INTELLECTUAL DEVELOPMENT OF TWINS — COMPARISON WITH SINGLETONS

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Analysis of mental and motor tests scores and intelligence test performance of twins born in the Collaborative Perinatal Project shows that twins perform more poorly than singletons from the same population and that the differences are greater in Negroes than in whites. The poor performance of twins relative to that of singletons is of complex etiology. It is partly due to poor prenatal environment, for twins brought up as singletons perform at the intelligence level of twins and not of singletons. It may also be partly due to the higher incidence of congenital malformations in twins, especially those of the central nervous system. But the performance of twins, relative to that of singletons, tends to improve as they get older, at least from 4 to 7 years, suggesting that prematurity is also a contributing factor, whose detrimental effects may be reversible.

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This report is still another contribution from the Collaborative Perinatal Project of the United States. In this prospective study about 56,000 women were followed from the first months of their pregnancy through labor and delivery, and the children born to study mothers are being followed through the age of 7 years, in an effort to relate prenatal and perinatal factors to the outcome of pregnancy.

The children were tested at 8 months with a research version of the Bayley Scales of Mental and Motor Development; at 4 years they were tested with the 1960 revision of the Stanford-Binet Intelligence Test, short form; and at 7 years they were given the Wechsler Intelligence Scale for Children (WISC), utilizing seven of the subtests. Thus, it is possible to follow the intellectual development of both twins and singletons in this large population, through the age of 7 years.

In all, 615 pairs of twins were born in the study and the zygosity of most of them was established by comparison of sex, blood types using nine systems, and gross and microscopic examination of the placenta.

It is well known that the mortality of twins is much higher than that of singletons and that most deaths occur during the first four weeks of life. In our material 17.3% of the twins died in utero or during the neonatal period, leaving 487 intact pairs (Myrianthopoulos 1970). In this investigation we have included white and Negro twin pairs whose members were both alive and were both given psychological tests at one or more of the study milestones, i.e., at 8 months, 4 years and 7 years. For one special analysis we used 44 twin individuals whose cotwins died at birth or soon after.

Most analyses will be presented by race since about half of the population of the Collaborative Project is Negro and it is well known that there are significant IQ differences between whites and Negroes in the United States. The causes of these differences, however, are not the focus of this study and will not be discussed. The distribution of the individual twins by zygosity, sex, birth order and race, and

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Table 1. *Means and standard deviations of 8-month Bayley mental scores of twins and singletons*

	White			Negro		
	N	Mean	SD	N	Mean	SD
Twins						
MZ	90	76.2	8.4	138	73.7	10.0
Like-sexed DZ	80	78.1	6.4	90	75.9	10.2
Unlike-sexed DZ	120	77.8	7.1	148	73.3	11.5
Male	142	77.3	7.0	172	73.5	11.6
Female	148	76.9	7.7	204	74.5	9.8
All twins	290	77.1	7.4	376	74.0	10.7
Singletons						
Male	7699	79.5	5.2	8247	78.7	6.3
Female	7339	79.6	5.1	8365	79.0	5.6

of singletons, available for analysis at this time, is given in the tables displaying the results of each test. The socioeconomic background of the families in which the twins were born has been assessed by means of a socioeconomic index which was especially developed to describe the population of the Collaborative Project (Myrianthopoulos and French 1968). The index is a composite numerical score for education, occupation and family income, which runs from a low of 0 to a high of 99. In general, the socioeconomic background of the twins was similar to that of the whole study population.

Table 1 shows the distribution of means and standard deviations of the Bayley mental scale scores of twins and singletons at 8 months of age. The most impressive feature was the fairly large differences between the scores of white and Negro twins, especially in the face of very little difference between white and Negro singletons. The greater variability in the twin scores, especially among Negroes, was due largely to the excess of very low scores.

There were no apparent sex differences. White twins averaged about 3 points below white singletons while Negro twins average about 5 points below Negro singletons. In other words the detrimental effects of being a twin, as reflected in the Bayley mental scale scores, are greter in Negroes than in whites. Among Negroes the like-sexed DZ twins average approximately 3 points above the MZ and unlike-sexed DZ twins.

