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ABSTRACT

The Illinois Test of Psycholinguistic Abilities (ITPA) is a psychodiagnostic instrument devised to assess theoretically discrete and basic cognitive skills. In its genesis the ITPA, comprising nine subtests, was designed to provide independent estimates of a child's level of functioning in each of the nine abilities theoretically addressed. Factor analyses of the ITPA subtest intercorrelations resulting from scores generated by 340 six-year-old children enrolled in a prekindergarten Head Start program cast doubt upon the independence of the abilities assessed. Issues relating to the practical use and future experimental work with the ITPA are discussed. (Author)

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The Illinois Test of Psycholinguistic Abilities (ITPA) is an assessment device which seeks to describe areas of adequacy and deficiency in psycholinguistic functioning, thereby permitting the test user to move toward a prescription of specific remedial techniques (McCarthy and Kirk, 1961). The ITPA is a rationally constructed instrument which owes its theoretical origin to Osgood's (1957) psycholinguistic model of communication. Osgood conceived of communicative acts as being reducible to three psycholinguistic processes: decoding, association and encoding. Each of the three processes is in turn, according to Osgood, capable of organization at either the automatic-sequential or representational (symbolic) level of language.

Within the framework of the ITPA, McCarthy and Kirk have attempted to assemble a battery of nine subtests, each designed to measure a different combination of psycholinguistic process, level of organization and channel of communication or sense modality (e.g. vision, audition). The specific intent of the test authors was to assemble a group of nine ability-specific assessment devices. As a measure of their success along this line, McCarthy and Kirk (1961) factor analyzed their original standardization data and found that the nine abilities for which the tests were designed did appear as separate factors--though of varying weights--throughout the different age groups examined.

In their original discussion of the factorial structure of the ITPA, McCarthy and Kirk (1961) dealt only with the initial principal axis factorization of the test data. Subsequently, Ryckman (1966) replicated McCarthy and Kirk's initial factorization and then subjected the matrices to variamax rotations. Ryckman found between two (at age 2 years, six months) and five (at age six years, six months) factors accounting for the bulk of the variance of the ITPA subtests. Center (1963) in factor analyzing the test results obtained from a group of third grade pupils, found that the ITPA subtests seemed to be represented by seven factors with five of these being "clearly significant."

In contrast to the findings of Ryckman and Center, both of whom found the factorial dimensionality of the ITPA to be less than nine (the number of subtests), Semmel and Mueller (1962) factored the ITPA test scores of 118 mentally retarded children (between the ages of six and nineteen years) and found that each of the ITPA subtests did indeed seem to define an independent factor.

While the ability-specificity of the ITPA subtests is open to question--and this is a crucial issue for a test which purports to measure specific abilities--there is another issue presently unresolved related to the utility of the ITPA; that is, the comparability of white and Negro children with respect to the abilities assessed by the ITPA. McCarthy and Kirk (1961) in standardizing the test specifically excluded Negro children from the original sample. Insofar as they were not included in the standardization sample, it becomes important to know to what extent the norms presented by the test authors are applicable to Negro children. A further question would be the extent to which the socioeconomic deprivation experienced by the overwhelming majority of Negro children interacts with the different psycholinguistic skills "tapped" by the ITPA.

This study was aimed at resolving these issues: (a) do the nine subtests contained in the ITPA correspond to independent factors, and (b) are there selective differences in the performance of Negro and white children on the various ITPA subtests.

Method

Subjects

The ITPA was administered to 340 six-year-old children who were enrolled in a pre-kindergarten Headstart Program in an eastern North Carolina community[2] (population 14,300). The children ranged in age from five years, eight months to seven years, nine months with a mean age of six years, four months at the time of testing. There were 180 boys and 160 girls of which 27 boys and 28 girls were Negro.

