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ABILITIES OF INFANTS DURING THE FIRST EIGHTEEN MONTHS*

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A variety of evidence from many points of view has been adduced to describe and explain the emergence of behavior during infancy. Developmental problems have been a major interest in Gesell's work for a number of years, and more recently Halverson (8), Shirley (17), and others have produced much significant material in this field. Basic to the quantitative estimation of patterns of behavior is the creation of tests, a task to which Gesell early devoted himself. Attempts to standardize Gesell's baby test situations or situations like them have been made by several investigators (2, 3, 4, 12, 14, 15).

We know of no attempt so far to analyse the results of baby test material by means of factor analysis; it is the purpose of this paper to present such analysis of test results secured from children at 6, 12, and 18 months. The Gesell tests were used at each age level, in the manner described by Gesell (7). Earlier papers (14, 15) have described the test results in detail; this study will be limited to the correlational and analytic procedures, results, and interpretation.

Eighty infants were used at each age level; about 40 per cent of the infants were included in each group, so that the study is longitudinal in certain respects. Sexes were distributed about evenly. Children were tested within four days of the six months birthday, five days of the one year birthday, and seven days of the eighteen months birthday.

The split half reliabilities of the total tests at each age level were obtained by using items alternating in difficulty. For these correlations all items were used (not only those used in the factor analyses). The corrected coefficients were as follows: 6 months .89, 12 months .84, 18 months .79.

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The total test scores intercorrelated as follows: six with twelve months, .72; six with eighteen months, .42; twelve with eighteen months, .56.

Item Intercorrelations

For the intercorrelations all tests were used at each age level which were passed by at least 25 and not more than 75 per cent of children and which were not contingent upon one another. (For example: since all children who walk can stand, standing was rejected and walking retained at twelve months.) This selection of items perhaps eliminated several which may be considered as particularly diagnostic, and the rejection of which may leave the schedule a different instrument than Gesell described. To our observation, however, the items in the middle 50 per cent are reasonably representative of the area tested by the total schedule at each level.

Tetrachoric coefficients were used throughout. On a group of 80 children, the tetrachoric coefficient has a standard error of from .00 to .22, depending on its size and the degree to which the two variables split the group evenly. The modal standard error at .17 indicates that a coefficient had to be .50 or better to be very significant of interrelationship.

Two types of factor analysis were used; the method of multiple factors, for which Thurstone's accounts (20, 21) were used as guides, and the bi-factor method of Spearman and Holzinger for which Holzinger's accounts were used (9, 10).

The intercorrelations at each age level appear in Tables 1, 2, and 3. We shall not pause to examine the coefficients at this point more than to point out the interesting fact that intercorrelations are greatest for the six months group and least for the twelve. This fact merits consideration in the light of the findings of several studies which show that for a given battery of tests intercorrelation drops with increasing age (and experience). These considerations will be treated in the discussion.

Multiple Factor Analysis

Two criteria were used in the multiple factor analyses to indicate when to halt the extraction of factors, the sigma of residuals criterion suggested earlier by Thurstone, and the criterion recently proposed

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TABLE 1
CORRELATION MATRIX, SIX MONTHS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Splashes in tub		.30	.15	.25	.21	.17	.28	.29	.30	.30	.14	.04	.53	.06	.12	.30	.08
2. Pats table			.85	.59	.77	.69	.39	.31	.42	.03	.69	.66	.38	.67	.60	.80	.15
3. Inhibits one hand and head				.60	.96	.83	.40	.52	.66	.07	.80	.59	.49	.82	.64	1.00	.36
4. Reaches direction spoon					.46	.48	.51	.58	.58	.38	.73	.44	.44	.66	.58	.69	.47
5. Manipulates hand						.68	.34	.51	.51	.05	.70	.43	.52	.68	.55	1.00	.34
6. Makes stepping movements							.40	.30	.62	.17	.57	.41	.31	.65	.42	.61	.20
7. Looks for fallen object								.73	.44	.45	.60	.35	.21	.50	.47	.52	.75
8. Throws object to floor									.44	.32	.62	.47	.51	.46	.35	.62	.61
9. Takes bottle in and out mouth										.56	.67	.21	.29	.44	.30	.40	.58
10. Music: stops crying											.23	.03	.02	.08	.24	.25	.89
11. Exploratory manips.												.50	.52	.68	.58	.75	.09
12. Bangs spoon													.25	.53	.41	.59	.22
13. Regards pellet														.38	.46	.58	.23
14. Dangling ring: persist reaching															.69	.73	.48
15. Drops one cube for third																.51	.50
16. Secures cube																	.36
17. Music: laughs																	

