Educational and Psychological Measurement
Vol. XXV, No. 2, 1965

VALIDITY OF THE DURRELL-SULLIVAN READING CAPACITY TEST[1]

HARRY SINGER
University of California, Riverside

The *Durrell-Sullivan Reading Capacity Test* (*DSRC*), designed to measure reading capacity in grades 3 to 6, is based on the principle that the potential reading achievement of an individual should be equal to his auditory comprehension.[2] The principle is dependent upon a basic assumption of uniformity in brain functioning in response to language relationships, whether input is through the visual or through the auditory system. This basic principle and its neurological assumption were explicitly formulated by Sullivan (1938, p. 40) in the first description of the test:

> The principle underlying the use of measures of auditory comprehension as criteria for potential reading achievement is that if the mind is able to handle auditory symbols up to a certain degree of complexity, it should be able to handle visual symbols up to that same degree of difficulty. This principle, of course, assumes a uniformity of brain structure in regard to the handling of symbolic relationships that are involved in language.

Although *DSRC* has now been in use for some 25 years, there is

[1] This investigation was part of a larger study supported by the U. S. Office of Education, Department of Health, Education and Welfare, Contract No. 2011.

[2] *DSRC* has two subtests. (1) For *Word Meaning*, the tester pronounces a word which corresponds to one of a group of eight pictures. (2) On *Paragraph Meaning*, the tester reads a short story, then asks five questions about the story. The pupil answers each question by selecting an appropriate picture from a set of three pictures. The reliabilities for these subtests are high: for grades 3 to 6 they range from .90 to .96 for *Word Meaning* and from .83 to .93 for *Paragraph Meaning* (Sullivan, 1938).

still very little evidence to support its validity as a measure of reading potential.

Related Research. Whatever *DSRC* measures does improve with grade level because there is an average increment of 16 points of raw scores between each year level (Alden, Sullivan, and Durrell, 1941). A correlation between *DSRC* and *Stanford-Binet Intelligence Test* (*SB*) scores for 80 children in grades 4 through 7 enrolled in a public school remedial reading program was .76, but *DSRC* in comparison with *SB* overestimated reading potential (Bliesmer, 1956). In a multiple regression equation, *DSRC* had about equal weight with the *California Test of Mental Maturity* in predicting scores on *California Reading Test* (Owen, 1958). However, for a sample of 87 fourth graders the correlation between *DSRC* and *Gates Basic Reading Tests Types A* and *D,* ranged from only .41 to .54; the highest correlation between *DSRC* and *Primary Mental Abilities* (*PMA*) was .64 between *DSRC* Word Meaning and *PMA* Pictures (Bond and Clymer, 1955). Toussaint (1961) found that the *STEP* Listening Test had a closer relationship with *Gates Reading Survey* than did *DSRC,* but the *STEP* test has some reading in it and therefore its correlation with the *Gates Reading Survey* may be spuriously high. The *DSRC,* although of some use in the clinic, is highly limited in estimating potential reading capacity of children with foreign language backgrounds or other language handicaps (Robinson, 1953).

Problem. The general purpose of this study is to test by means of a factor-analysis model the basic assumption underlying *DSRC* that there is uniformity of brain functioning in response to language relationships. Therefore, the following specific questions were formulated. (a) What is the factor analytic structure of *DSRC* when it is embedded in a matrix of variables selected for their known ability to predict speed and power of reading (Singer, 1960, 1962)? (b) Is the factor-loading pattern of *DSRC* similar to that of speed and power of reading? (c) How similar are the factor loading patterns of *DSRC* and such subskills as word meaning, word recognition, and visual and auditory perceptual abilities?

Further clarification of these questions is necessary. If there is a "uniformity of brain structure" in handling the symbolic relationships involved in responding appropriately to visual symbols of reading tests and to auditory symbols of *DSRC,* then the factor analytic structure of the visual and auditory tests would be similar. That is, the same factors or mental functions would contribute to the variability of the tests, if not equally then at least proportionately. If so, *DSRC* would gain support as a valid measure of potential reading achievement.

