Acta Genet Med Gemellol 36:121-134 (1987)

A New Method for Representing Mental Growth

Ronald S. Wilson
Louisville Twin Study, Department of Pediatrics, University of Louisville, Kentucky

Abstract. A new method is described for plotting the growth in mental development from birth to adolescence. Using data from a large sample of twins followed since birth, a dimension of mental growth was constructed by arraying all tests in order of difficulty, then computing the average gain from age to age. The gain was expressed in standard-deviation units, which reflected the upward shift in the score distribution from time X to time X + 1. When cumulated over ages, the scores generated a mental growth curve for the sample as a whole, as well as for each case individually. The curves displayed a very rapid gain in mental growth over the first 24 months of life, with the complexity of mental functions advancing by nearly 20 standard deviations from birth to two years. Thereafter the gain progressively tapered off until reaching a final increment of 0.5 SD gain between 15 years and adulthood. At this point, the terminal level of mental growth reached an average value of 31 SD units, with a spread of individual differences equal to ± 3 SD units. The scores at each age represented a combination of base level plus gain from the preceding age, and during infancy the gain scores were large in relation to base. At later ages, however, the gain scores were comparatively small, both in absolute terms and in relation to base. These characteristics help explain the typical low-order correlations obtained among mental test scores during infancy, vs the progressively larger correlations obtained at later ages.

Key words: Mental development, Longitudinal study, Mental gain scores, Twins

The Louisville Twin Study has traced the course of mental development for a large sample of twins who have been tested from infancy to adolescence. The testing program has been described in more detail elsewhere [8] but by way of brief summary, the twins were tested every 3 months during the first year, every 6 months during the second and third years, and annually thereafter. When the twins reached 9 years of age, the visits were discontinued until a final follow-up visit was made at 15 years. More than 450 pairs of twins have partecipated in the program, and while many of them have not yet completed the full 15 years, most of the twins have completed at least six consecutive years.

The tests employed were among the most carefully constructed and best standardized tests of intelligence for infants and children [8]. The scores were all in standard-score format, which represented the child's performance at each age as deviation score in relation to the mean and standard deviation for children the same age. This procedure built in necessary age correction and identified the child's ranking in relation to his peers, but of course it removed entirely the actual gains in mental ability that were made from age to age.

In earlier studies before the deviation IQ measure was introduced, the child's test performance was reported in units of mental age, where the succession of items passed was translated into cumulative months of mental age. The tests were constructed so that the mean number of items passed at each age yielded mental-age credits (in months) approximately equal to chronological age. Thus there was a progressive gain in mental-age scores over the course of childhood, and some of the early analyses of intelligence dealt with these cumulative mental age scores [1,2,6].

The measurement of infant mental development from birth to 24 months has always presented a formidable challenge to investigators, and while Bayley's early work [2] employed items that were age-graded for difficulty and furnished a cumulative index of mental growth, it was not until the final published version of the test that the items were carefully metricized on a large standardization sample [3]. By then, Bayley had also adopted the procedure of expressing each infant's test score as a deviation score, with age effects partialled out. The report of raw scores, in terms of the mean number of items passed at each age, was confined to a single table [3, Table 9], and received no further attention. The range of scores, however, extended from $X = 25$ at two months to $X = 145$ at 24 months, indicating the sharp gain in mental ability over this period.

With the extensive data available on the large sample at the Louisville Twin Study, attention was turned to finding an appropriate method for representing mental growth in terms of increments of gain over ages. The basic premise was that an ordered dimension of mental growth gradually unfolds from birth to adulthood, and this dimension is operationalized by a series of test items which are ordered by difficulty from the simplest to most difficult. The items may be age-graded in terms of the earliest age at which 50% of the infants pass the item, and after which a large percentage pass the item.

Once the items are arrayed in this order, the infant is moved through the test until he/she can no longer pass the more difficult items, and the resultant score reflects the total number of items. At the next age, the gain is represented by the additional items passed. The gain then needs to be expressed in some standard-score format that will make possible a comparison of magnitude of gain from age to age.

For the sample as a whole, the gain might be expressed as the upward shift in the raw score mean, which would then be divided by the standard deviation (SD) for age 1 or age 2, if the two SDs were about equal that was rarely the case, and the distributions were not always symmetrical. Therefore, a technique was adopted that would adjust the gain score in relation to the raw-score distribution at each age. With the two distributions arrayed by actual scores and by corresponding centile ranks, the specific raw score was selected that was equally displaced on either side of the median (eg, a raw score of 76 that fell at the 90th centile of the 6-month distribution, and at the 10th centile of the 9-month distribution). The upshift in the distribution was then measured in termes of this reference score, by computing its standard-score value in the distribution at each age.

At 6 months: $(76 - X_6 = 67.2) = 0.99$
$(SD_6 = 8.9)$
At 9 months: $(X_9 = 83.9 - 76) + 1.44$
$(SD_9 = 5.5)$
Total Gain in SD units = 2.43

In terms of mental growth, what this showed was that the distributions of test scores was shifted upward by 2.43 SDs between 6 and 9 months, as a measure of average gain in mental capability during this period.