TABLE 2

CORRELATION MATRIX, TWELVE MONTHS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Walks alone		.52	.19	.22	.23	.05	.33	.19	.20	.28	.24	.20	.51	.09
2. Climbs			.34	.45	.49	.19	.35	.05	.34	.30	.20	.15	.46	.15
3. Says three words				.30	.11	.14	.35	.06	.07	.70	.44	.26	.18	.22
4. Tower of two					.51	.40	.14	.00	.01	.10	.08	.20	.09	.31
5. Third cube						.34	.36	.22	.01	.06	.06	.16	.42	.26
6. Inhibits hand to mouth							.21	.08	.12	.02	.26	.14	.18	.02
7. Imitates scribble								.10	.11	.16	.41	.01	.51	.12
8. Dangling ring: uses string									.00	.40	.32	.20	.01	.15
9. Prefers one hand										.34	.19	.03	.28	.10
10. Says "Bye-bye," "hello"											.31	.07	.33	.14
11. Points to things at table												.29	.32	.19
12. Bowel control													.16	.13
13. Tries shoes														.29
14. Vocalizes to music														

TABLE 3
CORRELATION MATRIX, EIGHTEEN MONTHS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Asks for things at table		.55	.62	.06	.34	.03	.20	.40	.72	.11	.59	.39	.19	.11	.35	.16
2. Two or more words together			.39	.00	.28	.11	.11	.40	.63	.22	.71	.72	.52	.27	.47	.22
3. Tower of four				.08	.40	.40	—.15	1.00	.48	.44	.60	.33	.43	.09	.54	.36
4. Cube in cup; plate					.50	.29	.44	.46	.30	.12	.22	.12	.19	.29	.39	.15
5. Formboard, circle						.60	.41	.36	.50	.41	.42	.09	.20	.43	.39	.29
6. Formboard, shown							.30	.39	.45	.29	.27	.17	—.16	.07	.09	.06
7. Performance box, three square								.44	.37	.50	.37	.05	.11	.09	.46	—.15
8. Points three objects in pictures									.80	.48	.57	.30	.33	.41	.79	.08
9. Names one object in pictures										.57	.76	.41	.20	.33	.74	.00
10. Points two or more parts of body											.41	.30	.28	.17	.24	.01
11. Repeats things said												.34	.50	.39	.81	—.07
12. Says "hello," "thank-you"													.15	.03	.21	.17
13. Listens to stories with pictures														.25	.44	.31
14. Bladder control															.73	.16
15. Asks for toilet																—.03
16. Uses spoon well																

(21). Sigmas of successive tables of residuals are presented in Table 4. It will be seen that, by comparison with the sigma of the original

TABLE 4

SIGMA OF ORIGINAL COEFFICIENTS, AND OF RESIDUALS IN SUCCEEDING MATRICES FOR SIX, TWELVE, AND EIGHTEEN MONTHS' GROUPS

	Six months	Twelve months	Eighteen months
Correlation	.215	.148	.247
1st Residual	.148	.143	.182
2nd Residual	.093	.111	.149
3rd Residual	.083	.093	.138
Sigma of original coefficients	.17	.17	.17

coefficients, the variability in the case of the six months data drops to the error point after extraction of one factor. In the case of the 12 months material coefficients and successive residuals are at all points below the error limit. The 18 months material permits two factors before this point.

The criterion data are presented in Table 5. On the basis of this

TABLE 5

THURSTONE-TUCKER PHI CRITERION FOR SIX, TWELVE, AND EIGHTEEN MONTHS' ANALYSIS

	Six months	Twelve months	Eighteen months
Criterion	.9412	.9286	.9375
Factor 1	.5141	.6768	.6261
2	.7857	.8774	.8918
3	.9364	.8839	.9324
4		.9320	

criterion, the 6 months and 18 months data evidence two factors, and 12 months data three.

These conflicting results regarding the factors evidenced by multiple factor analyses of these data suggested that the factor loadings themselves should be consulted before any conclusion was made. Examination of the factor loadings in each analysis and of rotated factor weights suggested that there were two factors of importance at each level. However, at 12 months, analysis has been made of three factors as well. The material to follow will treat, therefore, of single factor matrices at 6 and 18 months, and of two such matrices at 12 months.

