, CR SS LIT, CR SS CR, CT DED, CTMM NON-LANG, METRO WORD, METRO READING, and METRO LANG SKILLS. This factor is considered to be a complex of language, reading and thinking activities particularly vocabulary, reading, interpretation, inference. It is

Table 2

Subtests' Means, Standard Deviations, Unrotated and Rotated Factor Loadings

			Unrotated				Rotated			
	$\bar{X}$	SD	I	II	III	IV	I	II	III	IV
CR SCI LIT	9.69	2.52	.38	-.55	-.38	-.35	.23	.10	.01	-.81
CR SCI CR	12.78	5.59	.74	-.05	.02	.41	.77	.36	.01	.07
CR SS LIT	19.22	5.40	.74	-.50	.14	.04	.78	.03	.25	-.38
CR SS CR	11.69	4.46	.74	-.36	.26	.20	.84	.05	.26	-.14
CT IND	12.22	3.68	.53	.16	.34	-.60	.07	.27	.82	-.18
CT REL	9.50	3.03	.56	.16	.57	-.20	.35	.13	.73	.15
CT DED	6.41	2.92	.75	-.05	-.15	.21	.63	.46	.03	-.13
CT FIND ASSUMP	3.78	1.31	.36	.50	.48	.12	.22	.26	.46	.55
CTMM LANG	5.47	2.05	.67	-.31	-.14	-.18	.48	.28	.21	-.50
CTMM NON-LANG	5.41	1.79	.72	-.28	-.03	-.15	.54	.27	.29	-.42
METRO WORD	4.38	1.74	.80	.00	.00	.08	.61	.45	.23	-.11
METRO READING	4.34	1.77	.87	-.19	.23	.12	.81	.25	.36	-.12
METRO SPELLING	5.16	1.87	.75	.41	-.27	-.15	.23	.84	.26	-.10
METRO LANG	4.63	2.17	.63	.17	-.17	.43	.57	.53	-.13	.15
METRO ARITH COMP	4.31	1.80	.63	.44	-.31	-.12	.14	.81	.17	-.05
METRO ARITH PROB SOLV	4.44	1.66	.66	.48	-.34	-.06	.17	.86	.13	-.01
METRO SS SKILLS	3.78	1.66	.80	.16	-.08	-.14	.41	.61	.35	-.17
% of σ^2 accounted for			46.25	10.85	7.71	6.53	38.44[1]	30.07[1]	17.32[1]	14.17[1]
Eigenvalues			7.86	1.85	1.31	1.11				

[1]% of σ^2 of these four factors accounted for by these four factors, not % of total σ^2.

difficult to generalize more molecularly without an analysis of items within each subtest, and within each total test. The second group factor was composed primarily of METRO SPELLING, METRO ARITH COMP, METRO ARITH PROB SOLV, METRO SS SKILLS. This factor was essentially a study skills and numerical, arithmetic computation factor. Factor III was a doublet, composed of CT IND and CT REL. It is seen as essentially concerned with relevance of evidence, and whether or not evidence supports or contradicts a particular conclusion, an activity apparently disparate from all others measured herein. Factor IV has a loading of -.81 from CR SCI LIT and other smaller loadings with different signs. Since CR SCI LIT had such low reliability estimates, and generally low correlations with the other variables, it is considered that this factor represents primarily error variance.

Table 3 indicates the total test score intercorrelations for CR SCI, CR SS, CT, CTMM, and METRO LANG.

Table 3

Total Test Score Intercorrelations

	CR SCI	CR SS	CT	CTMM	METRO LANG
CR SCI					
CR SS	.70				
CT	.55	.60			
CTMM	.57	.66	.49		
METRO LANG	.41	.41	.49	.40	

All correlations significant at .01 level.

Ns for these correlations were 46, 44, 41, 42, 43, 43, 44, 38, 44 respectively since not all students took all tests. Means and standard deviations are available upon request.

The most important correlation is .70 between CR SCI and CR SS, the two critical reading tests. This correlation indicates that 49% of the things measured by the two tests is the same. The other important finding is that CT correlated .55 and .60 with CR SCI and CR SS respectively. For these two correlations the common variance is 30% and 36% respectively. CTMM correlated slightly lower with all variables. METRO LANG correlated considerably lower, .40 to .49, with all variables. These lower METRO LANG correlations apparently reflect the fact that it measures usage, punctuation and capitalization, parts of speech - grammar, and kinds of sentences; activities substantially different from those measured by the other tests.

Table 4 indicates the total test score unrotated and rotated factor loadings, %s of variance accounted for by each factor, and eigenvalues.