Tests

The ITPA was administered to the subjects (Ss) in its standard form. The nine subtests administered were: auditory-vocal automatic (AVAU), visual decoding (VD), motor encoding (ME), auditory-vocal association (AVAS), visual-motor sequencing (VMS), vocal encoding (VE), visual motor association (VMA), auditory decoding (AD), and auditory vocal sequential (AVS) tests. Children were tested individually employing nine trained examiners for the group.

Scores

The raw scores obtained on the ITPA subtests by the 340 _S_s were then subjected to the analyses described in greater detail below.

Results

To determine if the resultant ITPA subtest scores for all 340 _S_s were systematically influenced by race or sex, the scores were subjected to a subtest x race x sex analysis of variance (Table 1).

(Table 1 about here)

Table 1 indicates a significant variation among the ITPA subtests. This is not surprising insofar as the various subtests have different scales of measurement. For example, the highest score obtainable on the AVAU was 22, while that on the VE subtest was without theoretical limit.

Aside from variation due to subtests, Table 1 suggests that race was of significant variation; therefore, tests were performed on the Negro versus white _S_s' subtest scores. The resulting analysis (Table 2) showed that the white _S_s were superior to their Negro classmates on all nine subtests. In six of the nine instances the differences were significant ($p < .01$ or $.0001$). Negro _S_s were particularly deficient on those subtests requiring language (e.g. AVAU and AVAS) and less deficient on those tests of perceptual or non-symbolic nature (e.g. VMS and AVS).

(Table 2 about here)

While the white Ss' subtest scores without exception were higher than the corresponding scores for the Negro sample, the scores obtained by the white Ss were lower than those given for the comparably aged norm group. Thus, the language ages (as determined from norm group performance) corresponding to the mean subtest scores for the white Ss were uniformly below those of the norm group. The average language age for the white Ss was five years, nine months. For the Negro Ss the average language age for all subtests was four years, ten months, compared with their mean chronological age of six years, four months.

Since male/female differences on the ITPA subtests were of interest, the significant ($p < .01$) sex x subtest intereaction was examined. The resulting t test analysis (Table 3) revealed that only for the ME subtest was there a significant sex effect ($p < .01$) with boys obtaining higher scores than girls. The fact that there was only one instance of a significant difference leads us to the tentative conclusion that, with the exception of the ME subtest, the ITPA subtests are not significantly influenced by the sex of the children under consideration.

(Table 3 about here)

Since the preceding analysis of variance suggested a racial influence on ITPA subtest scores, separate factor analyses were run for the Negro and white samples. For both Negro and white samples, the intercorrelations between the ITPA subtest raw scores were computed. The resulting correlations were then subjected to principal axis factor analyses. In the principal axis analyses, the squared multiple correlation of each subtest with the remaining eight tests in the ITPA battery were inserted on the main diagonal of the correlation matrix as the estimate of the subtest's communality (Harman, 1960). The resulting correlation matrices for white and Negro Ss are shown on Tables 4 and 5.

(Table 4 about here)

(Table 5 about here)

The magnitudes of subtest intercorrelations (Tables 4 and 5) obtained here were greater than the comparable coefficients reported by McCarthy and Kirk in their original standardization. The correlations for the white Ss ranged from .09 to .61 (Table 4), while those for the comparably aged standardization Ss (six years, six months) were between -.13 and .33. The mean discrepancy between corresponding coeffeicients--the correlations for the white sample minus the standardization correlations--was +.19. For the Negro sample, the divergence from the standardization coefficients was even greater; the correlations for the Negro sample ranged between .18 and .69 (Table 5) with a mean discrepancy from the standardization coefficients of +.30.

These discrepancies in correlation coefficient magnitude are quite large and may partially derive from the geographical/cultural differences accruing to the two samples; specifically the McCarthy and Kirk Ss were drawn from Decatur, Illinois (1965 population, 85,000) whereas the Ss in the present study resided in a small eastern North Carolina town (1965 population, 14,300).