TABLE 6

FACTOR PATTERN, COMMUNALITY AND ROTATED LOADINGS, SIX MONTHS

	Unrotated			Rotated	
	*K*1	*K*2	h^2	I	II
Music: Laughs	.610	.660	.808	.87	.23
Music: Stops crying	.420	—.745	.731	.86	
Looks for fallen object	.686	—.391	.623	.67	.42
Throws object to floor	.710	—.267	.575	.57	.50
Takes bottle in and out mouth	.686	—.267	.542	.56	.48
Reaches for spoon	.777	—.089	.612	.44	.64
Splashes in tub	.344	—.204	.160	.34	
Regards pellet	.568	.080	.329		.54
Bangs spoon	.576	.234	.387		.62
Drops one for third cube	.688	.124	.489		.67
Stepping movements	.707	.228	.552		.73
Exploratory manipulation	.820	.200	.712		.82
Reaches for dangling ring	.791	.263	.695		.82
Pats table	.775	.428	.784		.89
Manipulates one hand	.823	.397	.835		.91
Secures cube	.908	.280	.903		.93
Inhibits head and one hand	.910	.440	1.022		1.00

Table 6 presents the unrotated and rotated factor loadings for the six months group.[1] The structure presented in the columns to the right, headed I and II, is quite orthogonal. The factors may be designated as an *alertness* factor and a *motor* factor. The motor factor is present in some degree in practically all tests, probably because of the obvious fact that all behavior at this early level is, in a sense, motor, at least in expression. Factor I is present most heavily in those tests which seem to imply (*a*) distance reception and (*b*) playfulness. The term alertness has been used to characterize the group.

In another study (14), it was shown that the items *regards pellet* and *splashes in tub* correlated most highly with the Stanford-Binet at three years. According to our interpretation both items would seem to possess an element of alertness. However, *regards pellet* has no alertness saturation; *splashes in tub* has no motor factor. This anomaly is exemplary of the fact that the factor characterizations

[1]In a previous report (16) these were presented, and treated as if three factors were significant. These factors were described as a *Motor* factor, an *Alertness* factor and a *general or halo effect factor.* Subsequent analysis by means of correlating the factor scores indicated that the motor and general factor were correlated .94. It is seen above, also, that the criterion suggests that there are only two factors.

TABLE 7

FACTOR PATTERN, COMMUNALITY AND ROTATED LOADINGS, TWELVE MONTHS

	Unrotated					Rotated				
				h^2		Plan 1		Plan 2		
	*K*1	*K*2	*K*3	Plan 1	Plan 2	I	II	I′	II′	III′
Says "bye-bye," "hello"	.572	—.471	.376	.549	.690	.73		.82		
Says three words	.594	—.437	.179	.544	.576	.72		.71		.25
Points to things at table	.549	—.317	—.036	.402	.403	.60		.51		.38
Dangling ring; uses string	.319	—.337	—.274	.215	.290	.46		.23		.48
Bowel control	.335	—.180	—.261	.145	.213	.36				.43
Walks alone	.552	.108	.240	.316	.374	.28	.49	.45	.41	
Imitates scribble	.537	.129	.133	.305	.323	.25	.49	.37	.42	
Vocalizes to music	.363	.006	—.158	.132	.156	.23	.28		.21	.30
Prefers one hand	.313	.043	.262	.100	.169		.26	.33	.22	
Inhibits hand to mouth	.373	.131	—.295	.156	.243		.37		.31	.38
Tower of two	.486	.266	—.361	.307	.437		.54		.48	.45
Tries to put on shoes	.622	.301	.301	.477	.568		.67	.44	.61	
Accepts third cube	.548	.411	—.298	.469	.558		.68		.64	.38
Climbs	.660	.327	.209	.543	.586		.71	.40	.65	

are not nice, logical indices of system in the tests used; there are different exceptions which do not conform.

The twelve months analysis, in two configurations, is presented in Table 7.

Reference to the column headed h^2 will show (*a*) that the third factor adds very little to the communality over and above that contributed by the first two factors and (*b*) that the communality of the average test in the 12 months analysis, even if three factors are used, is considerably less than that of tests in the six months analysis. The mean h^2 values at six months compared with those at 12 months was .633, while the later tests yielded, for two factors, .333, and for three factors, .399. Obviously, this difference is an expression of the lower correlation at 12 months, mentioned above. In terms of factor theory, it is clear that the 12 months battery represents a group of tests with more specific factors than those at six—tests tending to measure more discrete functions.

