
What Effect Does Classroom Separation Have on Twins' Behavior, Progress at School, and Reading Abilities?

Lucy A. Tully¹, Terrie E. Moffitt^{1,2}, Avshalom Caspi^{1,2}, Alan Taylor¹, Helena Kiernan¹, and Penny Andreou¹

¹ Institute of Psychiatry, King's College London, UK

² University of Wisconsin, Madison, USA

We investigated the effects of classroom separation on twins' behavior, progress at school, and reading abilities. This investigation was part of a longitudinal study of a nationally-representative sample of twins (the E-risk Study) who were assessed at the start of school (age 5) and followed up (age 7). We examined three groups of twins: pairs who were in the same class at both ages; pairs who were in separate classes at both ages; and pairs who were in the same class at age 5, but separated by age 7. When compared to those not separated, those separated early had significantly more teacher-rated internalizing problems and those separated later showed more internalizing problems and lower reading scores. Monozygotic (MZ) twins showed more problems as a result of separation than dizygotic (DZ) twins. No group differences emerged for externalizing problems, ADHD or prosocial behaviors. The implications of the findings for parents and teachers of twins, and for school practices about separating twins, are discussed.

When twins start preschool or elementary school, parents frequently ask whether or not classroom separation will be beneficial for the cognitive, social and emotional development of the twins (Bryan & Hallet, 2001; Segal & Russell, 1992). In some schools, the decision about classroom separation of twins is left entirely up to the parent, in consultation with the child's teacher or school principal. However, it is not uncommon in schools in the United Kingdom and elsewhere in the world for decisions about separating twins to be made by educators alone, without the input of parents (Gleeson et al., 1990; Preedy, 1999; Segal & Russell, 1992). The rate of twin births has increased significantly in recent decades due to improvements in artificial reproductive technologies and the trend toward delaying childbirth, since multiple births occur more frequently among older mothers (Luke & Keith, 1992; Ventura et al., 2000). Despite the increase in twin births, and the increase in the number of twins in school, there is a paucity of research comparing the

adjustment of twins who are separated versus kept together at school, so decisions about separating twins are presently not evidence-based. The aim of this longitudinal study was to determine what effect, if any, classroom separation had on twins' behavior, progress at school and their reading abilities.

The issue of classroom separation of twins has been of interest since the 1960s when Koch (1966) conducted the first and only study to investigate the effects of separation on twins' adjustment. This study found that separated twins performed better than twins placed together: they showed more advanced speech and greater IQ differences within twin pairs. However, the significant methodological problems with this study make interpretation of the findings difficult. While there is a lack of contemporary research about the effects of classroom separation on twins' behavior and development, there is some survey research about school practices and parental attitudes toward the separation of twins.

Three surveys have been conducted with teachers and parents on the topic of classroom separation of twins. The Australian survey (Gleeson et al., 1990) found that 10% of teachers reported that it was official school policy to separate all twins without exception. This survey also found that 30% of parents reported that they were not consulted by teachers about whether or not to place twins in separate classes and an additional 40% of parents felt they were inadequately consulted. The American survey (Segal & Russell, 1992) found that almost half of the parents in the survey who were aware of a mandatory policy on separating twins at school did not endorse this practice. The UK survey obtained similar findings (Preedy, 1999; 2001). While most parents reported that they expected their children to be in separate

Received 16 June, 2003; accepted 15 December, 2003.

Address for correspondence: Professor Terrie E. Moffitt, Box Number P080, SGDP Centre, Institute of Psychiatry, De Crespigny Park, London SE5 8AF, England. Email: t.moffitt@iop.kcl.ac.uk.

classes by the time they reached secondary school, many felt they had been inadequately consulted about whether or not the twins should be separated at an earlier stage. Of the schools surveyed, only one in four reported that they regularly consulted parents about the decision to separate twins and half reported that they made decisions without consulting parents at all. This survey also found that only 1% of schools had official written policies about the education and management of multiple birth children, but despite this, 7% of schools reported that they always separated twins and 23% reported that they always kept them together (Preedy, 2001). These contradictory findings suggest that while almost all schools reported that they did not have formal policies about classroom separation, one-third of them implemented practices that applied to all twins.

