



Eight-Year Follow-up of Cognitive Development in 33 Twin Pairs

B. Alin Åkerman

Department of Special Education, Institute of Education, Stockholm, Sweden

Abstract. This is a follow-up study of twins, including 33 twinpairs from the Stockholm area, aiming to study the cognitive development of twins at eight years of age. The twins have been followed at different ages from birth onwards. All children were tested with the Wechsler Intelligence Scale for Children in a Swedish translation (WISC). The WISC test consists of a Verbal and a Performance Scale. There were no significant differences between twin girls and twin boys on these Scales. On the Performance subtests Block Design, Object Assembly, and Coding, however, the twin girls performed significantly better than the twin boys. In comparing cognitive development for twins and singletons, the twin group had somewhat lower average scores than the singletons. Prematurity and low birth weight continued to be related to cognitive development at eight years of age. Also at this age the school teacher completed a questionnaire about the twins social behaviour and some personality traits. There was a relation between one questionnaire factor, a low score of assertiveness, and the mother's negative or ambivalent expectations concerning the twin pregnancy. The twin group with the mother's negative expectations also had significantly lower results on the subtests Comprehension and Coding. Negative mothers had more premature twins than mothers who were positive toward the twin pregnancy.

Key words: Twins, Cognitive development, Mental development, Prematurity, Birthweight

INTRODUCTION

Prognosis for children born prematurely (< 37 gestational week) or small for gestational age (SGA) has been studied in several investigations [12, 16]. Most of these studies have had a short follow-up time, and lay emphasis on neurological handicaps. From these studies we know that there is an increasing occurrence of cerebral palsy, especially for those with the lowest birthweights. The children who are small for gestational age (SGA) are exposed to a larger risk to develop other neurological handicaps.

Some studies have compared the mental development to IQ-tests between low-weighted and normal-weighted twins [10, 20, 21]. They have found differences in these groups with lower IQ for the children with low birth weight. Other studies on mental development have shown a lag in development of twins compared to singletons, especially with respect to cognitive performance and language development [9, 15, 19]. A follow-up of locomotor and language development in 34 twin pairs [3] has shown no differences in language, locomotor or total mental development between full term twins and singletons at four years of age. Also, twins who weighed less than 2,500 g at birth, either because of immaturity or because of growth retardation, had significantly lower locomotor and total scores. It is therefore of interest to study longitudinal development in this group at eight years of age who had been followed closely from birth. The focus is on language and performance fields. In this study I want to examine whether the differences between low birth weight premature twins compared to normal birth weight twins in intellectual capacity was as low as at four years of age. At that time the premature low-birth weight children had lower results at the mental development scale. I have chosen to meet the twins at eight years of age in the first grade at school just to compare the teachers evaluations and the results from the development scale.

The Stockholm study of twins started in 1982, with 34 twin pairs who were tested from infancy to eight years of age. The testing program has been described in detail in previous papers [3, 4]. In the Stockholm twin-study the parents to be were interviewed during pregnancy about their expectation of having twins [1]. Observations were made, during the first week after the delivery, on the interaction between mother and twins and also on father's interaction with twins. Assessments were done at nine months, 18 months, four years and eight years of age. Their mental development was described by using the Griffiths Mental Development Scale at the first three occasions.

MATERIAL AND METHODS

The Wechsler Intelligence Scale for Children [18] was used at eight years of age to estimate children mental development. The WISC test consists of a Verbal and a Performance Scale, each with six subtests. In my study all subtests except the Mazes subtest of the Performance Scale were included. The raw scores for each child were transformed to an age-related stanine score. The mean score of each subtest was originally five, but it has been gradually elevated to six in Sweden [17]. The full scale score was the sum of stanine scores of all subtests. This sum was also transformed to stanine scores. The Student's t-test was used and $p < .05$ was regarded as significant. The reliability coefficient of the test in the WISC scales are 0.96 for the Verbal IQ, 0.90 for the Performance IQ and 0.96 for the Full Scale IQ at this age [18]. The differentiating power might be less at the far right end of the distribution since the test results are positively skewed [17].

At the same time the twins were asked to "draw a person" by using a technique described in a study [13]. This technique has been applied to increase the knowledge about a possible relationship between the way of drawing and general intellectual devel-

opment. It is believed that these drawings provide an alternative mean for the study of mental growth [13]. The average correlations with the Stanford-Binet mental age is 0.76 for the age groups 4 to 12 taken separately. Significant correlations have also been obtained with other standardized intelligence tests. Instructions to twins were: "On this paper I want you to make a picture of a person. Make the very best picture that you can". Drawings were estimated by counting all details in the figure and translated to a scale with 100 as mean value. Boys and girls were coded separately.