Plan I in the rotated system at 12 months suggests again the orthogonal arrangement demonstrated at six months. Again there is a motor factor (II), and a factor composed of alertness items like *pointing to things at table, dangling ring,* etc. (though *tries to put on shoes* does not possess this factor). The two language items have the greatest saturation with the alertness factor, so that the factor may be designated as *alertness-language.* Incidentally, these language items had greater predictability for later mental status than did most remaining items at 12 months (15).

Plan 2 is no aid in interpretation. Factor II′ seems to be the II of Plan 1, but Factor I′ and III′ are present in a variety of tests, without apparent logic. This fact plus the doubtful communality contribution would suggest that Factor III′ is an artifact,—a function of error.

Table 8 presents the unrotated and rotated factor loadings of tests used in the 18 months analysis.[2] Here the communality of the tests is considerably above that of tests at 12 months, at a mean of .479 compared with .333, but it is less than the mean of .633 at six months. We may say that the 18 months tests have more in common with each other,—are less specific—than the tests at 12

[2]Mr. James McDowell deserves thanks for the work he did on the 18 months material.

TABLE 8

FACTOR PATTERN, COMMUNALITY AND ROTATED LOADINGS: EIGHTEEN MONTHS

	$K1$	$K2$	h^2	I	II
Two or more words together	.669	.491	.689	.83	
Blocks: Tower of four	.742	.386	.700	.82	
Repeats things said	.815	.286	.746	.80	.32
Picture 11, names one object	.853	.170	.757	.76	.43
Picture: Points 3 or more objects	.869	.090	.763	.71	.50
Asks for toilet	.786	.141	.638	.69	.41
Asks for things at table by words	.586	.351	.467	.67	
Says "hello," "Thank you"	.476	.244	.286	.52	
Listens to stories and pictures	.472	.159	.248	.46	
Points to 2 or more parts of body	.542	—.203	.335	.28	.51
Bladder control	.481	—.150	.254	.27	.43
Uses spoon well	.220	—.067	.053		
Performance box: square	.429	—.362	.315		.55
Formboard: Shown	.419	—.380	.320		.56
Places cube in cup, plate	.435	—.404	.352		.59
Formboard: circle	.658	—.552	.738		.85

months. This would bear out the suggestion above, that the 18 months test covers a more restricted area than the 12 months test. Either certain functions measured at 12 months have dropped out of the developmental picture, or tests for them are rejected because they are not regarded as worth sampling at 18 months.

Rotated loadings at 18 months suggest again the *motor* and *alertness-language* factors. There is an increased number of impure or mixed tests, however, indicating that the Gesell tests at this level tend to be more complex,—to involve mixtures of functions more than do the 12 months tests.

BIFACTOR ANALYSES

Using the bifactor method of Spearman-Holzinger, factor loadings were obtained for each of the age levels as shown in Tables 9, 10, 11. Table 9 presents two sets of loadings, based on the same material. Professor Karl J. Holzinger and his assistants very kindly analysed the six months material independently of us. It will be seen that the results of the two independent analyses agree rather closely in most respects.

Interpretation of the six months factors on the basis of the bifactor loadings is difficult. It is immediately apparent that by comparison with the multiple factor method, the Spearman-Holzinger

TABLE 9

FACTOR LOADINGS FOR TWO ANALYSES ACCORDING TO BI-FACTOR METHOD: SIX MONTHS

	Fels analysis				Holzinger analysis				
	G	(*a*)	(*b*)	(*c*)	*G*	(*a*)	(*b*)	(*c*)	(*d*)
Secures cube	.81	.50			.85	.42			
Inhibits head and one hand	.77	.70			.75	.71			
Manipulates one hand	.69	.58			.69	.57			
Pats table	.64	.62			.63	.65			
Stepping movements	.58	.46			.58	.44			
Reaches for dangling ring	.72	.38			.69	.48			
Bangs spoon	.48	.34			.46	.41			
Music: Stops crying	.27		.91		.42	—.34	.39		(.70)
Music: Laughs	.47		1.01		.45		.69		(.50)
Takes bottle in and out of mouth	.65		.28		.68		.50		
Looks for fallen object	.66		.30		.61		.69		
Regards pellet	.55			.60	.56			(.59)	
Splashes in tub	.30			.60	.33			(.59)	
Reaches for spoon	.85				.90				
Drops one for third cube	.71				.66	.20			
Throws object to floor	.81				.74		.40		
Exploratory manipulation	.87				.80	.27			