The Bayley motor scale scores are shown in Table 2. The results are very similar to those discussed

Table 2. *Means and standard deviations of 8-month Bayley motor scores of twins and singletons*

	White			Negro		
	N	Mean	SD	N	Mean	SD
Twins						
MZ	88	30.7	5.9	138	29.7	6.0
Like-sexed DZ	80	30.8	4.8	90	29.6	6.2
Unlike-sexed DZ	120	30.0	5.3	146	29.0	6.7
Male	140	30.5	5.3	171	28.6	6.7
Female	148	30.3	5.4	203	30.0	5.9
All twins	288	30.4	5.4	374	29.4	6.3
Singletons						
Male	7699	32.8	4.8	8247	32.8	4.7
Female	7339	33.1	4.5	8365	33.3	4.4

above, although the difference in variability between scores of twins and singletons was less pronounced. White twins scored about 2 points below singletons while the decrement for Negro twins was nearly 4 points. Females scored slightly higher than males in both races.

The Stanford-Binet IQ scores for twins and singletons at age 4 years are shown in Table 3. The most apparent difference between these results and the results from the Bayley scales was the large race

Table 3. *Means and standard deviations of 4-year Stanford-Binet IQs of twins and singletons*

	White			Negro		
	N	Mean	SD	N	Mean	SD
Twins						
MZ	80	95.6	15.2	126	83.2	14.2
Like-sexed DZ	66	93.4	14.2	82	85.8	14.8
Unlike-sexed DZ	102	96.5	17.3	136	82.9	14.5
Male	123	94.2	15.4	150	83.0	14.6
Female	125	96.6	16.3	194	84.3	14.4
All twins	248	95.4	15.9	344	83.7	14.5
Singletons						
Male	6175	102.8	16.5	7068	90.2	13.9
Female	5738	106.5	16.7	7134	92.5	13.9

effect. This effect was 12 to 13 points, and highly significant. A sex difference in favor of females of 4 points among whites and 2 points among Negroes was noted. In general, the mean IQs of the twins averaged about 8 points below those of singletons.

The results at 8 months are consistent with the observation that tests designed to measure cognitive development during the first 2 years of life usually fail to detect any systematic racial differences It is clear that the kinds of performances sampled at 8 months and 4 years are quite different. In the Collaborative Project, the correlations between Bayley scores and IQ at age 4 years were only 0.22 to 0.25 (Broman et al. 1975).

Table 4 shows the means and standard deviations of WISC IQs at age 7 years. These data are based on smaller samples of both twins and singletons but are still large enough to make meaningful comparisons. Preliminary analysis of these data suggested that the sex, race and twin differences were all slightly smaller at age 7 than at age 4 years. Males scored higher than the females, especially among whites. The race difference was approximately 10 points in favor of whites. The IQs of twins averaged about 5 points lower than singletons among whites and 7 points lower among Negroes. On all the tests, the scores of Negro twins were lower than would be expected from the observed combined Negro decrement and twin decrement.

It is now well-established that the average IQ of twins is from 4 to 7 points lower than that of singletons (Sandon 1957, Drillien 1961, Vandenberg 1968) though in our study the difference extends to 10 points for white females at age 4 years. The etiology of the relatively poor intellectual performance of twins is at present a matter of theorizing and speculation. It is certainly complex, and both prenatal and postnatal deprivation have been invoked to explain it.

The poor performance of twins relative to singletons must be partly due to poor prenatal environment for in our sample twins brought up as singletons scored at the level of twins, not of singletons. Four-year IQs were available for 44 twins, 22 white and 22 Negro, whose cotwins died (N = 42), or were separated at birth or soon after (N = 2). Seven-year IQs were available for 33 of these children. As seen in Table, 5, the mean IQs of twins raised as singletons were practically identical with those of twins raised together in both races. Though our sample of 44 twins raised as singletons was smaller

than that of Record et al. (1970) in which opposite results were obtained, it should be adequate to show such a trend, if it existed. The socioeconomic background of white and Negro twins raised as singletons was not significantly lower than that of twins raised together and could not account for the findings.