Table 4
Total Test Score Unrotated and Rotated Factor Loadings

	UNROTATED					ROTATED	
	I	II	III	IV	V	I	II
CR SCI	.80	.24	-.46	-.14	-.26	.79	-.28
CR SS	.84	.28	.00	-.16	.43	.85	-.27
CT	.78	-.33	.38	-.34	-.17	.44	-.72
CTMM	.78	.34	.28	.43	-.12	.83	-.19
METRO LANG	.67	-.65	-.22	.27	.11	.16	-.92
% of σ^2 accounted for	60.31	15.57	9.62	8.31	6.20	59.07[1]	40.93[1]
Eigenvalues	3.02	.78	.48	.42	.31		

[1]% of σ^2 of these two factors accounted for by these two factors only, not % of total σ^2.

Means and standard deviations were respectively 22.22 and 6.29 for CR SCI, 31 and 8.72 for CR SS, 31.19 and 7.74 for CT, 5.49 and 1.98 for CTMM, and 4.43 and 1.80 for METRO LANG. N was 37.

Factor analysis indicated a general factor accounting for 60% of the variance with strong loadings from all five variables. One other specific factor had a loading from METRO LANG about as strong as its loading on the general factor.

Rotation sharpened the factor structure. The general factor became a group factor, accounting for 59% of the variance, consisting of CR SCI, CR SS and CTMM. It is difficult to interpret this factor precisely because of the large number of skills purportedly tested, 15 alone in CR SCI and CR SS not to mention CTMM. CTMM apparently measures logical reasoning, numerical reasoning, verbal concepts, and memory. This factor is again seen as composed of language and thinking activities in varying degrees, particularly vocabulary, reading, interpretation, inference, etc., similar to the subtests' largest group factor.

CT was separated from the general factor by rotation, and loaded with METRO LANG. This factor probably reflects primarily the different activities of CT IND and CT REL particularly judgments about the reliability of evidence and whether or not evidence supports a conclusion, as well as the skill and non-language components of METRO LANG. A question is the validity of CT, a test which has had relatively little validation.

CONCLUSIONS

1. Critical reading apparently consists of a number of reading, thinking and language activities particularly vocabulary as well as a considerable number of critical reading skills. It is separate from

study skill activities and also from reliability of evidence, and judgment whether or not evidence supports a conclusion.

2. Critical reading seems to involve at least some activities different from those associated with the critical thinking test. Critical reading also has considerable variance in common with critical thinking particularly CT DED.

3. Additional analyses of the two critical reading tests and subtests are in order, first and second order partial correlation, canonical correlation, and particularly inter-item correlation, factor analysis and rotation to determine the factor integrity of the critical thinking skills jointly posited by Maney (1958) and Sochor (1958).

4. An admonition, the validity of any correlational and factor analytic study depends upon the reliability and validity of the tests and subtests used.

Further, while these results should be interpreted as tentative because of the sample size, it is noted that the results are consistent with those of similar studies.

REFERENCES

California Test Bureau. California Test of Mental Maturity. McGraw-Hill Book Company, Monterey, California, 1964.

Denberg, R., and Jones, C. Critical reading in a developmental reading course. Journal of Reading, 1967, 10, 399-403.

Durost, W. N., Bixler, H. H., Hildreth, G. H., Lund, K. W., and Wrightstone, J. W. Metropolitan Achievement Tests. Harcourt, Brace and World, Inc., New York, New York, 1959.

Ennis, R. H. A concept of critical thinking. Harvard Educational Review, 1962, 32, 81-111.

Ennis, R. H., and Millman, J. Cornell Critical Thinking Test, Form X. Cornell University, 1961.

Follman, J. C. A factor analytic study of three critical thinking tests, one English test, and one logical reasoning test. Ph.D. Dissertation, Indiana University, 1969.

Gainsburg, J. C. Critical reading is creative reading and needs creative teaching. The Reading Teacher, 1961, 6, 185-192.

Glaser, E. M. An experiment in the development of critical thinking. Teachers College Contributions to Education, No. 943, 1941, New York Bureau of Publications, Teachers College, Columbia University.

Maney, E. S. Literal and critical reading in science. Journal of Experimental Education, 1958, 27, 57-64.

Penfold, D. M. and Abou-Hatab, F. A. H. The factorial dimensions of verbal critical thinking. The Journal of Experimental Education, 1967, 36, 1-12.

Rust, V. I. Factor analyses of three tests of critical thinking. Journal of Experimental Education, 1960, 29, 177-182.

Sochor, E. E. Literal and critical reading in social studies. Journal of Experimental Education, 1958, 27, 49-56.

Trela, T. M. Comparing achievement on tests of general and critical reading. Journal of the Reading Specialist, 1967, 6, 140-142.

Wolf, W., Huck, C. S., King, M. L., Ellinger, B. D., and Gansneder, B. M. Critical reading ability of elementary school children. Final Report, Project No. 5-1040, Contract No. OE-4-10-187, U. S. Department of Health, Education and Welfare, Ohio State University, June, 1967.