The same procedure was repeated for all ages at which the Bayley was administered to this large sampe of twins (3 to 30 months), and the gain between successive ages was computed accordingly. At the earliest ages, the gain beween 1 and 3 months was computed from data reported in the test manual [3: p 22]; and since the test is not given to newborns, the gain from birth to one month was set arbitrarily as equal to one-half of the 1-to-3-months gain. In the absence of a newborn measure, the mental capability at birth was designated as the unknown quantity X.

The tests at later ages involved somewhat different formats, but by working with the twins data and the standardization data published in the test manuals, it was possible to employ the same basic method of calculation. In essence, the upshift in test performance between any two ages was expressed in SD units, which represented the average gain in mental growth between, say, 3 and 4 years, or 8 and 9 years.

The gain scores between successive ages are presented in Table 1. By progressively cumulating the gain scores, a mental growth curve was obtained that displayed the course of development in SD units. These values are also shown in Table 1, extending from birth to 15 years. For the sake of completeness, values were computed from the standardization data for those ages at which the twins had not been tested, and these are also included in Table 1.

The curve of mental growth can best be visualized from a graph of the cumulative SD values, and this is shown in Fig. 1.

Perhaps the most compelling feature of the mental growth curve was the dramatic gain over the first 24 months of life, then the gradual tapering off of gain until the curve became barely flat by late adolescence. The rapid rise in the first two years signified a profound expression of capabilities that transformed the primitive reflexes of the neonate into the elementary conceptual and verbal skills of the two-year-old.

It is undoubtedly true that the expansion of capabilities is intimately related to the maturation of the cortex, which renders functional the extensive neural circuits that underwrite learning and memory. It is notable that Blinkov and Glezer, in reviewing the extensive synaptic connections within the cortex that are progressively established during this period, then concluded: "It is during the first 2.5 years after birth that the main processes of formation of higher nervous activity take place" [4: p 193]

This curve differs somewhat from prior curves of mental growth [cf 2] mainly in showing greater initial acceleration through 24 months, and then somewhat reduced increments of gain at later ages. Prior curves have typically been plotted in units of mental age, where the items passed were credited for so many months of mental age, and where the progression in mental age was keyed to chronological age in roughly linear fashion.

With the shift to the deviation-score format, however, the curve of mental growth is now

Table 1. Mental growth: age-to-age gains and cumulative scores

Age period	Gain (in SDs)	Age	Cumulative (in SDs)
Prenatal	X	Birth	X
Birth-1 month	1.67	1 month	1.67
1-3 months	3.34	3 months	5.01
3-6	4.06	6	9.07
6-9	2.43	9	11.50
9-12	2.31	12	13.81
12-18	3.40	18	17.21
18-24	2.27	24	19.48
24-30	1.26	30	20.74
30-36	1.20	36	21.94
3-4 yr	1.81	4 yr	23.75
4-5	1.27	5	25.02
5-6	1.06	6	26.08
6-7	0.89	7	26.97
7-8	0.75	8	27.72
8-9	0.73	9	28.45
9-10	0.50	10	28.95
10-11	0.49	11	29.44
11-12	0.42	12	29.86
12-13	0.22	13	30.08
13-14	0.21	14	30.29
14-15	0.28	15	30.57
15-24 yr	0.50	24 yr	31.07

expressed in terms of the overlapping range of individual differences at each age. As this range expands with age, the raw-score gain between ages becomes of lesser consequence because it is small in relation to the range of individual differences. Thus, the present curve may best reflect the actual curve of mental growth. Between 12 and 24 months, the age gain was so great that the 24-month distribution was elevated completely above the 12-month distribution, representing an upshift of nearly 6 SDs. Between 8 and 9 years, however, the age gain amounted to only 0.7 SD, and the range of individual differences far exceeded the age gain.

With the mental growth curve established for the entire sample, the test scores for all twins were then transformed to cumulative SD scores. These cumulative SD scores furnished the empirical definition of mental growth, and at each age they had a mean value as shown in Table 1, plus a standard deviation of ± 1.0. For those twins who were missing one or two scores throughout the age range due to missed visits, interpolated scores were generated by a special computer program (BMD PAM: Description and Estimaton of Missing Data), using a multiple-regression procedure.

How did the mental growth curves look for individual twins? For clarity of display, the individual curves have been separated into three age periods, so that the scale might be expanded and the trends seen more clearly.