However, reading ability is not unidimensional, but divides into two major interrelated components, speed and power of reading. Underlying and supporting each component is a complexly interrelated structure of subskills and capacities (Holmes, 1948). Broadly categorized, this general structure consists of interrelated input, mediating, output, and both short-term and long-term memory systems; all of these systems are overlaid with emotional systems and undergirded by physiological systems (Holmes and Singer, 1964; Davis, 1964). Within the limitations of developmental changes and test battery comparability, this general structure for attaining speed and power of reading has been verified at the college (Holmes, 1954a), high school (Holmes and Singer, 1961), and intermediate grade level (Singer, 1962).

These subskills and capacities are predictors at some level in the general structure for speed and power of reading. For example, the following are some of the predictors which occur in the structural model for power of reading in the fourth grade (Singer, 1960, 1962). At the lowest level, spelling recognition together with prefixes and spelling recall enter into the constellation of subabilities that make up Word Recognition in Context. At the middle level, word recognition in context, plus suffixes, and mental age contribute to the variance in Vocabulary in Isolation. Finally, on the highest level, vocabulary in isolation becomes integrated with suffixes, mental age, and matching sounds in words to culminate in Power of Reading.

The question then is whether *DSRC* is also a "capacity" test for one or more of these predictors, particularly the word recognition predictors. This question is quite important because at least from an instructional viewpoint the nature of the reading task changes during the developmental continuum. In the initial stages of reading instruction, development of perceptual and word recognition subskills is emphasized. At this stage, individuals have already matured sufficiently in their reasoning or mediational processing systems so that they could adequately comprehend the relatively simple ideas presented in beginning instructional material, provided that their input or word recognition subsystem were adequately developed for transforming printed stimuli into mental processes. But, during this initial stage there are individual differences in the input system which may be attributable to variation in ability to conceptualize linguistic stimuli (Singer, 1960), effectiveness of instructional strategies, modality sensitivity and receptivity, or to an interaction of these sources of variance (Bond, 1935; Fendrick, 1935). However, as individuals progress through the grades, they gradually tend to master word recognition processes (Singer, 1964); instructional emphasis then shifts to further development of ability to reason about the increasingly complex ideas presented in the instructional material. Hence, during the developmental continuum of learning to read, there is a shift in instructional emphasis from an estimate of input to an estimate of mediational processing potential.

Method

Sample. A battery of 30 tests was administered to 283 fourth graders in a school located in an average socio-economic district in Alvord, California. From comparison of the means of the sample data with standardized test norms on age, I.Q., Speed and Power of Reading, as shown in Table 1, the sample appears to be somewhat representative of the general population of fourth graders because it is close to the norms on I.Q.; *Gates Reading Survey,* Speed of Reading; and *Gates Reading Survey,* Level of Comprehension or Power of Reading.

The grade equivalents for the current sample, according to the norms in the Durrell-Sullivan Manual, is 5.8 on Paragraph Meaning *Achievement* and 5.4 on Paragraph Meaning *Capacity.* Not only is the sample higher on achievement than on capacity, but the sample is also advanced approximately one grade level on both tests! However, on the *Gates Reading Survey* results, the current sample is approximately at grade level. A similar comparison between *DSRC* and *Gates Reading Survey* yielded comparable results in a previous investigation (Singer, 1960). These findings suggest that the Durrell-Sullivan norms probably overestimate grade equivalencies.

The cumulative records of the subjects revealed that they had been taught by a wide variety of teachers, had used a heterogeneous set of basal and supplementary readers, and had been regis-

TABLE 1

Comparison of Certain Sample Means with Fourth Grade Norms

Variable	Sample Mean $N = 283$	National Norm
Chronological Age	9–11	9–11
PMA Intelligence Quotient	102.0	100.0
Gates Speed of Reading	19.8	18.7
Gates Level of Comprehension	15.6	18.0

tered in many school systems throughout the country. Therefore, the results of this study cannot be related to any particular set of materials nor to any particular methodological emphasis.