Children's teachers were asked to fill in a questionnaire to estimate the social competence as well as personality of these children. This questionnaire consisted of 52 items with the aim to give a picture of child's persistence and independence in a school situation, capacity to adjust to and handle various social situations, ability to interact and cooperate with others and similar social skills. Teachers rated how well each description fit the child, using a five-point scale from "does fit very well" to "does not fit at all". To validate the preliminary classification into different dimensions I used a factor analysis described in a study [5]. Nine factors consisting of 38 items were considered meaningful and interpretable. These factors are: 1. persistence and independence, 2. social confidence, 3. short temper and impulsiveness, 4. peer contacts, 5. verbal facility, 6. attentiveness vs. distraction, 7. anxiety, 8. assertiveness and 9. transition to preschool-school. The Cronbach's alpha coefficients were calculated in the Anderson study and varied from 0.96 to 0.70 with a mean value of 0.87. In this paper the sample is somewhat smaller but still the reliability of these scales can be considered sufficient.

Zygoty was based on histological examination of foetal membranes and/or blood typing.

The group consists of 33 twin pairs of whom 13 are monozygotic (MZ). One family has left the country and I have not been able to locate them. Thirty-six are girls and 30 boys. Six children were born with physical handicaps; one had a distal myelomeningocele (MMC), one twin pair had craniosynostosis of a sagittal suture, and three infants showed significant skeletal malformations. None of the twins had any signs of cerebral injury at birth.

I have met the families in their homes 7 days prior to, or 7 days after, the eighth birthday of the twins. Both parents were usually present.

Most families live under good socioeconomic circumstances. Six parents are divorced or do not live together. Most twins are raised by their mother or by both their mother and father.

Table 1 - Distribution of twin pairs by sex and zygoty

	MZ pairs	DZ pairs	Total
Female	9	5	14
Male	4	7	11
Different sex	–	8	8
Total	13	20	33

Table 2 - Distribution of birth weights

	Birth weight (g)			Total
	< 2000	2001-2499	≥ 2500	
Female twins	5	9	22	36
Male twins	13	8	9	30
Total	18	17	31	66

A total of 22 children (32%) had physical or psychological problems [4]. These complications influenced primarily the locomotor, language/speech and emotional development scales.

The ethical committee of Karolinska Hospital approved the investigation.

RESULTS

The distribution of twin pairs by sex and zygosity is shown in Table 1. The average birth weight for the 30 twin-boys was 2240 g and for the 36 twin girls 2526 g. MZ twins were slightly heavier than DZ twins. Most of them are girls and this might explain the difference in birth weight between MZ and DZ twins. The weight distribution of the 66 twin boys and twin girls at birth is shown in Table 2. Infants who had lowest weight at birth were male twins.

Table 3 summarizes mental development expressed in mean WISC scores for twin girls and twin boys. There were no significant differences between twin girls and boys on the Verbal and total Performance Scales. In the Performance subtests: Block Design, Object Assembly and Coding, however, twin girls performed better than boys. When comparing cognitive development for twins and singletons, twins had a little lower average scores than singletons. The study of the singleton group is described in a study [17]. This singleton group is not separated according to sex and yields only one child who fulfilled the psychometric criterion of mental retardation or other physical problems.

There were no significant differences between MZ and DZ twins at eight years of age. The mean results for MZ and DZ on the Verbal scale, Performance scale and the total WISC are summarized in Table 4.

Thirty-five twins had a birth weight of less than 2500 g. The differences between low birth weight twins vs. those of normal birth weight were not significant on the verbal part of the WISC scale except for the subtest arithmetic. On the performance part of the scale there is a tendency for lower results for the low birth weight group but no subtest shows significant differences between the two group (Table 5).