In view of the issue of the factorial specificity of the individual ITPA subtests, the results of both principal axes factorizations seem unequivocal. For the white Ss the factor analysis yielded a common factor space of one with the first principal axis accounting for more than the entire common factor variance (110%)[3]. For the Negro Ss the first principal axis accounted for 95% of the common factor variance, and with the extraction of a second principal axis the percentage of common factor variance accounted for rose to 105%[4].

Inspection of the first principal axis factor loadings for the white sample (Table 6) shows that those subtests most clearly differentiating white and Negro Ss in the analysis of variance (e.g. AVAU, AVAS and ME) received the highest loadings; similarly, those subtests showing the least difference between Negro and white Ss (e.g. VE, VMA and AVS) received the lowest loadings on the first principal axis. An interpretation of the first factor, for the white sample, would be that of a general linguistic or symbolic ability. The first principal axis extracted for the Negro Ss (Table 6) was defined at the upper end of the loading range by the AVAS and AD subtests and at the lower end of the range by the VD and VMA subtests; the dimension in question here seems to be that of a combined auditory-linguistic versus visual-perceptual factor.

(Table 6 about here)

Insofar as there were--though perhaps equivocally--two factors in the common factor space of the Negro sample, the initial principal axis analysis for the Negro Ss was subjected to a normal variamax rotation to simple structure. The two rotated factors obtained were far from simple in the composition of abilities tapped (Table 7). The first variamax factor for the Negro Ss seemed to be based upon the aforementioned linguistic-symbolic ability. The highest loading on this factor was contributed by the AVAS subtest which is related to language and syntax; the lowest loading on this factor was contributed by subtest VMA which is non-language based. The one difficulty in the interpretation of the first variamax factor is that the ME subtest contributes the second highest loading. In considering the task confronting the S taking the ME subtest, the contradiction perhaps dissipates. In ME tasks the S must look at a printed page and decide what action is to be performed on the object represented there. Implicit symbolic manipulations are required for the ME subtest.

(Table 7 about here)

The second variamax factor for the Negro Ss seemed to refer to the visual-perceptual abilities. Subtest VMS contributed the highest loading on this factor and subtest VD the second highest loading. The lowest loadings were contributed by subtests AVAU and ME, each of which contributed high loadings to the first or linguistic-symbolic factor.

Discussion

In terms of the central concern of this paper and within the age range sampled, the preceding results offered little support for the factorial specificity of the ITPA subtests. The ITPA would seem to be directed at one or, perhaps, two specific abilities. The divergence of the presently obtained results and those of previously mentioned authors (e.g. Center, 1963; Ryckman, 1966: and Semmel and Mueller, 1962) is most likely due to a variation in the estimates of communality employed in factoring the correlation matrices. Surprisingly enough, none of the previous factor analytic studies of the ITPA specify the actual values used to complete the correlation matrices prior to factoring. From inspection of results obtained, it would seem that Center (1963), Ryckman (1966) and Semmel and Mueller (1962) used unities in the main diag correlation matrices.

The lack of specification of the main diagonal entries is anamolous particularly since for any given correlation matrix, the dimensionality of the common factor space is affected by the values entered on the main diagonal[5]. By present day standards (Harman, 1960, pp. 69-96) the squared multiple correlation, used in the present study, is the most adequate estimate of communality and furnishes a lower bound estimate of "true" communality.

Though the issue of the factoral specificity of the ITPA subtests is crucial for a test purporting to be of educational diagnostic value, the way in which one goes about examining the specificity of the subtests has hitherto been ignored. It is not surprising that when one factor analyzes the results obtained from a sample representing the general population, one comes up with a general linguistic factor and perhaps also a visual-perceptual factor; the factorial structure of a test geared toward disabilities of diverse sorts is clearly influenced by the particular contours of cognitive capacities in the disability group. What remains to be done is to take different groups of learning disabled children and note variations in factorial structure of the ITPA <u>between</u> such groups. As an example of what might be done in this area, it would be enlightening to examine the factorial structure of the ITPA obtained from a group of dyslexic children compared with that of a group of children who exhibited difficulty in arithmetic.