The mental growth curves for a pair of MZ twins are shown in Fig. 2. During the first 12 months, the dramatic age gains were apparent, but the twins had rather different patterns

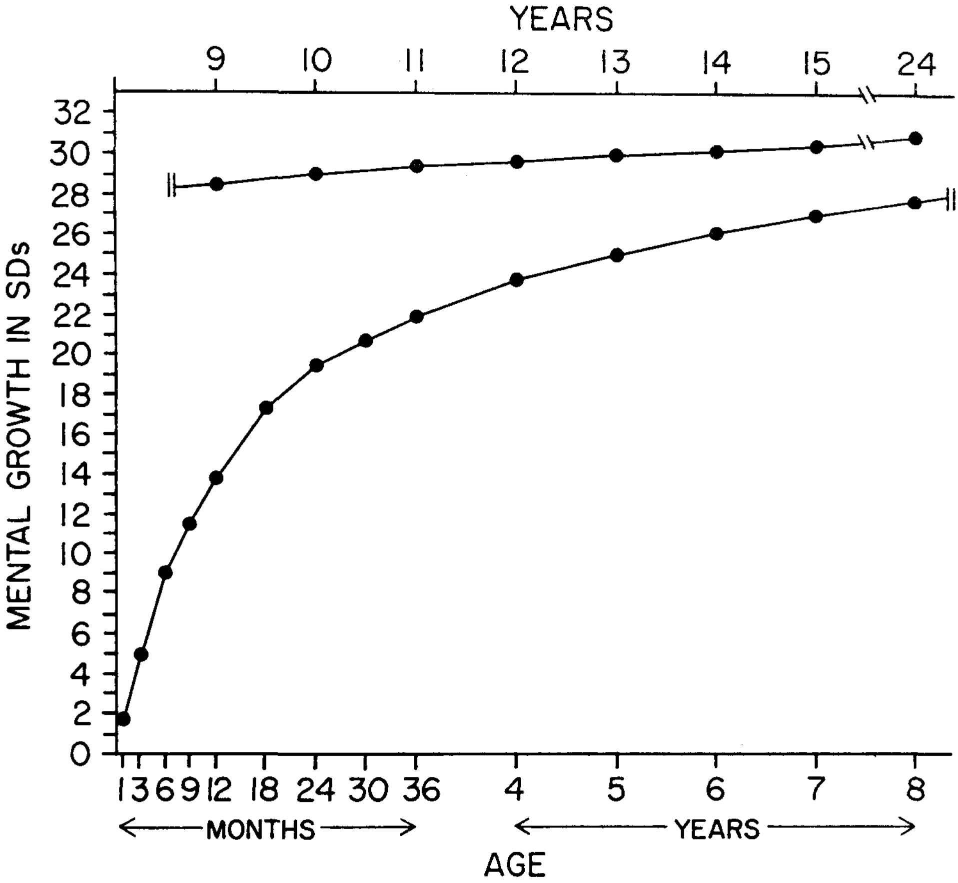

Fig. 1. Mental growth curve in cumulative SD units.

of gain from one age to the next, as reflected in the low value for the developmental synchronies index (DSI = 0.29). In the following period, however, the twins converged markedly by 18 months, and thereafter displayed more concordant growth curves.

The concordant trend was even more pronounced for the growth curves from 3 to 15 years, as displayed in Fig. 3. These MZ twins were closely coordinated for mental growth throughout childhood and adolescence, and the extent of their concordance was reflected in a DSI value of 0.93. So the initial disparities in mental growth were progressively offset during early childhood for these MZ twins, and we might query whether this convergence represented the typical trend for most MZ twins in the sample.

Turning to a pair of DZ twins, their early mental growth curves are illustrated in Fig. 4. During infancy, the twins were moderately concordant, with only one notable discrepancy at 9 months; and in the following two years, the twins' curves were very similar (DSI = 0.90). For this age span, they were more concortant than the preceding MZ twins.

In the ensuing years, however, the DZ twins diverged, and they maintained a steady difference in mental growth that amounted to nearly 2 SDs by 9 years (cf Fig. 5). In this case, the high concordance in the early years was reduced as each twin appeared to get on a separate

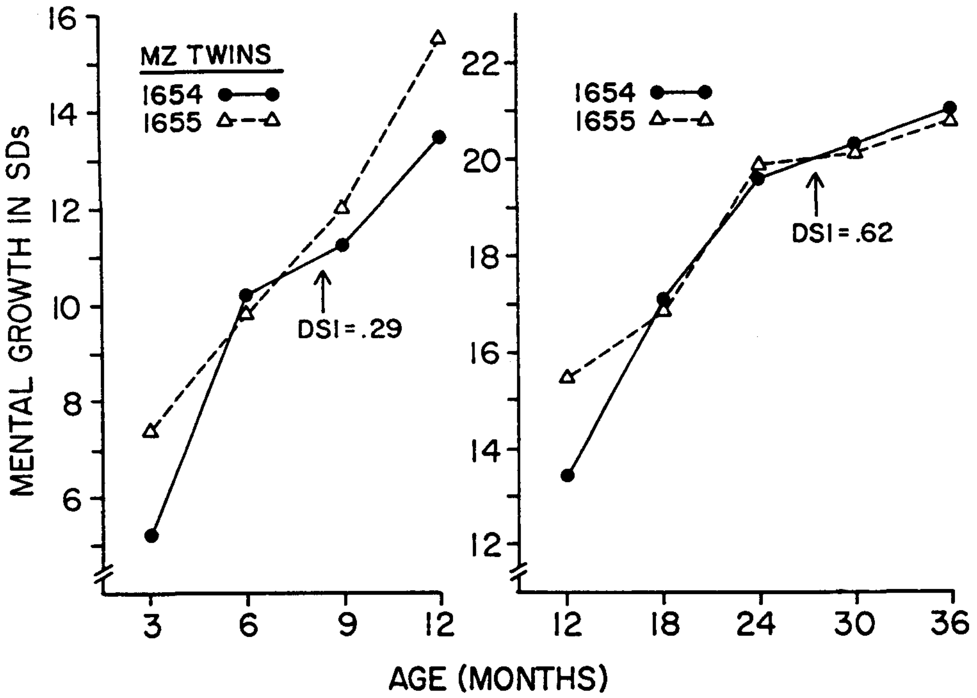

Fig. 2. Mental growth curve in cumulative SD units for a pair of identical (MZ) twins assessed from 3 to 36 months.