TABLE 10

FACTOR LOADINGS ACCORDING TO BI-FACTOR METHOD: TWELVE MONTHS

	G	(*a*)	(*b*)	(*c*)
Walks alone	.38	.44		
Climbs	.45	.64		
Imitates scribble	.38	.38		
Tries to put on shoes	.47	.45		
Tower of two	.30	.27	.56	
Third cube	.28	.64	.46	
Inhibits hand to mouth	.31		.55	
Says three words	.57			.63
Says "bye-bye," "hello"	.53			.63
Dangling ring—uses string	.33			
Points to things at table	.65			
Bowel control	.38			
Prefers one hand	.30			
Vocalizes to music	.40			

analysis discriminated more factors. It also accounted for more variance. In addition to the general factor, of which all tests have a sizeable loading at six months, the motor (*a*) and the alertness (*b*) factors seem to be present. The tests possessing Factors (*c*) *regards pellet* and *splashes in tub* would be classified by us as alert-

TABLE 11

FACTOR LOADINGS ACCORDING TO BI-FACTOR METHOD: EIGHTEEN MONTHS

	G	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	(*g*)
Two or more words together	.53	.83						
Says "hello," "thank you"	.36	.43						
Asks for things at table by words	.36	.66						(.65)
Pictures: Names one object	.76	.41	.34					
Repeats things said	.71	.39	.41					
Asks for toilet*	.54		.86*	.37			(.55)	
Pictures: Points three or more objects*	.87			.88*				
Blocks: Tower of four	.71			.43				(.56)
Performance box: Square	.16		.56		.58	(.56)		
Places cube in cup, plate	.35				.48			
Formboard: Circle	.63				.63			
Formboard: Shown	.30				.48			
Points two or more parts of body	.55					(.74)		
Bladder control	.44						(.89)	
Listens to stories with pictures	.51							
Uses spoon well	.22							

*Factor loadings account for more than unity variance.

ness tests, but they have no Factor (*b*). However, strangely enough, these two tests rank above all other tests in correlating rather highly with later mental status (see 14). Perhaps by comparison with the unitary alertness factor shown by the Thurstone analysis, the bifactor method yields two sub-factors, one of which is characterized by tests predictive of later mental status—or to be designated as indicative of an essential core of developmental nature. Holzinger's analysis indicated the possibility of a fourth group factor, Factor (*d*), present in the two responses to music. These tests possessed the alertness factor in the Thurstone analysis, but there they may characterize an auditory alertness.

Table 10 presents the bifactor loadings of the tests at 12 months. Here language becomes set off by the doublet (*c*), which we may call a language factor. Factors (*a*) and (*b*) seem both to be motor in character, (*a*) tending toward more gross activities such as climbing, walking, etc., (though *accepts third cube* is heavily saturated) while (*b*) tends toward finer manipulations. This interpretation is very tentative, however. It is interesting to note that this analysis does not result in a greater number of factors at 12 months than did the six months analysis.

Bifactor loadings at 18 months are presented in Table 11. Two tests at 18 months accounted for more than unity variance, *asks for toilet* and *pictures: points three or more objects.* At 18 months language characterized Factor (*a*), while Factor (*d*) is characterized by so-called "performance" tests, and may be designated as a manipulatory (or spatial) factor. Factors (*b*) and (*c*) may be some splitting up of alertness. Doublets designated as Factors (*e*), (*f*), and (*g*), are impossible of interpretation, and can probably be disregarded until more evidence is obtained with respect to them. The 18 months analysis accounts for more factors (probably) than were obtained at 12 months. This is contrary to the evidence suggested by the Thurstone analyses.

Intercorrelation of Factors

In order to determine the extent to which the factors were correlated, coefficients were calculated as follows: Each child at each age level was given the Thurstone factor weight for each of his successes. These crude factor scores were then correlated at each age level, and with like scores at each of the other age levels. An identical group of children who had received a score on each item at each age level was so small that the correlations were based on maximum groups obtainable for each level. Consequently the coefficients are based on different sub-groups throughout. They may be regarded as representing similar samplings, however.

Table 12 presents the coefficients in the upper left half of the table, and the numbers of cases for each coefficient in the lower half.