The results of these surveys clearly demonstrate that schools in the UK, Australia and the United States (US), often do not take parents' views about separation into consideration and some even endorse practices that apply to all twins. The rationale for encouraging separation appears to be based on the notion that the close social relationship between twins may be damaging for their development, and that separation may promote their individuality and independence (Koch, 1966). In support of this view, 92% of teachers in the Australian survey believed that the most important reason to place twins in separate classes was to enhance their individual development (Gleeson et al., 1990). On the other hand, the start of school may be the first time in their life when twins spend time apart so the rationale for keeping children together is based on the belief that separation may cause distress and could even lead to emotional difficulties for some children (Segal & Russell, 1992). This belief is supported by the findings of the UK survey, since the main reason given by teachers for not separating twins was to enable children to be supportive to one another (Preedy, 2001). At present, theories about the potential beneficial and harmful effects of classroom separation are not supported by research evidence. Given the number of schools making decisions about classroom separation of twins without the involvement of parents, the paucity of research about classroom separation of twins is of concern.

Consideration of the school policies and parental beliefs about classroom separation of twins should take into account the twins' zygosity, since there is some evidence that monozygotic (MZ) twin pairs have closer social relationships than dizygotic (DZ) twin pairs (Segal, 1984, 1988; Segal & Hershberger, 1999). For this reason, it is possible that parents and teachers may be more hesitant to separate MZ twins when compared with DZ twins, and indeed MZ twins themselves may be more reluctant to separate. While the surveys in the UK and in Australia did not report information about twins' zygosity, the US survey identified that MZ twins were significantly less likely to

be in separate classes when compared to DZ twins (Segal & Russell, 1992). This survey also found that a higher proportion of parents of MZ twins were in favour of not separating twins early in the school years, when compared with parents of DZ twins. Thus, it is possible that twins' zygosity may influence parental views about classroom separation and may also determine the effect of separation on twins. However, given the lack of research on separation of twins in school, there is presently no evidence that the effects of classroom separation vary according to twins' zygosity.

Overall, it would appear that many schools are making decisions about classroom separation of twins that do not take parents' preferences into account. At present, it is not known what effects, if any, classroom separation has on twins' development. For this reason, it has become imperative to investigate the effects of classroom separation on twins' behavior and their progress at school in order to provide an evidence base that may assist parents and educators in decision-making and in the formulation of school policies. The overall aim of this longitudinal study was to determine whether there were differences in children's school behavior, progress at school, and reading abilities according to whether twins were separated or together at school.

To test whether classroom separation had an effect on children's school behavior, three groups of twins were assessed at two points in time: at age 5 (the first year of school) and approximately 18 months later. The twins were classified into three groups: (1) Twins who were in the same classroom at both ages (Not Separated [NS] group), (2) twins who were in separate classes at both ages (Separated Early [SE] group), and (3) twins who were in the same class at the beginning of school, but in separate classes 18 months later (Separated Late [SL] group). Using longitudinal data, we examined the following questions:

1. Does separation in the first year of school lead to difficulties? If yes, the SE group should have more problematic outcomes at age 5 than the NS and the SL group.
2. Does separation in the first year of school have long-lasting negative effects? If yes, the SE group should have more problematic outcomes at follow-up than the NS group.
3. Is later separation also associated with difficulties at school? If yes, the SL group should have more problematic outcomes at age 7 than the NS group.

In addition to the above questions, tests 4 and 5 (below) allowed us to distinguish (a) whether separation leads to onset of new problems in children who were problem-free before separation, versus (b) whether problems co-occur with separation merely because pre-existing problems prompted separation.

4. Is it possible that the SL group was separated because they already had problems? If yes, the SL

group should have more problematic behavior at age 5 than the NS group.

5. Does the experience of separation increase problems over and above any problems before separation? If yes, the SL group should show an increase in problems from age 5 to follow-up, relative to the NS group.

Finally we examined whether the effects of separation, as outlined in the five questions above, vary as a function of zygosity.