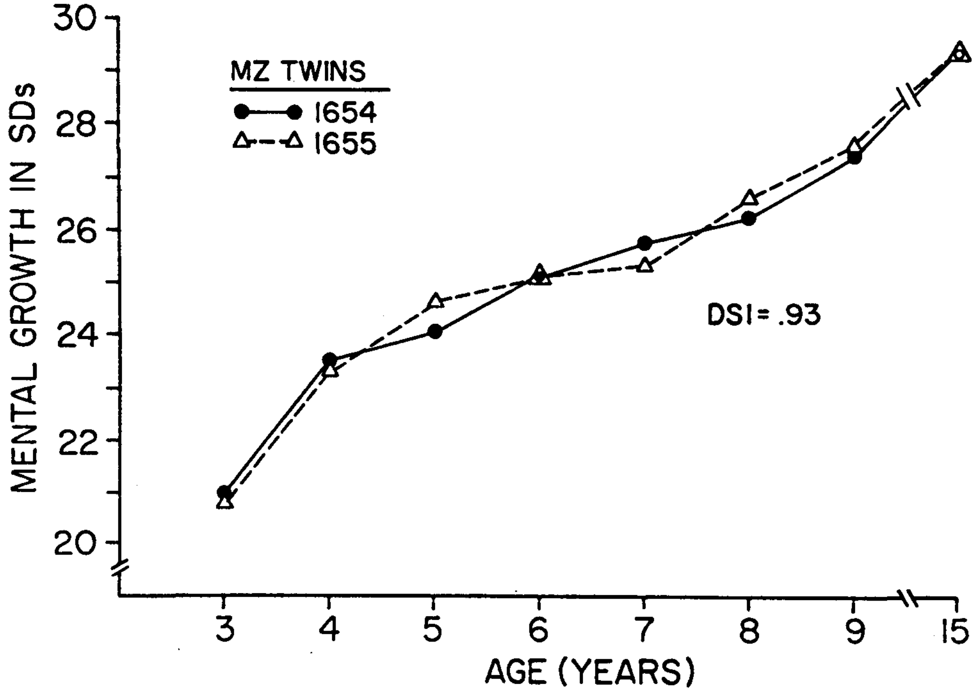

Fig. 3. Mental growth curve in cumulative SD units for a pair of identical (MZ) twins assessed from 3 to 15 years.

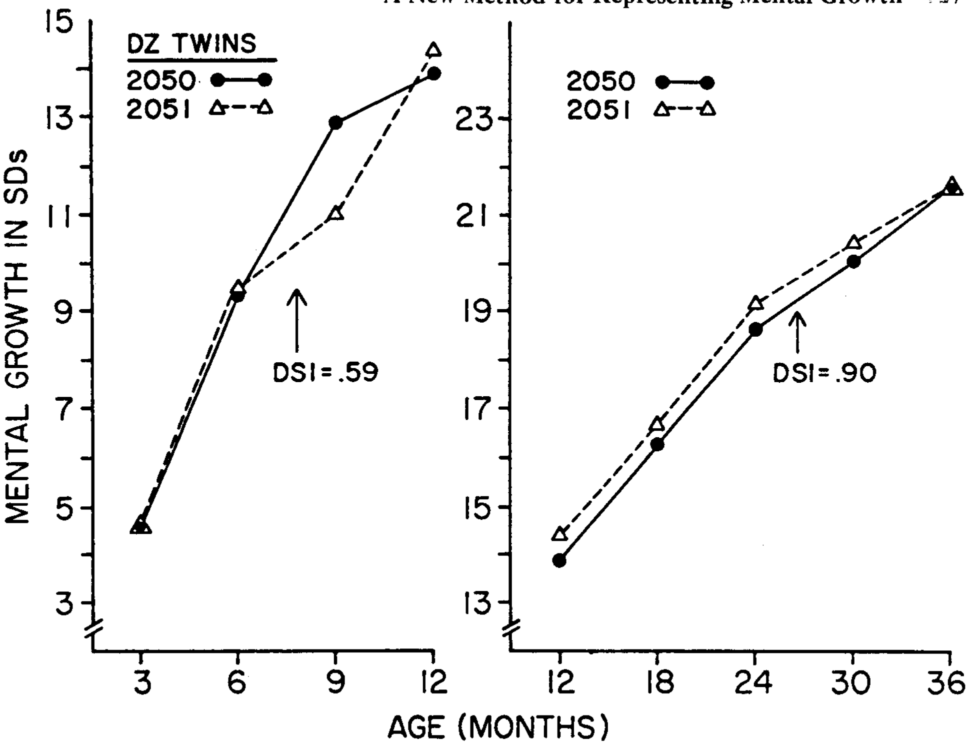

Fig. 4. Mental growth curve in cumulative SD units for a pair of fraternal (DZ) twins assessed from 3 to 36 months.