Tests. A test battery, listed in Table 2, was constructed of variables which would presumably measure comparable input and mediational processes in the visual and auditory systems for reading and listening, respectively. The tests were selected from the batteries of Durrell and Sullivan (1937); Gates (1953); Holmes (1962); Kwalwasser-Dykema-Holmes Test, Holmes (1954b); Singer (1963); Thurstone and Thurstone (1954); and Van Wagenen and Dvorak (1953).

Reliability coefficients, also presented in Table 2, reveal that all the tests had substantially high reliabilities. Bivariate distributions of each variable with Speed of Reading and Level of Comprehension, respectively, satisfactorily passed the chi-square test for rectilinear regression.[3]

Concurrent validity coefficients between each of the tests and the subtests of *DSRC* are also given in Table 2. The highest correlation is .64 between *DSRC* Word Meaning and *PMA* Pictures, exactly the same degree of relationship between these variables as that reported by Bond and Clymer (1955). The next highest correlation is .56 between the subtests of *DSRC,* which means that listening vocabulary and listening comprehension in this sample have only 31 percent variance in common. The correlation of .48 between *Durrell-Sullivan* Paragraph Meaning Capacity and Paragraph Meaning Achievement is surprisingly low, since Sullivan (1938) stated that these tests were constructed with parallel content and

[3] Computations were performed on the IBM 7090 Computer at the University of California, Berkeley, by means of RSCAT program written by M. Maruyama. Mr. Price Stiffler, programmer consultant, is acknowledged for his extremely competent assistance in processing all the data for this study on the computer.

TABLE 2

Statistical Data on 30 Variables for 283 Fourth Graders

Test Battery	r_{11}	Correl. with Capacity for: Words	Par.	Principal Components Rotated Factor Loadings Factors* 1 VVM	2 AUD	3 VR	4 SVP	5 AP
1 Durrell-Sullivan Reading Capacity								
Word Meaning	85**	—	56	18**	75	18	20	16
Paragraph Meaning	87	56	—	16	62	40	10	25
2 Gates Reading Survey								
Speed of Reading	88	40	33	62	39	−19	35	15
Level of Comprehension	89	45	45	75	40	12	−02	13
3 Durrell-Sullivan Reading Achievement								
Paragraph Meaning	91	52	48	66	44	11	16	24
4 Thurstone Primary Mental Abilities								
Words	91	43	38	76	39	00	00	15
Pictures	70	64	49	28	78	10	07	11
Space	83	25	42	14	19	74	−01	12
Word Grouping	79	39	42	68	29	30	02	08
Figure Grouping	84	37	42	20	21	73	09	06
Perception	94	28	34	27	04	57	40	07
5 Van Wagenen-Dvorak Silent Reading								
Range of Information	73	49	53	40	67	13	04	04
6 Singer Linguistic Tests								
Auding Conceptual Ability	76	45	49	51	34	29	10	25
Meaning of Affixes	77	46	46	71	43	12	04	22
Word Recog. in Context	93	28	34	80	11	18	−02	15
Matching Sounds in Words	96	35	32	86	18	17	−01	03
Blending Word Elements	85	32	32	80	11	23	05	12