Method

Sample

Participants are members of the Environmental Risk (E-risk) Longitudinal Twin Study, which investigates how genetic and environmental factors shape children's development. The study follows an epidemiological sample of families with young twins. The E-risk sampling frame was two consecutive birth cohorts (1994 and 1995) in the Twins' Early Development Study, a birth register of twins born in England and Wales (Trouton et al., 2002). The full register is administered by the government's Office of National Statistics (ONS), which invited parents of all twins born in 1994–1995 to enroll. Of the 15,906 twin pairs born in these 2 years, 71% joined the register. Our sampling frame excluded opposite-sex twin pairs and began with the 73% of register families who had same-sex twins. The E-risk Study sought a sample size of 1100 families to allow for attrition in future years of the longitudinal study while retaining statistical power. An initial probability sample of families was drawn from the register to target for home visits, with a 10% oversample to allow for nonparticipation. The sample has been demonstrated to be statistically representative of families having children in England and Wales (see Moffitt & the E-Risk Study Team, 2002, for a full description of sampling methods). Of the 1203 eligible families, 1116 (93%) participated in the first home-visit assessments when the twins were 5 years old (Phase 5); 4% of families refused, and 3% were lost to tracing or could not be reached after many attempts. Teachers returned questionnaires for 94% of the 2232 twins in the sample. A follow-up home visit was conducted 18 months after the twins' age-5 assessment, when they were 6.5 years old on average (range 6.0 to 7.0 years) (Phase 7). Follow-up data were collected for 98% of the 1116 E-Risk Study families. At this follow-up, teacher questionnaires were obtained for 91% of the 2232 E-Risk twins (93% of those taking part in the follow-up). At both phases of the study, families were given shopping vouchers for their participation, and children were given coloring books and stickers.

From the questionnaires returned at Phase 5, we were able to ascertain whether the twins had the same or different teachers for 2060 out of 2084 children (99% of the sample). There were 813 (79%) twin pairs who were in the same class at school and had

the same teacher and 217 (21%) pairs who were in separate classes with different teachers. From the questionnaires returned at Phase 7, we were able to ascertain whether the twins had the same or different teachers for 1936 out of 2000 children (97% of the sample). At this phase of the study, there were 643 (64%) pairs who were in the same class at school and 357 (36%) pairs in separate classes.

For the present study we required complete data from teachers about both members of each twin pair at both assessment phases. There were 552 (61%) twin pairs who shared their classroom at both Phase 5 and Phase 7 (the not separated [NS] group), 162 twin pairs (18%) who were in separate classes at both Phase 5 and Phase 7 (the separated early [SE] group), and 164 twin pairs (18%) were in the same class at Phase 5 but in separate classes by Phase 7 (the separated later [SL] group). In addition, 28 twin pairs (3%) were in separate classes at Phase 5 but had moved to the same class by Phase 7. The analyses for this study will exclude the latter group of twins who moved from different classes at Phase 5 to the same class by Phase 7, given the small number of these twins. Thus, there were 878 twin pairs and 1756 children included in this study.

Table 1 displays the percentages, means and standard deviations of the family demographics and child characteristics for the not separated group, separated early group and the separated later group. To test whether the three groups differed on these variables at Phase 5, Chi-square tests were used for categorical variables and analysis of variance was used for continuous variables. Significant differences were found between the groups on whether the teachers had referred a child to special education or social services. The separated early group contained a higher proportion of twins who had been referred for special education or social services when compared to the other two groups. In all subsequent analyses, we controlled for this variable by introducing it as a covariate in statistical models.

Measures

The zygosity of the twins was determined by questionnaire (Price et al., 2000). Where zygosity was unclear from questionnaire responses, cheek cells were collected and zygosity ascertained using DNA testing.

Household income was established by asking mothers to indicate how much total income the household received from all sources before tax in the previous 12 months. For analyses, income was divided into three categories: less than £20,000, between £20,000 and £34,999 and more than £35,000.

Family social class was determined by the current (or last) occupations of mothers (and their spouses or partners) using the Office of Population Censuses and Surveys (1991) Standard Occupational Classification (1 = professional and managerial; 2 = skilled manual and non-manual; and 3 = partly skilled and unskilled).

Table 1

Comparison of Child Variables and Family Sociodemographic Characteristics on the basis of Classroom Separation Status