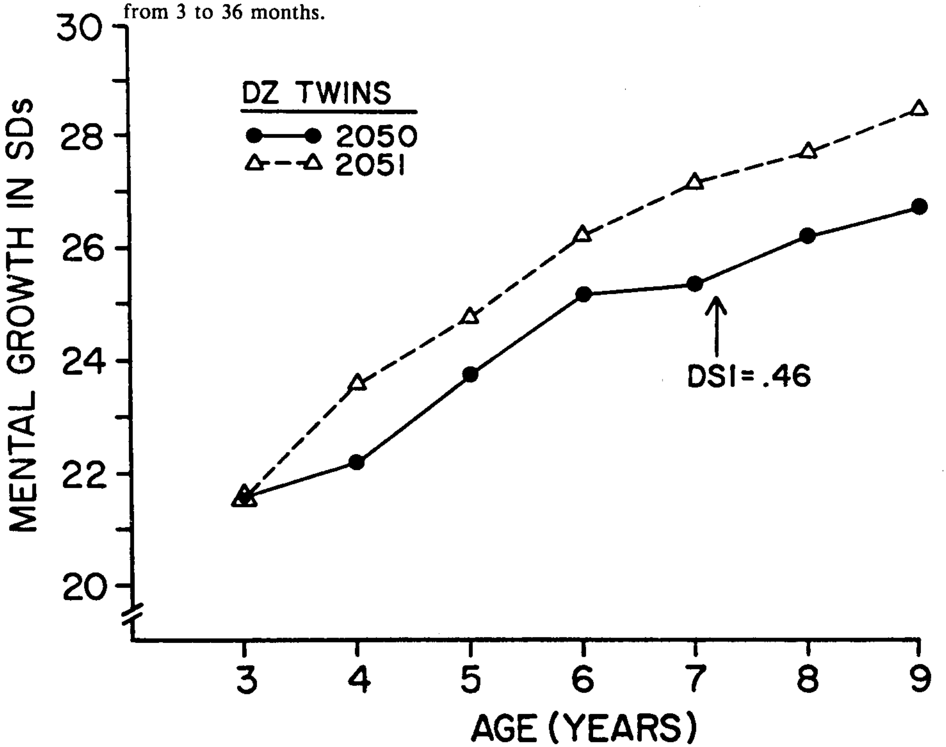

Fig. 5. Mental growth curve in cumulative SD units for a pair of fraternal (DZ) twins assessed from 3 to 9 years.

track, and the question here is whether this particular pair was representative of the trend for most DZ twins.

For a longituadinal sample, the issue of concordance in mental growth may be addressed in two ways: (a) within-pair correlations for MZ twins and DZ twins at each age, and what changes the correlations may show over age; and (b) an assessment of MZ and DZ concordance for the growth curves as illustrated in the preceding figures. In the latter case, the analysis computes the sample-wide concordance for the curves of all twin pairs, and yields an overall correlation comparable to the developmental synchronies index shown for each pair.

The within-pair correlations at each age are presented in Table 2, along with the number of pairs entering into each correlation.

The MZ and DZ correlations did not differ significantly in the first year and apparently such birth-related factors as prematurity and low birth weight may have masked the effects of zygosity in this early period. Beginning at 18 months, however, there was a steady trend for MZ twins to become more concordant over successive ages, while DZ twins regressed to an intermediate level of concordance near $R_{DZ} = 0.60$. As the effects or prematurity, and as each child was drawn insistently towards its own distinctive development pathway, the mental growth scores progressively converged for MZ twins, but diverged for DZ twins. Evidently the genetic influences on mental growth became more sharply drawn over age, and not only enhanced MZ concordance, but also reduced DZ concordance toward a level commensurate with the number of genes shared in common.

Turning to an analysis of the growth curves as previously illustrated in Figs. 2 and 3, the results for the entire sample of MZ twins and DZ twins are presented in Table 3.

During the first year, the mental growth curves were equally concordant for both groups of twins, but in the ensuing periods, the growth curves for MZ twins progressively converged

Table 2. Twin correlations for mental growth scores at each age

Age	Correlations		No. pairs	
	MZ	DZ	MZ	DZ
3 months	0.68	0.68	84	105
6	0.72	0.73	121	121
9	0.65	0.54	115	110
12	0.69	0.59	126	118
18	0.77*	0.66	129	137
24	0.82*	0.73	129	141
30	0.84**	0.67	106	119
36	0.87*	0.81	145	161
4 yr	0.82**	0.69	148	157
5	0.85***	0.66	168	172
6	0.87***	0.60	178	172
7	0.84***	0.64	157	152
8	0.83***	0.64	179	177
9	0.87***	0.60	117	122
15	0.88***	0.62	123	112