The data in Table 12 suggests that (*a*) there is a definite correlation between factor scores at each age level. This is due to the

TABLE 12

Intercorrelations between Factor Scores at Six, Twelve, and Eighteen Months (Above Diagonal) with Numbers of Cases (Below Diagonal)

	Six months		Twelve months		Eighteen months	
	Alertness	Motor	Alertness	Motor	Alertness	Motor
Six—alertness		.755	.371	.478	.277	.384
Six—motor	61		.286	.634	—.065	.244
Twelve—alertness	39	39		.709	.448	.491
Twelve—motor	39	39	77		.157	.239
Eighteen—alertness	36	36	51	51		.826
Eighteen—motor	36	36	51	51	74	

impure nature of the tests (that is, to the fact that most of the tests at every age level possess both factors to some extent), (*b*) the six months factors predict the 12 months factors about evenly, motor tending to predict motor, alertness to predict alertness. The six months factor predicts little at 18 months, however. This may be due to the fact that the 18 months test is, as a whole, composed of more alertness material. Only the alertness factor at 12 months has much predictive value. (*c*) At 18 months, motor performance seems to be predicted better than does alertness, but is better predicted by alertness tests.

These crude data would indicate that baby test material such as that used in this study is composed of motor tests in abundance. However, those tests which best predict later status are tests of less motor character. The alertness factor at six months cannot be regarded as identical with the alertness factor at 18 months, but the two are similar factors in relation to the total test at each level; the more mental elements, which later become more characteristically motor as they are replaced by more mental elements.

Discussion

The most direct approaches to the effect of age on mental organization have been made by Spearman (18), Garrett, Bryan, and Perl (6), and Anastasi (1). It is rather well shown that as age increases abilities tend to become more and more discrete. Spearman has suggested that the general factor may drop in importance as children grow older. Thurstone, in a recent discussion, feels that:

> If it should be established that the intercorrelation of psychological tests tend to decrease with age, the effect can be interpreted in terms of a rather simple hypothesis. If we assume that the mental abilities of the young child are not clearly differentiated, he will use a wider spread of abilities in solving a problem than later when he can restrict his efforts to those mental abilities that are most appropriate for the problem. This effect is readily seen in the muscular coördination of children in which larger muscle groups are involved than when the same coördination is effected by an older child or by an adult. Examples are early efforts in writing, at the piano, and in typewriting. If the mental abilities become more and more differentiated with exercise and maturity, it should follow that psychological tests become less and less correlated with age (21, pp. 87-88).

Where do these Gesell data fit into this study-picture of the genesis of mental organization?

Genetic data may be considered from two points of view: (*a*) We may define as equivalent sampling any two sections of behavior which use identical test situations and employ the same criteria of response. This means simply that the same tests are used for each age group. But the tests are defined as similar because a similar criterion of performance is maintained. (*b*) The second point of view would define as similar those tests at two different age levels which tended to correlate. This would imply that the underlying factors which two tests shared were of primary importance, and that the nature of the performance was secondary. Stoddard and Wellman have stated this viewpoint rather clearly:

> It is necessary to avoid the error of believing that things contributing to the same general function must themselves be alike or look alike. A task may be performed with or without verbalization, and the two acts appear grossly unlike, yet they may make essentially the same contribution to a pattern of intelligence. For example, the placing of one cube on top of the other by a child may contribute to the measurement of intelligence as adequately as the definition of *pity* fifteen years later.
>
> In measuring intelligence, we are getting at not only ingredients of the whole pattern, but at indicators, surrogates and prognosticators. We need not bother at all about the external appearance of our tests if they are shown (*a*) to be, or to be related to (*b*) to be surrogates of, or (*c*) to predict the likelihood of, *intelligent behavior as defined*. If the goal is not so much to measure intelligence as to analyze the whole behavior pattern of the child, we are of course justified in focusing our attention upon any practical aspect of development or behavior, such as motor skills, speech or ability in spatial relations (19, p. 45).

Since the Gesell items at any two age levels separated by six months are in most cases not identical tests, we cannot consider the material here presented from the first viewpoint. Hence, it is not entirely comparable material to that of Garret, *et al.*

From the second point of view, these Gesell items may be considered as indices of underlying abilities at each age level. The intercorrelations of total tests scores and of factor scores indicated

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earlier in this paper suggest that the 12 months test samples $(72)^2$ or 50 per cent of the six months area, and that the 18 months test measures a smaller portion $(56)^2$ or 30 per cent.

Obviously the group of tests or the area sampled by the tests may be biased in the direction of certain abilities, may measure only a small proportion of the total number of factors demonstrable at each age level, etc. This possibility of uneven sampling is a serious handicap to interpretation of our data. If we could assume that, despite great differences in the apparent nature of the tests used at different age levels, they covered a similar area of behavior, then our age levels would be comparable. On this assumption since within the three age levels here used (6, 12, and 18 months) there was a drop in intercorrelation between test items, there was an increasing discreteness of factors from 6 to 12 months, but a decrease from 12 to 18 months (since the 18 months items intercorrelate more highly than the 12 months). At 18 months there is a drop in correlation when compared with the six months correlation, so that the 18 months level is less highly unified than the six months schedule. But the 18 months series presents a greater unification than the 12 months series.