Child and family variables	Not Separated (552 pairs) n%	Separated Early (162 pairs) n%	Separated Later (164 pairs) n%	χ^2 value	<i>p</i> value
Gender of twins					
Male	255 (46.2)	86 (53.1)	82 (50.0)	2.65	0.270
Female	297 (53.8)	76 (46.9)	82 (50.0)		
Zygoty of twins					
Monozygotic	302 (54.7)	80 (49.4)	102 (62.2)	5.51	0.060
Dizygotic	250 (45.3)	82 (50.6)	62 (37.8)		
Family income					
Less than £20,000	248 (46.6)	87 (56.1)	72 (47.1)	6.35	0.170
£20,000 to £34,999	156 (29.3)	43 (27.7)	49 (32.0)		
More than £35,000	128 (24.1)	25 (16.1)	32 (20.9)		
Family social class					
Professional/managerial	217 (39.3)	55 (34.0)	67 (40.9)	4.97	0.550
Skilled manual and non-manual	215 (38.9)	70 (43.2)	63 (38.4)		
Partly skilled and unskilled	80 (14.5)	19 (11.7)	21 (12.8)		
No occupation	40 (7.2)	18 (11.1)	13 (7.9)		
Relationship status					
Living with biological father	430 (77.9)	123 (75.9)	130 (79.3)	0.54	0.770
Not living with biological father	122 (22.1)	39 (24.1)	34 (30.7)		
Child referred for special education or to social services					
Not referred	963 (88.3)	240 (74.8)	273 (84.3)	36.23	0.001
Referred	127 (11.7)	81 (25.2)	51 (15.7)		
Mother's age at interview					
	mean (<i>SD</i>)	mean (<i>SD</i>)	mean (<i>SD</i>)	<i>t</i> test	<i>p</i> value
Mother's age at interview	33.05 (5.89)	33.60 (5.88)	32.42 (5.45)	1.70	0.180
Total number of children in family	3.35 (1.31)	3.39 (1.37)	3.25 (1.07)	0.50	0.600

Children's symptoms of ADHD at school (at Phases 5 and 7) as rated by teachers were measured with 18 items concerning inattention, impulsivity, and hyperactivity derived from the Rutter Child Scales (Sclare, 1997) and the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV;* American Psychiatric Association, 1994) diagnostic criteria for Attention Deficit Disorder. The internal consistency reliabilities (alphas) of the teacher reports were $> .90$.

Children's externalizing and internalizing problems at school (at Phases 5 and 7) were assessed with the Child Behavior Checklist Teacher Report Form (TRF) (Achenbach, 1991). The externalizing problem score reported in this article comprises the sum of items in the Delinquent Behavior and Aggressive Behavior scales; alphas $> .90$. The internalizing problem score reported in this article comprises the sum of items in the Withdrawn, Somatic Complaints, and Anxious/Depressed scales; alphas $> .80$.

Children's prosocial behavior at school (Phases 5 and 7) was rated by teachers using items from the Revised Rutter Scale for School-Age Children and the Strengths and Difficulties Questionnaire (Goodman, 1994; Sclare, 1997); alphas $> .90$.

The items in the teacher questionnaire were supplemented with additional questions about the child's progress at school: "How hard is he/she working?" and "How much is he/she learning?" Teachers rated the child's performance in relation to his or her peers

using a seven-point scale, ranging from (1) *much less* to (7) *much more compared with other children in the classroom*.

The above-mentioned teachers' measures were administered both at Phase 5 and Phase 7 of the study.

Children's IQ was individually tested using a short form of the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI; Wechsler, 1994). Using two subtests (Vocabulary and Block Design), children's IQs were computed following procedures described by Sattler (1992; Table H-7). The children in the study had an average IQ score of 96 ($SD = 14.5$, range 52 to 145). Children's IQ was assessed at Phase 5 of the study only.

Children's reading was individually tested using the Test Of Word Reading Efficiency (TOWRE; Torgesen et al., 1999). The TOWRE provides a quick assessment of sight word efficiency (SWE), which measures the number of real printed words that can be accurately identified in 45 seconds and provides an index of the size of the child's reading vocabulary. Children's reading scores were converted to standardised scores, with a mean of 100 and a standard deviation of 15. Children's reading was assessed at Phase 7 of the study only.

Data Analysis

To address hypotheses about the effects of classroom separation, data were analyzed by a series of

planned comparisons using sets of contrast codes (Rosenthal et al., 1999), corresponding to the hypotheses (listed above).

Statistical analysis of data about the study children (for example, ratings of child-specific behavior) was complicated by the fact that our twin study contained two children from each family, leading to non-independent observations. As such, we analyzed data about the study children using standard regression techniques but with all tests and confidence intervals based on the sandwich or Huber/White variance estimator (Rogers, 1993; Williams, 2000), a method that is available in the statistical package STATA 7.0 (StataCorp, 2001) which adjusts estimated standard errors and accounts for the dependence in the data due to analyzing sets of twins.

Results

Table 2 displays the means and standard deviations for teacher ratings of MZ and DZ twins' behavior and progress at school as well as twins' reading scores according to classroom separation status.

The results of the planned contrasts are presented for each hypothesis.