* $P < 0.05$, ** $P < 0.01$, ***$P < 0.001$ for $R_{MZ} > R_{DZ}$

Table 3. Twin concordance for mental growth curves

Age period	Trend correlations		No. pairs	
	MZ	DZ	MZ	DZ
3, 6, 9 and 12 months	0.67	0.64	125	123
12, 18, 24, 30 and 36 months	0.80*	0.68	118	118
3, 4, 5, 6, 7, 8, and 9 yr	0.86***	0.67	108	125
9 and 15 yr	0.87***	0.63	133	120

* $P < 0.05$, *** $P < 0.001$ for MZ > DZ

and became highly synchronized. By contrast, the DZ curves showed only a slightly increment in concordance during the childhood years, then by adolescence lapsed back to the initial value. So MZ twins became more closely synchronized for the profile and elevation of the mental growth curve, and ultimately displayed a correlation for the sample as a whole that was very close to the value for the single pair illustrated in Fig. 3. The DZ twins, however, became less synchronized for the pattern of mental growth, with degree of divergence among all pairs that approached the discrepancy shown for the single pair in Fig. 5.

These results, from a large sample and making use of cumulatve SD scores rather than traditional IQ scores, corresponded very closely to previously reported results [8]. The transformation in scores permits us to think of mental development as a process in which an increment of gain is added to the preceding base, and which establishes a new base upon which further increments of gain may be added. The increment is jointly determined by age — large early, but much smaller later — and by individual differences in the pattern of spurts and lags between ages. Each child appears to have a distinctive chronogenetic pattern of gain that is superimposed upon the main age trend, and that moves the child progressively towards the terminal level of intelligence to be reached as an adult.

By conceptualizing the mental growth curves as a cumulative sum of base plus gain scores, some interesting linkages with other results are opened up. In infancy, the gain between ages is large in relation to base, and consequently the gain scores may have a powerful effect in reordering the individual differences between, say, 6 months and 12 months. But at later ages, the gain scores are much smaller in relation to the preceding base (cf Table 1), and the effect of the gain scores is drastically curtailed. In fact, by expressing the mental growth scores in cumulative SD units, the degree of overlap between the capabilities available at any two adjacent ages may be represented as some function of the ratio between the first-age score and second-age score. At early ages, the ratio is comparatively small, while at later ages it approaches unity. A more formal analysis of overlap will be presented later.

The relationship between gain and base is shown in Fig. 6, where the size of the gain at each age is expressed as a percentage of the preceding base. The resultant curve is read against the left ordinate of Fig. 6, and it shows the large gain scores during the first 18 months, where each increment of gain represented more than 20% of the prior base. After 24 months, however, the gain scores represented less than 7% of the base scores, and ultimately declined to 3% at 8-9 years.

These results bring to mind the frequently-observed pattern of correlations between mental test scores obtained during infancy and childhood [2,5,8]. The correlations are relatively

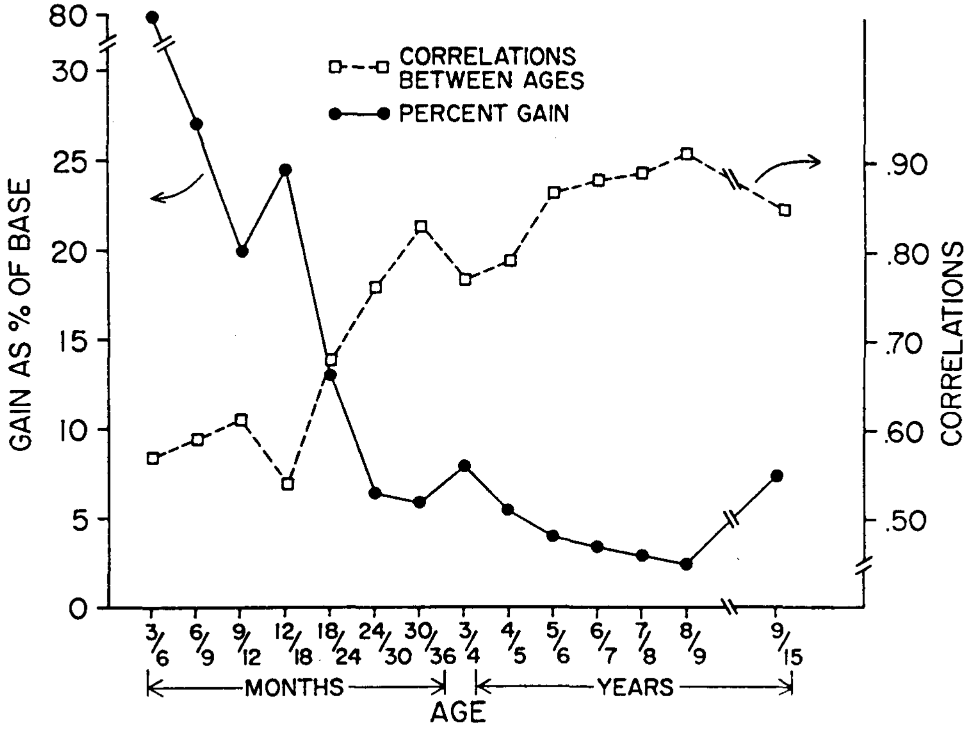

Fig. 6. Percent of gain in SD units of mental growth; and age-to-age correlations for mental test scores from 3 months to 15 years.

low-order at the early ages, even for tests obtained only 3 months apart, but then became progressively larger until reaching r = 0.91 between 8 and 9 years. The correlations for the present sample are plotted in Fig. 6, where the values are read against the right ordinate.