Three interpretations are possible: If the behavioral areas were equally sampled at each age then (*a*) the situation above might indicate that there was a differentiation of abilities from six months to 12 months: indeed at 18 months there was a differentiation from six months. But between 12 months and 18 months there occurs an integration to some extent. Such an interpretation would suggest that the abilities required to pass items at six months were few, and were common to a large number of tests. At 12 months the abilities required are more diffuse, discrete, and possibly greater in number. At 18 months there is a return to a greater unity or integration of abilities, so that fewer abilities, with greater saturation in tests are in evidence.

A second interpretation is (*b*) that the 12 months sampling is, for some reason, less adequate or even than the sampling at six months and 18 months. Thus, at 12 months we may have sampled only a portion of the core of abilities sampled at six months (and at 18 months). The drop in intercorrelation between tests from six months to 18 months suggests the differentiation principle outlined above. The exaggerated drop from six months to 12 months, and

the increase from 12 months to 18 months suggest that the 12 months sampling is inadequate for some reason, and renders that level less comparable to the other levels. This interpretation suggests immediately that if the sampling at one level is regarded as inadequate, so may the others be inadequate, and it may be entirely idle to compare them in any way.

Another interpretation of the drop and later rise in intercorrelation (c) is that, due to the selection of test items, consciously or otherwise, there is, during the first year, a tendency to sample a wider spread of abilities than at 18 months. In later childhood there is a tendency to select items for their value as correlates with "intelligence." This selection explains the situation found by McNemar (13) to hold for the Revised Stanford-Binet. McNemar found that one factor accounted for the intercorrelation of test items at almost all points. Garrett and his associates, and others, selected their tests not for their tendency to correlate with such a criterion as "general intelligence," but in the hope that they would measure discrete factors, perhaps analogous to those found by Kelley (11), Thurstone (21), and others. As a consequence, such studies present more of a multiple factor picture.

If we assume that the "alertness" factor we found to operate in these early Gesell schedules is comparable or identical with "intelligence," it is logical to suppose that as "intelligence" responses become with increasing age more and more observable, non-mental items are rejected to a greater extent in selecting test material. At the very early age levels, most responses have a heavier non-mental saturation than later, because "intelligence" is less observable, for which there are much less adequately objective crtieria of response.

It is a commonplace thing that evidence for a communality of tests depends very greatly on the tests used (or sampling of abilities). Furfey, Bonham, and Sargent (5) used a group of reflex tests on newborn infants, and found little communality between tests; there was no general factor, and hence, very little evidence for an integration of these responses. This result may be explained at least partly on the basis of the responses used, we believe. That is, the sampling of behavior pattern was not general; it comprised a number of discrete items. If one were to regard these as a fair sampling of mentality or behavior of the newborn infant, then he should regard the result as indicating no unity at all to mental organization at that

level. But it is logical at least to consider the possibility that they do not represent an adequate sampling of mental or behavioral potentiality at that level.

Probably the correct interpretation of our material lies somewhere in the middle ground. Without an abundance of factual material upon which to base our opinion, some such interpretation as this seems possible. From the behavioral point of view, it can be stated generally that the child's behavior becomes more and more "mental" as age proceeds. To this extent, a total section of his behavior will seem less and less non-mental, or "motor." Thus, the selection of Gesell items to give a rough section of behavioral possibilities will include items which, defined behaviorally, or in terms of the conventional psychological categories, will be heavily motor early in life, and less heavily motor—more "mental" later, as language, problem solving, etc., appear.

Conclusions

From six months on there appear to be two factors present in the mental organization of the child. Whether these factors are present before this point, we do not know. The work of Furfey, Bonham, and Sargent would be considered negative (though not strong) evidence that the factors are not clearly present in the newborn infant. Bayley's work would suggest that at about six months the non-motor, or alertness factor first appears.

Whatever the past history of the factors prior to two months, they do possess psychological significance. In general, it may be said that tests heavy in the alertness factor also correlate best with later mental status. As this factor of alertness becomes more and more apparent in the total picture, it becomes incorporated as a greater and greater element in mental tests. Perhaps it is the only important factor in the Stanford-Binet at later age levels (see McNemar, 13). Perhaps it is general in psychological tests to such an extent that it is regarded as *"g"* by those adhering to the bifactor theory. In these early baby tests there is considerable evidence that non-mental functions are considered important in the sampling of behavior. The abundance of these "non-mental" functions probably explains in part, the lack of correlation of later tests with later mental status. But we cannot be certain that ignoring these functions would leave sufficient residue for a psychological test at all. Earlier than six months

there may be no "mental" ability of the type tested later in childhood.