TABLE 2—Continued

Statistical Data on 30 Variables for 283 Fourth Graders

Test Battery	r_{II}	Correl. with Capacity for: Words	Par.	Principal Components Rotated Factor Loadings Factors* 1 VVM	2 AUD	3 VR	4 SVP	5 AP
Phonics	92	38	35	75	24	16	02	16
Syllabication Consistency	83	28	27	71	11	15	13	11
Auditory Verbal Abstraction	90	30	33	75	14	19	00	09
Spelling Recognition	90	34	30	83	16	00	19	13
Speed of Word Perception	80	29	31	57	11	−00	46	14
Recog. of Affixes and Roots	89	31	25	68	02	24	14	10
Word Reversals	73	30	40	43	06	48	15	36
7 Holmes Language Perception								
Word Embedded	92	24	31	59	03	17	44	−01
Figure and Ground	78	20	08	−01	08	−01	82	−04
Cue Symbol Closure	78	29	27	07	16	29	65	10
8 K-D-H Musical Aptitudes								
Pitch Discrimination	73	21	22	17	21	10	−01	50
Rhythm Discrimination	64	24	25	19	01	15	07	72
Tonal Intensity Discrim.	82	24	34	07	15	02	02	73

*Identification of Factors

1. Visual Verbal Meaning
2. Auding
3. Visual Relationships
4. Speed of Visual Perception
5. Auditory Perception

**Decimals before correlations and factor loadings have been omitted.

comprehension questions. At the correlational level then, *DSRC* subtests are not highly predictive of any of the variables used in this study.

Factor Analysis. A principal components factor analysis with communalities of 1.0 was used to factor the matrix. The rank of the matrix was specified as the number of eigenvalues equal to or greater than 1.0. Kaiser's (1959) normalized varimax rotation technique for maximum interpretability was employed.[4]

Results and Interpretation

The rotated principal component factor loadings, shown in Table 2, yielded five interpretable factors. Factor I was identified as *Visual Verbal Meaning* because tests with high loadings on this factor require subjects to read for comprehension, vocabulary, and word recognition. Factor II was labeled *Auding* since the listening tests, such as *PMA* Pictures, *DSRC* subtests, and Range of Information correlate highly with this factor. Factor III was named *Visual Relationships* to represent its saturation of *PMA* Space, Figure Grouping, and Perception, plus its substantial correlations with *DSRC* subtests and Word Reversals. Factor IV was defined as *Speed of Visual Perception* by high test loadings of Speed on Reading, Perception, Speed of Word Discrimination, Word Embedded, Figure and Ground, and Cue Symbol Closure. Factor V was called *Auditory Perception* because of its high correlations with Pitch, Rhythm, and Intensity.

Comparison of the factor loadings of either the *Gates* or *Durrell-Sullivan* reading comprehension tests with either of the *DSRC* subtests reveals that their patterns are not similar. The reading comprehension tests correlate .62 to .75 with *Visual Verbal Meaning* and .40 to .44 with *Auding Factors.* The *DSRC* subtests' highest loadings are .62 to .75 on *Auding* and .18 to .40 on *Visual Relationships Factors.* Although both the reading and the listening tests have substantial loadings on Factor II, the quantitative variation in their factor pattern does not substantiate the assumption that brain functioning in performance on these tests is uniform. On the contrary, the evidence supports the contention that the visual and auditory

[4] Dr. Alan B. Wilson, Survey Research Center, University of California, Berkeley, wrote the principal components factor analysis program, FA80, and integrated it with the varimax program.

systems mobilized for performance on the reading and listening tests, although having some common functions and therefore some degree of cortical interfacilitation, are nevertheless separate systems. Hence, at least at the fourth grade level, listening comprehension alone cannot justifiably be used as a valid measure of concurrent reading achievement, and vice versa.

Nor should *DSRC* subtests be used as a valid measure of concurrent word recognition achievement at the fourth grade level because none of the word recognition measures has any substantial loading on the *Auding Factor*. Furthermore, the loadings of .18 for *DSRC* Paragraph Meaning and .16 for *DSRC* Word Meaning on the *Visual Verbal Meaning Factor* are quite low. Again, the evidence suggests that two more or less separate systems are operating in performance on *DSRC* subtests and on word recognition abilities.