After a series of age-to-age correlations near 0.60 during the first year, the values then rose steadily and approached 0.90 from 6 years onward. Note that the sharp rise in the correlations coincided with the age period in which the gain percent dropped markedly, so age-to-age stability became prominent when the increment of gain was reduced to a small percentage of the prior base.

Following Anderson [1], the expanding correlations between ages may be taken to represent the degree of overlap: r^2 equals the percent of variance in scores at age t accounted for by the prior base scores at age t - 1. At 8-9 years, the overlap accounted for 81% of the variance, while at 12 months the overlap with the preceding 9-months' scores accounted for only 37% of the variance.

Obviously the overlap is inversely related to the gain/base ratio, and it is striking that the two curves cross in dramatic fashion around 24 months. It has also been observed that the prediction of later IQ is significanty improved after 24 months, whereas prediction from first-year scores is very weak [2].

This has been attributed to the emergence of more distinctly conceptual and integrative processes around 24 months, which presage the components of adult intelligence, in contrast to the primitive sensorimotor coordinations of infancy [7]. While this explanation continues to be a plausible description of changing cognitive functions, as will be illustrated later, it is also abundantly clear that changes in the gain-to-base percentage have a direct bearing on the predictive correlations from early to later childhood.

In fact, the complete matrix of correlations between all ages can be constructed from three items of information: (a) the variance of the scores at each base age, (b) the variance of the gain scores between the base age and the later predicted age[1], and (c) the correlation between the gain scores and the base scores. When the scores are in standard-score format, the latter correlation will typically be negative — the large gains will tend to occur for cases that have a low base score, and vice versa. While it is beyond the scope of this paper to construct the complete matrix, the correlation between the mental-test score at any two ages is given by:

$$rx.y = \frac{SDx + (rx.y\ gain)\ (SD\ gain)}{SDy}$$

where
x = base-age standard scores
y = terminal-age standard scores
rx.gain = correlation between base scores and gain scores
SD gain = standard deviation of gain scores, where latter are given by (y - x)
SDx & SDy = standard deviations of base and terminal scores for those cases having scores at both ages, and entering into rx.y.

For example, the actually-computed correlation between the mental test scores at 12 months and 4 years of age was r = 0.31; and when the appropriate values (as shown below) were inserted into the preceding equation, a similar result was obtained:

$$rx.y = \frac{(0.995) + (-0.58)\ (1.18)}{0.994} = \frac{0.311}{0.994} = 0.31$$

For later ages, the variance of the gain scores was reduced and the negative correlation between base and gain was smaller, so the correlation between the two ages was substantially higher. For example, at 5 and 9 years the following values are appropriate:

$$rx.y = \frac{(0.993) + (-0.356)(0.644)}{0.972} = \frac{0.764}{0.972} = 0.79$$

---

[1] While the relationship between base scores, gain, and age-to-age correlations is most easily illustrated by looking at the size of the gain scores, it is actually the variance of the gain scores that affects the correlations. The larger the variance, the greater the effect upon the correlations; and as it happens in this sample, the variance of the gain scores is closely related to their size. Thus the variance of the gain scores drops over ages, roughly parallel to the gain percentage curve shown in Fig. 6, and it is the principal factor in the rising correlations between ages.

The small correlations at early ages, and the progressive larger correlations of later ages, are thus a direct function of the gain scores and their relationship to the base scores. The low order predictability from scores in the first year is not likely to be improved by further refinements in the tests, because of this inherent ceiling imposed by gain scores. The rapid gains in mental growth infancy, and the fact that they are negatively correlated with the preceding base scores, sets a strict upper limit on the predictive power of infant test scores. It is not until 24 months that the gain-score variance, and the negative correlations between base and gain, are reduced enough to yield substantial predictive correlations[2].

Recognizing the extraordinary gains made in the first two years, what advances in capabilities might be inferred from the typical test items that are employed at each age? As mentioned previously, the Bayley items are ordered by difficulty according to the age at which they are first passed, and consequently they top the emerging capabilities that become manifested at each age. Several representative items from the early months are shown in Fig. 7.

At 3 months, the capabilites involve elementary eye-hand coordination, visual tracking, orientation to sound, and the typical insertion of objects into the mouth. There is little to suggest any significant degree of central processing going on.

By 6 months, however, there is evidence of intentionality and an awareness of means-end relationships (pulling string to secure ring), and of using memory to infer the presence of something not currently visible (fallen spoon). Rudimentary as it may seem, it represents an advance of 4 SDs over the primitive sensori-motor coordinations of the previous age.