The bifactor analyses did not give results which agreed entirely with those of the Thurstone analyses, but the differences were not marked. On the whole the bifactor analyses discriminated more (group) factors.

REFERENCES

1. ANASTASI, ANNE. Differential Psychology: Individual and Group Differences in Behavior. New York: Macmillan, 1937. Pp. xviii+615.
2. BAYLEY, NANCY. Mental growth during the first three years: A developmental study of sixty-one children by repeated tests. *Genet. Psychol. Monog.*, 1933, **14**, 1-92.
3. ———. The development of motor abilities during the first three years. *Monog. Soc. Res. Child. Devel.*, 1935, No. 1, 1-26.
4. FILLMORE, EVA A. Iowa tests for young children. *Univ. Iowa Stud. Child Wel.*, 1936, **11**, 1-58.
5. FURFEY, P. H., BONHAM, MARTHA A., & SARGENT, MAE K. The mental organization of the newborn. *Child. Devel.*, 1930, **1**, 48-51.
6. GARRETT, H. E., BRYAN, ALICE I., & PERL, RUTH E. The age factor in mental organization. *Arch. of Psychol.*, 1935, No. 176. Pp. 31.
7. GESELL, A. The Mental Growth of the Preschool Child: A psychological outline of normal development from fifth to the sixth year, including a system of developmental diagnosis. New York: Macmillan, 1925. Pp. x+447.
8. HALVERSON, H. M. An experimental study of prehension in infants by means of systematic cinema records. *Genet. Psychol. Monog.*, 1931, **10**, 107-286.
9. HOLZINGER, K. J. Preliminary report in Spearman-Holzinger unitary trait study. Nos. 1-9, Statistical Laboratory, Dept. of Education, Univ. Chicago, 1934-1936.
10. HOLZINGER, K. J., ASSISTED BY SWINEFORD, F., & HARMAN, H. Student Manual of Factor Analysis: An Elementary Exposition of the Bifactor Method and Its Relation to Multiple Factor Methods. Chicago: Dept. of Education, Univ. Chicago, 1937. Pp. 102.
11. KELLEY, T. L. Crossroads in the Mind of Man: A Study of Differentiable Mental Abilities. Stanford University: Stanford Univ. Press, 1928.
12. LINFERT, HARRIETTE-ELISE, & HIERHOLZER, HELEN M. A scale for measuring the mental development of infants during the first year of life. *Stud. Psychol. & Psychiat.*, 1925, **1**, No. 4. Pp. v+33.
13. MCNEMAR, Q. To be published in a forthcoming book on the New Revision of the Binet Tests by L. M. Terman, *et al.*
14. NELSON, VIRGINIA L., & RICHARDS, T. W. Studies in mental development: I. Performance on Gesell items at six months and its predictive value for performance on mental tests at two and three years. *J. Genet. Psychol.*, 1938, **52**, 303-325.

15. ————. Studies in mental development: III. Performance of twelve months old children on the Gesell Schedule and its predictive value for mental status at two and three years. *J. Genet. Psychol.,* 1939, **54**, 181-191.

16. RICHARDS, T. W., & NELSON, VIRGINIA L. Studies in mental development: II. Analysis of abilities tested at the age of six months by the Gesell Schedule. *J. Genet. Psychol.,* 1938, **52**, 327-331.

17. SHIRLEY, MARY M. The First Two Years: A Study of Twenty-five Babies. Vol. I: Postural and Locomotor Development. Minneapolis, Minn.: Univ. Minn. Press, 1931. Pp. 227.

18. SPEARMAN, C. The Abilities of Man: Their Nature and Measurement. New York: Macmillan, 1927. Pp. 416.

19. STODDARD, G. D., & WELLMAN, BETH L. A Manual of Child Psychology. New York: Macmillan, 1936. Pp. 117.

20. THURSTONE, L. L. The Vectors of Mind: Multiple and Factor Analysis for the Isolation of Primary Traits. Chicago: Univ. Chicago Press, 1935. Pp. 266.

21. ————. Primary Mental Abilities. Chicago: Univ. Chicago Press, 1936. Pp. 121.

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