1. Does separation in the first year of school lead to difficulties? If yes, the separated early (SE) group should have more problematic outcomes at age 5

than the not separated (NS) and the separated later (SL) group.

Table 3 presents the *t* tests and *p* values for group comparisons between SE and NS groups and between SE and SL groups for MZ and DZ twins at age 5. The SE group showed more teacher-rated internalizing problems at age 5 than the NS group, for both MZ and DZ twins. The SE group also showed more internalizing problems at age 5 than the SL group, but for MZ twins only. In addition, the SE group was rated as showing more ADHD symptoms and learning less at school than the NS group, for DZ twins only. (All analyses were controlled for whether children had been referred for special education or social services.)

2. Does separation in the first year of school have long-lasting negative effects? If yes, the separated early (SE) group should have more problematic outcomes at follow-up than the not separated (NS) group.

Table 4 presents the comparisons between SE and NS group, for MZ and DZ twins at follow-up. The SE group had more internalizing problems than the NS group at follow-up. This finding held for MZ twins only; no significant differences emerged for DZ twins.

3. Is later separation also associated with difficulties at school? If yes, the separated later (SL) group should have more problematic outcomes at follow-up than the not separated (NS) group.

Table 2

Teacher Ratings of MZ and DZ Twins' Behavior and Progress at School and Children's Reading Scores, According to Classroom Separation Status

	Not Separated (NS)		Separated Early (SE)		Separated Later (SL)	
	MZ (<i>n</i> = 604)	DZ (<i>n</i> = 500)	MZ (<i>n</i> = 160)	DZ (<i>n</i> = 164)	MZ (<i>n</i> = 204)	DZ (<i>n</i> = 124)
Teacher ratings of children's behavior						
Externalizing behavior problems						
Age 5 years	4.7 (8.2)	4.2 (6.3)	5.0 (7.8)	5.2 (7.4)	6.5 (8.9)	4.3 (6.0)
Age 7 years	4.6 (4.2)	4.2 (7.3)	4.2 (7.0)	4.4 (6.5)	5.2 (7.8)	3.8 (7.0)
Internalizing behavior problems						
Age 5 years	5.2 (5.0)	5.8 (5.6)	7.6 (6.5)	7.2 (6.8)	5.4 (5.4)	7.4 (6.9)
Age 7 years	4.9 (5.2)	5.5 (6.2)	6.4 (6.4)	6.1 (6.0)	7.0 (6.5)	6.2 (5.8)
Prosocial behavior						
Age 5 years	12.1 (4.8)	11.9 (4.6)	11.4 (5.2)	11.5 (4.9)	10.9 (5.0)	11.4 (4.6)
Age 7 years	12.9 (4.8)	13.0 (4.9)	13.6 (4.5)	12.4 (4.3)	11.9 (4.5)	13.1 (5.0)
ADHD symptoms						
Age 5 years	4.7 (6.7)	4.4 (5.9)	5.6 (7.0)	6.1 (7.3)	5.6 (6.2)	4.9 (6.5)
Age 7 years	4.3 (6.2)	4.0 (5.9)	3.7 (6.1)	4.9 (6.5)	4.9 (6.7)	4.1 (5.1)
Progress at school						
How hard is s/he working? (Teacher ratings)						
Age 5 years	4.3 (1.2)	4.5 (1.2)	4.6 (1.3)	4.3 (1.4)	4.3 (1.3)	4.2 (1.3)
Age 7 years	4.5 (1.2)	4.5 (1.3)	4.7 (1.4)	4.5 (1.4)	4.3 (1.3)	4.7 (1.4)
How much is s/he learning? (Teacher ratings)						
Age 5 years	4.2 (1.3)	4.4 (1.3)	4.4 (1.5)	4.0 (1.5)	4.1 (1.3)	4.1 (1.4)
Age 7 years	4.3 (1.3)	4.4 (1.4)	4.6 (1.6)	4.2 (1.4)	4.1 (1.4)	4.2 (1.5)
Reading scores (TOWRE)						
Age 7 years	105.5 (12.7)	107.1 (12.4)	107.3 (11.9)	108.2 (14.4)	102.5 (13.2)	105.8 (12.5)

Note: The table presents means and standard deviations

Table 3

Does Separation at School Entry Have Damaging Effects? If Yes, at Age 5, the Separated Early group (SE) Should Have Significantly More Problematic Outcomes than the Not Separated (NS) and Separated Late (SL) groups