Discussion

If the *DSRC* type of test is taken as a valid measure of an individual's reading potential, then an explanation has to be sought for a significant discrepancy between reading potential and reading achievement, even when achievement is actually higher than potential (Alden, Sullivan, and Durrell, 1941; Maxwell, 1959). For some individuals the discrepancy may be validly attributed to inadequate instruction, desire to learn, or to some other causal factor, all of which assume that under optimal conditions there would be no discrepancy. A more general explanation, supported by the results of this study and by the findings of a similar investigation on only 60 fourth graders (Singer, 1960), is that at least two separate, though moderately interrelated systems are mobilized for performance in reading and in listening; therefore, an individual could perform better or have higher potential in one than in the other system, possibly as a result of intraindividual variation in mental capacities or asynchronous development of mental functions (Bayley, 1949).

Further support for the interpretation of the separateness of the two systems can be adduced from several studies: Gates (1926) concluded that visual perception for words, objects, and geometric symbols are specific abilities; Karwoski, Gramlick, and Arnott (1944) inferred that the longer reaction times for objects and pictures than for words was due to the formulation of an intermediary symbol before a verbal response to objects and pictures could be made; Strang (1943) explained that verbal and nonverbal mental tests tap different mental processes; Caffrey (1953) at the high school level identified an auding factor, which was distinct from reading comprehension, mental age, chronological age, and interests; and Spearitt (1962) at the sixth grade level using the *STEP* listening test in a battery that included reading, reasoning, and rote memory, also isolated a listening comprehension factor. Consistent with all these findings is the localization theory of neurology (Nielsen, 1951) with its implications for the reading process (Holmes, 1957) that different areas of the brain are involved in (a) *visual* perception of objects, pictures, and words and (b) *auditory* perception of music and language. Moreover, from a battery of tests the best predictor of first grade reading achievement was the visual *word* discrimination subtest of *Gates Reading Readiness* (Balow, 1963). It would therefore seem that a valid test of silent reading potential would necessarily be weighted with items or scales that require perception, retention, manipulation and conceptualization of *written* or *printed* verbal symbols, with input through the visual mode.

Summary

The validity of the basic assumption supporting the use of the *Durrell-Sullivan Reading Capacity Test* as a measure of reading potential was investigated by means of principal components factor analysis. Factors were extracted from a matrix of 30 variables that had been selected to measure both visual and auditory input and mediational processing systems for listening and for reading. The varimax rotated factor loadings for a sample of 283 fourth graders did not support the Durrell-Sullivan assumption that there is a uniformity of brain structure in regard to the handling of symbolic relationships in listening and reading tests. The listening tests primarily loaded on an *Auding Factor* while the reading tests primarily tapped a *Visual Verbal Factor*. However, the pattern of loadings suggested that what *DSRC* actually assesses in the fourth grade is listening comprehension at a concrete or auditory-visual associational level rather than listening comprehension at a more abstract level. Consequently, an alternate hypothesis was advanced that what is mobilized for performance in listening and reading in the fourth grade are two separate, though moderately interrelated, mul-

tidimensional systems in which individuals could have higher potential in one system than in the other. Caution should therefore be exercised in the use in the fourth grade of the *Durrell-Sullivan Reading Capacity Test* alone for assessing concurrent reading capability.

This conclusion should not, of course, be generalized to other measures of listening comprehension, to other grade levels, nor to other curricula without further investigation. In fact, Holmes and Singer (1961) found in a factor analytic study of a similar battery at the high school level that another measure of listening comprehension and reading achievement did indeed correlate highly with the same factor. Further integration in these two systems apparently occurs sometime after the fourth grade level. Moreover, it is possible that emphasis at the elementary level upon the development of listening comprehension may accelerate this integration. If so, then listening comprehension would serve as a more valid group esimate of concurrent reading capability even at the elementary school level, but caution would still be necessary in estimating expectancy levels in particular individuals because of the possibility of (a) intraindividual variation in capacities or (b) asynchronous development of an individual's cognitive systems for listening and for reading.

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