It has been shown in an earlier paper (Myrianthopoulos 1974) that twins have a higher risk for mal-

Table 4. *Means and standard deviations of 7-year WISC IQs of twins and singletons*

	White			Negro		
	N	Mean	SD	N	Mean	SD
Twins						
MZ	42	95.7	14.5	88	83.8	13.4
Like-sexed DZ	42	98.5	13.6	42	84.7	13.4
Unlike-sexed DZ	80	96.8	15.5	102	85.2	14.8
Male	80	99.6	15.3	95	84.3	14.7
Female	84	94.4	13.9	137	84.8	13.6
All twins	164	96.9	14.8	232	84.6	14.0
Singletons						
Male	1940	101.9	13.5	1461	91.3	12.6
Female						

formations than singletons, especially of the cardiovascular, alimentary and central nervous systems. This is yet another demonstration of the detrimental effects of the prenatal environment on the development of twins. The extent to which the presence of these malformations contributes to the lowering of IQ scores in twins is not known but is now under investigation.

Twins are generally premature and this must also be considered as a contributing factor. One need only be reminded that singletons of low birthweight in general also perform poorly, at least during early postnatal life. But prematures are known to be able to "catch up" and so, apparently, do twins. A comparison of the performance of the twins on the Stanford-Binet and the WISC showed

Table 5. *IQ scores of twins raised as singletons and raised together*

	Mean 4-yr. IQ	Mean 7-yr. IQ	Mean SE index score
Twins raised as singletons			
White	95.4 (N = 22)	97.0 (N = 18)	51.2
Negro	83.1 (N = 22)	85.3 (N = 15)	37.3
Twins raised together			
White	95.8	97.2	56.9
Negro	84.1	84.0	38.7

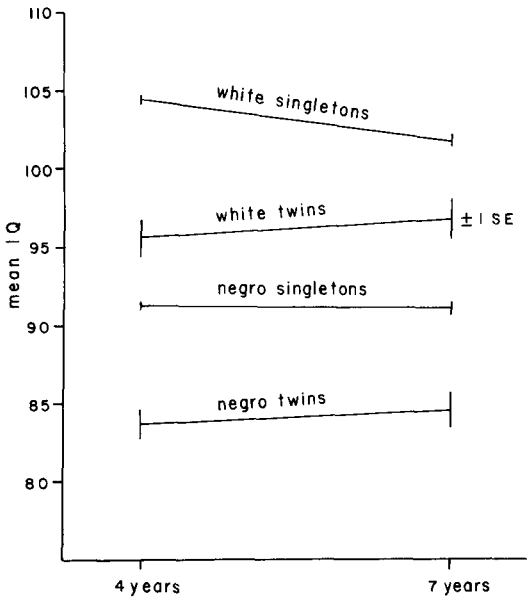

Figure. Change in mean IQ from 4 to 7 years in twins and singletons.

that both white and Negro twins had a slight increase in IQ from 4 to 7 years (Figure). The increase appears to be mostly due to higher performance IQs at age 7 years. It is possible, then, that factors in the environment which affect IQ tend to improve for twins, relative to singletons, and that in time the detrimental effects of prematurity may be partly or wholly reversible.

REFERENCES

Broman S.H., Nichols P.L., Kennedy W.A. (1975). Preschool IQ: Prenatal and Early Developmental Correlates. New York: Lawrence Erlbaum Associates.

Drillien C.M. 1961. A longitudinal study of the growth and development of prematurely and maturely born children. Part VII: Mental development 2-5 years. Arch. Dis. Child., 36: 233.

Myrianthopoulos N.C., French K.S. 1968. An application of the U.S. Bureau of the Census socioeconomic index to a large, diversified patient population. Soc. Sci. Med., 2: 283.

Myrianthopoulos N.C. 1970. An epidemiologic survey of twins in a large, prospectively studied population. Amer J. Hum. Genet., 22: 611

Myrianthopoulos N.C. 1974. Congenital malformations in twins. Proc. Ist. Int. Congr. Twin Studies, Rome. Acta Genet. Med. Gemellol. (Roma), 25: 331-335.

Record R.G., McKeown T., Edwards J.H. 1970. An investigation of the difference in measured intelligence between twins and single births. Ann. Hum. Genet., 34: 11.

Sandon F. 1957. The relative numbers and abilities of ten-year-old twins. J. Roy. Stat. Soc., 120: 440.

Vandenberg S.G. 1968. The nature and nurture of intelligence. In D.G. Glass (ed): Genetics [Chapter 1]. New York: Rockfeller University Press and Russell Sage Foundation.

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