Aside from the factorial specificity of the ITPA subtests, a second issue was raised by the presently obtained results. In view of the much larger subtest intercorrelations obtained here than in the standardization sample, to what extent do geographically related cultural factors influence ITPA subtest scores and the correlations derived from these scores. The intercorrelations obtained by Center (1963), based on data obtained from eight- to nine-year-old Georgian children, have some bearing on this issue. Center's coefficient's ranged between -.12 and .44 and as such are intermediate in magnitude between the lower coefficients reported by McCarthy and Kirk and the higher coefficients obtained in this study. Also suggestive of regional influences upon ITPA performance is the finding that the language ages corresponding to the mean subtest scores of the white sample were without exception below those of the corresponding norm group. From the foregoing it is clear that the norms provided by McCarthy and Kirk may well be expected to show a systematic bias when contrasted with data obtained from other geographic regions.

A final implication of the study is that Negro children, who are of predominantly low socioeconomic background, diverge from their white classmates in tasks requiring language skills. Any program for early intervention--such as Headstart--ought to take cognizance of this fact and address itself to making up this language or symbolic deficit.

Resources

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Footnotes

1. A version of this paper was presented by the senior author at a meeting of the Society for Research in Child Development in New York City, March, 1967.

2. Acknowledgement is due the Halifax County North Carolina Department of Public Health, Dr. Robert F. Young, Director. Also, to Mr. J. W. Talley, Superintendent of Schools in Roanoke Rapids, North Carolina and Mr. James Small, Department of Psychology, Duke University. Dr. John Altrocchi, Dr. Irving Alexander and Dr. Carl Eisdorfer, Department of Psychology, Duke University were most cooperative in acquisition and provision of the data.

3. The finding that more than 100% of the common factor variance was accounted for by the first factor is due to the fact that when communalities rather than unities are inserted on the main diagonal of a correlation matrix, the principal roots extracted are at first large and positive and then negative and small; the net result here being that the ensemble of positive and negative roots will sum to no more than 100% of the variance. (Harman, 1960, p. 187.)

4. Again, the apparent impossibility of accounting for more than the entire variance is due to the insertion of communalities rather than unities on the main diagonal.

5. When unities were inserted on the main diagonal of both the Negro and white intercorrelation matrices, nine factors accounted for 100% of

the common factor variance; with the insertion of the highest coorelation of each variable with any of the other eight, four and five factors accounted for all of the Negro and white Ss' common factor variance.

6. This study was supported in part by NIMH grant #8045-04, Duke University.

Table 1.

Analysis of Variance of ITPA Subtest Scores

Source	df	MS	F
Between Subjects	339	82.46	
Sex (A)	1	58.59	.82
Race (B)	1	3649.49	51.22**
(AB)	1	306.06	4.30*
Subjects within groups	336	71.25	
Within Subjects	2720	25.64	
Subtests (C)	8	3729.32	262.63**
AC	8	36.33	2.56**
BC	8	162.77	11.46**
ABC	8	16.37	1.15
CX Subjects within groups	2688	14.20	

* $p < .05$

** $p < .01$

Table 2.

t Tests on Differences Between Negro and White

Mean Subtest Scores

	Negro		White		p. level
	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$p <$
(1) Auditory-Vocal Automatic	6.20	3.71	11.05	4.28	.0001
(2) Visual Decoding	10.93	3.83	12.66	3.38	.01
(3) Motor Encoding	11.05	3.67	13.99	4.06	.0001
(4) Auditory-Vocal Association	11.93	5.10	15.98	4.18	.0001
(5) Visual-Motor Sequential	11.14	4.02	11.95	3.25	n.s.
(6) Vocal Encoding	10.05	5.65	15.39	5.98	.0001
(7) Visual-Motor Association	12.94	4.16	13.84	4.14	n.s.
(8) Auditory Decoding	15.22	5.51	20.18	5.38	.0001
(9) Auditory Vocal Sequential	19.22	6.27	20.35	5.18	n.s.