When the twins were four years of age I was told by the parents that a total of 22 children had physical or psychological problems. Apart from the six earlier diagnosed children with physical handicaps, eight twins were delayed in their locomotor development, two had hearing problems, one a visual problem, eight were delayed in their lan-

Table 3 - Mental development (Mean WISC score) for the twins related to sex

	Male (n = 30)		Female (n = 36)		Singletons
	M	SD	M	SD	(n = 392)
Information	5.8	2.16	5.86	2.53	5.51
Comprehension	5.73	1.64	5.64	2.13	5.90
Arithmetic	3.77	1.81	4.56	1.98	5.47
Similarities	4.77	2.16	5.25	2.40	5.56
Vocabulary	5.67	1.94	5.61	2.14	6.52
Verbal sum	5.27	1.76	5.56	2.37	6.02
Picture Completion	4.38	1.50	4.61	1.38	4.99
Picture Arrangement	5.40	2.08	5.44	2.30	5.50
Block Design	4.43*	2.05	5.36*	1.84	5.63
Object Assembly	3.70**	1.62	4.89**	1.47	5.38
Coding	3.50*	1.61	4.56*	2.09	6.17
Performance sum	4.13	1.53	4.81	1.80	5.76
WISC WHOLE	4.63	1.65	5.28	2.33	6.05

* $p < 0.05$ ** $p < 0.01$

Table 4 - Mean Verbal, Performance och Total WISC related to zygosity

	M,Z (n = 26)		DZ (n = 40)	
	M	S	M	SD
Verbal Sum	5.69	2.31	5.25	1.97
Performance sum	4.50	1.70	4.50	1.73
WISC whole	5.19	2.28	4.85	1.92

guage development and two of the twins were emotionally disturbed. A comparison between this group (with any form of physical or psychological problems) and the rest of the twins is summarized in Table 6. The differences are significant for all the subtests except comprehension and for the total scale.

When comparing the rest of the twin group to the twins whose mothers were negative or ambivalent concerning the twin pregnancy, these twins had significantly lower results on the subtests Comprehension and Coding, which is illustrated in Table 7.

The results for the socioemotional variables assessed by the children's teachers were similar for twins and singletons (Table 8). Both twin girls and singleton girls were rated as more persistent and independent and also more attentive to the school situation than boys. There are no differences between twins and singleton girls. There is a relationship

Table 5 - Mental development (Mean WISC score) in twins related to birthweight

	< 2500 g (n = 35)		≥ 2500 g (n = 31)	
	M	SD	M	SD
Information	6.06	2.08	5.58	2.67
Comprehension	6.00	1.68	5.32	2.10
Arithmetic	3.71*	1.62	4.74*	2.13
Similarities	5.06	2.21	5.00	2.41
Vocabulary	5.07	1.90	5.23	2.10
Verbal sum	5.51	1.79	5.32	2.84
Picture Completion	4.46	1.40	4.55	1.48
Picture Arrangement	5.43	2.24	5.42	2.16
Block Design	4.74	1.93	5.16	2.04
Object Assembly	4.11	1.66	4.61	1.61
Coding	3.77	1.59	4.42	2.26
Performance sum	4.37	1.50	4.65	1.92
WISC WHOLE	4.94	1.80	5.03	2.35

* p < 0.05 ** p < 0.01

Table 6 - Mental development (Mean WISC score) in twins with physical and psychological disorders (group I) compared to those without (group II)

	Group I (n = 21)		Group II (n = 45)	
	M	SD	M	SD
Information	4.91*	2.63	6.27*	2.10
Comprehension	5.24	2.17	5.89	1.76
Arithmetic	3.14**	1.78	4.69**	1.81
Similarities	4.10*	2.02	5.47*	2.92
Vocabulary	4.86*	2.93	6.00*	1.76
Verbal sum	4.33**	2.22	5.93**	1.86
Picture Completion	3.75*	1.53	4.76*	1.32
Picture Arrangement	4.48*	2.23	5.87*	2.04
Block Design	4.14*	2.27	5.31*	1.73
Object Assembly	3.57**	1.60	4.71**	1.55
Coding	3.14**	1.39	4.51**	2.03
Performance sum	3.57**	1.54	4.93**	1.62
WISC WHOLE	3.81***	1.94	5.53***	1.89

* p < 0.05 ** p < 0.01 *** p < 0.001

Table 7 - Mental development (Mean WISC score) in twins related to the mother's expectations of the twin pregnancy

	Positive (n = 44)		Negative/ambivalent (n = 22)	
	M	SD	M	SD
Information	6.04	2.36	5.36	2.32
Comprehension	6.00*	1.88	5.05*	1.84
Arithmetic	4.41	1.92	3.77	1.93
Similarities	5.11	2.37	4.86	2.17
Vocabulary	5.59	1.93	5.73	2.27
Verbal sum	5.64	1.99	5.00	2.31
Picture Completion	4.52	1.47	4.46	1.37
Picture Arrangement	5.64	2.23	5.00	2.07
Block Design	4.93	2.12	4.96	1.70
Object Assembly	4.48	1.68	4.09	1.57
Coding	4.41*	1.91	3.41*	1.89
Performance sum	4.66	1.82	4.18	1.44
WISC WHOLE	5.18	2.12	4.59	1.92

* $p < 0.05$

between the subfactor assertiveness as rated with low score by the teacher and the mother's negative or ambivalent expectations concerning twin pregnancy.