The prototype items for 12 and 24 months are presented in Fig. 8. If attention is focused on the 24-month items, they illustrate the more advanced and integrative cognitive processes

MENTAL GROWTH
(Items Passed At Each Age)

3 MONTHS

- ☐ **Reaches for dangling ring**
- ☐ **Head follows dangling ring**
- ☐ **Visually tracks rolling ball**
- ☐ **Manipulates edge of table**
- ☐ **Carries ring to mouth**
- ☐ **Turns head to sound**

↓

4.1 SD GAIN TO:

↓

6 MONTHS

- ☐ **Lifts cup with handle**
- ☐ **Looks for fallen spoon**
- ☐ **Retains 2 of 3 cubes offered**
- ☐ **Vocalizes 4 syllables**
- ☐ **Pulls string to secure ring**
- ☐ **Examines details of bell**

↓

4.7 SD GAIN TO 12 MONTHS

Fig. 7. Representative Bayley items that contribute to gain in mental growth for 3 to 12 months.

---

[2] The relationship between base scores and gain scores was explored in an early paper by Roff [6], who applied similar calculations to the data from several studies. These studies typically made use of mental-age scores rather than deviation IQ scores, however, and the correlations between gain were markedly different from study, depending on the variances of the mental-age scores.

MENTAL GROWTH
(Items Passed At Each Age)

12MONTHS

☐ **Puts 3 cubes in box**
☐ **Finds hidden object in box**
☐ **Imitates words**
☐ **Discriminates shapes:○△□**
☐ **Builds tower of 2 cubes**
☐ **Says 2 words**

↓
5.7 SD GAIN TO:
↓
24 MONTHS

☐ **Recognizes incomplete picture**
☐ **Discriminates cup, plate and box**
☐ **Names and points to 7 objects**
☐ **Mends broken doll**
☐ **Solves reversed form board**
☐ **Makes train of 10 cubes**

↓
2.5 SD GAIN TO 36 MONTHS

Fig. 8. Representative Bayley items that contribute to gain in mental growth from 12 to 36 months.

available at this age. For example, recognizing an incomplete picture and mending the doll require a percept of an object as being composed of differential parts, each of which may be separately identified, but which nevertheless combine into a single entity. The items further require the subject's ability to identify the whole when certain parts are missing, a demonstration that the child's internalized image can make a compensatory adjustment for an incomplete model.

Naming and pointing to 7 objects involves word knowledge — the correct association of word with object, and the ability to vocalize the word. These represent the emergent aspects of language, and the emphasis is more on comprehending what the word stands for as a symbol than on articulation skills.

The form-board item requires accurate spatial skills and a sensitivity to form differences, plus an awareness of the match between the block outline and the corresponding hole in the form board. The latter becomes crucial when the form board is reversed.

The final train-of-cubes item involves not only psychomotor dexterity, but perhaps more importantly, sustained goal-oriented activities rather than a drift into egocentric play. The infant must retain the instructions in memory and must organize his production to match the examiner's model, with the necessary intermediate steps of comparison and adjustment.

These capabilities represent a much more advanced mode of central processing than the earlier sensori-motor functions, and in fact they are nearly 6 SDs beyond the cognitive skills of the one-year-old child. While the conceptual grasp of the toddler may seem prosaic and routine to the point of being simplistic when viewed from the adult's perspective, nevertheless it is dramatically advanced beyond the infant's level. It is the prologue of the conceptual and symbolic processes that make up the foundation elements of intelligence in the school-age child and, ultimately, the adult.

Note

During the week prior to Ronald Wilson's death on 16 November 1986, Ron had mentioned several possibilities for revising sections of this paper and completing the Discussion in light of comments and questions received from participants at the ISTS meeting in Amsterdam. His extensive notes and my familiarity with the study led to the completion of this paper up to this section. However, for me to have interpreted Ron's broader view of the data sets would have risked my performing poor service to his careful work. Therefore, the paper abruptly ends with the spirit of Ron's work intact. Whatever errors remain are mine.

Adam P. Matheny
Louisville Twin Study

REFERENCES

1. Anderson JE (1939): The limitations of infant and preschool tests in the measurement of intelligence. Journal of Psychology, 8: 351-379.
2. Bayley N (1955): On the growth of intelligence. American Psychologist 10: 805-818.
3. Bayley N (1969): Bayley scales of infant development. New York: Psychological Corp.
4. Blinkoov S, Glezer II (1985): The human brain in figures and tables: A quantitative handbook. New York: Basic Books.
5. McCall RB, Eichorn DH, Hogarty PS (1977): Transitions in early mental development. Monographs of the Society for Child Development 42: 1-108. (Serial No. 171).
6. Roff M (1941): A statistical study of the development of intelligence test performance. Journal of Psychology 11: 371-386.
7. Wilson RS (1978): Synchronies in mental development: An epigenetic perspective. Science 202: 939-948.
8. Wilson RS (1983): The Louisville Twin Study: Developmental synchronies in behavior. Child Development 54: 298-316.

Correspondence: Louisville Twin Study, Department of Pediatrics, Health Sciences Center, University of Louisville, KY 40292, USA.