Note: Negro N=55, white N=285.

Table 3.

t Tests on Differences Between Male and Female

Mean Subtest Scores

	Male $\bar{X}$	Male s.d.	Female $\bar{X}$	Female s.d.	p. level $p <$
(1) Auditory-Vocal Automatic	10.33	4.90	10.19	4.13	n.s.
(2) Visual Decoding	12.68	3.58	12.04	3.40	n.s.
(3) Motor Encoding	14.16	4.05	12.79	4.14	.01
(4) Auditory-Vocal Association	15.46	4.67	15.18	4.50	n.s.
(5) Visual-Motor Sequential	11.77	3.56	11.88	3.20	n.s.
(6) Vocal Encoding	14.99	6.79	14.01	5.54	n.s.
(7) Visual-Motor Association	13.59	3.97	13.81	4.34	n.s.
(8) Auditory Decoding	19.49	5.96	19.25	5.38	n.s.
(9) Auditory Vocal Sequential	19.78	5.26	20.60	5.50	n.s.

Note: Male N=180, Female N=160.

Table 4.

ITPA Subtest Intercorrelations: White Subjects[a]

		1	2	3	4	5	6	7	8	9
(1)	Auditory-Vocal Automatic	.477	.427	.468	.608	.303	.306	.233	.470	.254
(2)	Visual Decoding		.329	.414	.500	.285	.253	.279	.356	.094
(3)	Motor Encoding			.361	.494	.281	.370	.278	.382	.142
(4)	Auditory-Vocal Association				.542	.363	.362	.288	.498	.329
(5)	Visual-Motor Sequential					.168	.181	.096	.201	.188
(6)	Vocal Encoding						.205	.226	.291	.207
(7)	Visual-Motor Association							.139	.245	.117
(8)	Auditory Decoding								.318	.171
(9)	Auditory-Vocal Sequential									.140

[a]The entries on the main diagonal are the squared multiple correlations between each subtest and the remaining eight subtests.

Table 5.

ITPA Subtest Intercorrelations: Negro Subjects[a]

	1	2	3	4	5	6	7	8	9
(1) Auditory-Vocal Automatic	.496	.260	.561	.642	.394	.458	.222	.485	.338
(2) Visual Decoding		.316	.133	.320	.414	.416	.175	.399	.413
(3) Motor Encoding			.460	.627	.426	.336	.235	.482	.377
(4) Auditory-Vocal Association				.742	.552	.508	.406	.693	.636
(5) Visual-Motor Sequential					.488	.505	.389	.601	.404
(6) Vocal Encoding						.406	.322	.450	.434
(7) Visual-Motor Association							.222	.296	.264
(8) Auditory Decoding								.565	.473
(9) Auditory-Vocal Sequential									.474

[a] The entries on the main diagonal are the squared multiple correlations between each subtest and the remaining eight subtests.

Table 6.

First Principal Axis Factor Loadings for ITPA Subtests

Subtest	White	Negro
(1) Auditory-Vocal Automatic	.712	.667
(2) Visual Decoding	.600	.481
(3) Motor Encoding	.643	.636
(4) Auditory-Vocal Association	.793	.877
(5) Visual-Motor Sequential	.421	.702
(6) Vocal Encoding	.477	.645
(7) Visual-Motor Association	.385	.434
(8) Auditory Decoding	.600	.762
(9) Auditory-Vocal Sequential	.328	.651

Table 7.

Variamax Factor Loadings for ITPA Subtests: Negro Subjects

Subtest	Factor I	Factor II
(1) Auditory-Vocal Automatic	.667	.267
(2) Visual Decoding	.088	.603
(3) Motor Encoding	.701	.187
(4) Auditory-Vocal Association	.759	.475
(5) Visual-Motor Sequential	.391	.608
(6) Vocal Encoding	.345	.572
(7) Visual-Motor Association	.259	.356
(8) Auditory Decoding	.531	.546
(9) Auditory-Vocal Sequential	.374	.550