A comparison in test results of "drawing-a-person" according to sex, zygosity, prematurely-born, SGA and physical or psychological problems is illustrated in Table 9. The differences are significant in all comparisons except zygosity.

DISCUSSION

Earlier studies have shown that twins were slightly behind singletons in intelligence up to four years of age. It was [9] found that twins were inferior to singletons on virtually all language measures at this age. A South Africa research project, comparing twins and singletons, showed that a significant difference was still present at 14-15 years of age. This finding applied not only to the verbal IQ scale but also the performance scale [8]. In the Louisville Study it was found that although twins were relatively behind at 18 months compared to singletons, they had caught up by their sixth birthday and by this age there were no significant differences between twins and singletons [19]. The children in the Louisville study were six years of age when no significant differences between twins and singletons were found. An analysis between twins and singletons at eight years of age might have resulted in differences between the two groups.

Table 8 - Socioemotional variables for twin boys (n=30) and twin girls (n= 36) compared to singleton boys (n = 52) and singleton girls (n = 62)

	Twin boys		Twin girls		Singleton boys		Singleton girls	
	M	SD	M	SD	M	SD	M	SD
Persistence and independence	37.5**	10.46	44.75**	9.62	41.31***	12.00	47.62***	10.20
Social confidence	19.08	5.62	20.69	7.56	17.17	5.75	20.69	6.17
Short temper and impulsivity	20.88	4.13	20.78	4.79	18.83	5.48	20.17	5.27
Peer contacts	17.19	4.05	17.19	3.23	17.18	2.67	17.27	3.18
Verbal facility	11.48	3.20	12.25	3.42	12.52	2.29	12.74	2.81
Attentiveness vs distractibility	12.01*	3.08	13.66*	1.93	11.89***	3.32	13.56***	2.27
Anxiety	13.30	1.51	13.06	2.20	12.93	2.44	13.56	1.79
Assertiveness	5.56	1.76	6.41	2.13	5.86	1.97	6.56	2.14
Transition to preschool-school	24.40	5.76	24.12	5.30	24.54	4.62	26.34	3.97

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

It has been reported that a group of low birth weight children born in 1966 often were assigned to special education in grade 1 and had more difficulties regarding attentiveness at school [6].

In the Stockholm Metropolitane project we found differences between low birth weight boys still at 18 years of age compared to those with normal birth weight [2].

In this study of the Stockholm twin group, I have found significant differences between twin boys and singleton boys, but not between twin girls and singletons girls at four years of age [4]. The most obvious problem for the twin boys up to four years of age has been the locomotor and perceptual development. The malformations of the six children should however not affect this mental development.

As far as language development is concerned, I have not found any differences at any age earlier. But at eight years of age there are differences between twins and singletons in both the verbal and the perceptual parts of the measurement scale. I can also assume that low birth weight twins still at eight years of age seem to have some lasting impact on mental development. It is also a difference between twins and singletons irrespective of birth weight. Something must have happened between four and eight years of age.

One of my hypothesis is that this difference can be due to the fact that children at this age need to have more verbal and intellectual contact with their parents when starting school and in reading and learning processes. It will be more obvious that a parent-twin

Table 9 - "Drawing-a-person-test" of twins in relation to sex, zygosity, prematurebirth, small-for-date and physical or psychological impairment

	N	M	SD
Male	30	90.30***	12.9
Female	36	109.36***	16.32
Monozygotic	24	104.70	16.69
Dizygotic	42	98.41	17.87
Prematurely born	28	94.07**	17.85
Not prematurely born	38	105.58**	15.91
SGA	18	93.39*	14.10
Not SGA	48	103.44*	18.11

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

triadic interaction situation is more common than a dyadic one and it is perhaps more important to try to create a dyadic situation between one twin and his parent. Those twins who had a severe start in life: SGA, premature born and/or with physical and psychological disorders are obviously more sensitive when starting school. Another interpretation is that as the school situation is quite different compared with the pre-school situation this may influence children's concentration capacity and also their possibility to learn.

The study has not shown any significant differences between twin boys and twin girls using the WISC. There is however a tendency that girls perform better than boys although without significant differences. Differences between monozygotic and dizygotic twins were not expected as I have not found any at earlier measurements. The monozygotic twins in the Project Metropolitan in Sweden [2] performed less well than the dizygotic twins, but those twins were at ages 13 and 16 and not comparable with the Stockholm group. But the differences are obvious when using the "draw-a-man" test. One hypothesis can be that this test also measure the childrens body image and self-confidence. This can reflect their learning situation at school and explain why girls are more persistent and independent and more attentive than boys.

In summary it is important particularly for teachers to recognize that twins may have problems when starting school and that they need to be treated individually. If teachers can appreciate the adjustment issues faced by twin families, they can begin the orientation process from a sensitive and empathetic perspective.

Acknowledgements: I am grateful to Mrs Evy Blid-Andreason for her help to code the drawings and the questionnaires from the teachers. The study would not have been possible without the cooperation of parents, school teachers and the participating twins.

REFERENCES

1. Alin Åkerman B (1987): The expectation and parentage of twins. A study on the language development of twin infants. *Acta Genet Med Gemellol* 36: 225-232.
2. Alin Åkerman B, Fischbein F (1991): Twins: Are They at Risk? A longitudinal study of Twins and Nontwins from Birth to 18 Years of Age. *Acta Genet Med Gemellol* 40: 29-40.
3. Alin Åkerman B, Thomassen PA (1991): Four-year follow-up of locomotor and language development in 34 twin pairs. *Acta Genet Med Gemellol*: 36: 225-232.
4. Alin Åkerman B, Thomassen PA (1992): The Fate of "small twins": A Four-year Follow-up Study of Low Birthweight and Prematurely Born Twins. *Acta Genet Med Gemellol*: 41: 97-104.
5. Andersson B-E (1989): Effects of Public Day-Care: A Longitudinal Study. *Child Development*. 60: 857-866.
6. Bjerre I, Hansen E (1976): Psychomotor development and school-adjustment of 7- year-old children with low birthweight. *Acta Paediatrica Scand*. 65: 88-96.
7. de Chateau P (1989): Det ofödda barnets upplevelse (The experiences of the nonborn baby). *Psykisk hälsa* 3: 213-227.
8. Clark PM, Dicman Z (1984): Features of Interaction in Infant Twins. *Acta Genet Med Gemellol* 33: 165-171.
9. Day E (1932): The development of language in twins. A comparison of twins and single children. *Child Dev* 3: 179-199.
10. Drillien CM, Thomson AJM, Burgoyne K (1980): Low-birthweight children at early school-age: A longitudinal study. *Develop Med Child Neurolog* 22.
11. Fischbein S (1978): School Achievement and Test Results for Twins and Singletons in Relation to Social Background. *Twin Research: Psychology and Methodology*. Alan R. Liss, Inc. N.Y. 101-109.
12. Fitzhardinge PM (1976): Follow-up studies on the low birth weight infant. *Clin Perinatol* 3: 503-16.
13. Goodenough F (1954): Measurement of intelligence by drawings. New York and Burlingame. Harcourt, Brace & World, Inc.
14. Lagerström M, Bremme K, Eneroth P, Faxelius et al. (1991): WISC-test scores at the age of 10 for children born to women with risk pregnancies. *J Perinat. Med*. 19: 269-283.
15. Mittler P (1979): Biological and social aspects of language development in twins. *Dev Med Child Neurol* 12: 741-757.
16. Neligan GA, Kolvin I, McScott D, Garside R-F (1976): Born too soon or born too small. *Clin Dev Med No* 61. London. Heinemann.
17. Sonnander K (1990): Prevalence of mental retardation: An empirical study of an unselected school population. In: Fraser WI: Key issues in mental retardation research. Proceedings of the Eighth Congress of the International Association for the Scientific Study of Mental Deficiency. London: Routledge.
18. Wechsler D (1992): Wechsler Intelligence Scale for Children – Third Edition. Manual. The Psychological Corporation. Harcourt Brace Jovanovich, Pub.
19. Wilson RS (1975): Twins. Patterns of cognitive development as measured on the Wechsler Pre-school and Primary Scale of Intelligence. *Dev. Psychol* 11: 126-134.
20. Wilson RS (1983): Developmental Synchronies in Behaviour. *The Louisville Twin Study*. *Child Development* 54: 298-316.
21. Wilson RS (1984): Twins and Chronogenetics: Correlated Pathways of Development. *Acta Genet Med Gemellol* 33: 149-157.

Correspondence: PhD Britta Alin Åkerman, Institute of Special Education, P.O Box 47308, 100 74 Stockholm, Sweden.