	Group comparisons	Monozygotic twins		Dizygotic twins	
		<i>t</i> test	<i>p</i> value	<i>t</i> test	<i>p</i> value
Externalizing behavior problems, age 5 years	SE > NS	0.22	0.94	1.43	0.15
	SE > SL	1.37	0.17	0.97	0.33
Internalizing behavior problems, age 5 years	SE > NS	3.70	0.01	2.19	0.03
	SE > SL	3.22	0.01	0.71	0.48
Prosocial behavior, age 5 years	SE > NS	1.07	0.29	0.81	0.42
	SE > SL	0.68	0.50	0.07	0.94
ADHD symptoms, age 5 years	SE > NS	1.11	0.27	2.12	0.03
	SE > SL	0.09	0.93	1.20	0.23
How hard is s/he working? age 5 years	SE > NS	1.29	0.20	1.12	0.26
	SE > SL	1.10	0.27	0.37	0.71
How much is s/he learning? age 5 years	SE > NS	1.48	0.13	2.40	0.02
	SE > SL	1.51	0.13	0.55	0.58

Table 4

Does Separation at School Entry Have Long-lasting Effects? If Yes, the Separated Early group (SE) Should Have Significantly More Problematic Outcomes at Follow-up (age 7 years) than the Not Separated (NS) group

	Monozygotic Twins		Dizygotic Twins	
	<i>t</i> test	<i>p</i> value	<i>t</i> test	<i>p</i> value
Externalizing behavior problems, age 7 years	0.46	0.65	0.33	0.74
Internalizing behavior problems, age 7 years	2.03	0.04	1.01	0.31
Prosocial behavior, age 7 years	1.22	0.22	1.26	0.21
ADHD symptoms, age 7 years	0.88	0.38	1.39	0.16
How hard is s/he working? age 7 years	1.36	0.18	0.38	0.70
How much is s/he learning? age 7 years	1.57	0.12	1.29	0.20
Standard reading scores, age 7 years	0.85	0.40	0.89	0.37

Table 5 presents the comparisons between SL and NS groups for MZ and DZ twins at follow-up. The SL group had more teacher-rated internalizing problems at follow-up than the NS group, for MZ twins only. In addition, the SL group had lower standard reading scores than the NS group at follow-up, for MZ twins only (controlling for age 5 IQ). No significant contrasts emerged for DZ twins.

4. Is it possible that the twins in the separated later (SL) group were separated because they already had problems? If yes, the SL group should have more problematic behavior at age 5 than the not separated (NS) group.

Table 6 presents the comparisons between the SL and NS group at age 5 for MZ and DZ twins. Only one finding was significant ($p = .05$). The NS group was rated as having more prosocial behavior than the SL group at age 5. This finding was for MZ twins only.

5. Does the experience of separation increase problems over and above any problems before separation? If yes, the separated later (SL) group should show an increase in problems from age 5 to follow-up, relative to the not separated (NS) group.

Table 7 presents the comparisons between the SL and NS group in the level of increase in problem behaviors from age 5 to follow-up, for both MZ and DZ twins. The SL group showed a significantly greater increase in internalizing problems from age 5 to follow-up when compared to the NS group. This finding was for MZ twins only. The SL group showed lower standard reading scores at follow-up when compared to the NS group, after controlling for IQ at age 5. Once again, this finding was only for MZ twins. For DZ twins, the SL group showed greater increases in ratings of how hard they were working from age 5 to follow-up relative to NS group. No significant findings emerged for MZ twins on this variable.

In order to address the question of which twins did well or poorly as a result of separation, exploratory analyses were performed using MZ twins in the SE and SL groups. A series of regression analyses were run with teacher-rated internalizing problems at age 7 as the dependent variable and a range of child and family variables as the predictor variables (twins' birthweight, gender, ethnicity, social class, income, mothers' age, marital status and number of children in the family). Separate regression analyses were run for

each predictor variable. There were no significant findings for any of the regression analyses performed for the SE group and the SL group.

Discussion

To our knowledge, this is the first longitudinal study to investigate the effects of classroom separation on twins' behavior, progress at school and their reading abilities. Four findings stand out. First, relative to twins not separated, twins who were separated in the first year of school had more internalizing problems and for MZ twins, these problems persisted over time. In fact, longitudinal analyses showed that MZ twins' internalizing problems actually increased following the first year of separation. Such evidence of within-individual change supports the interpretation that school separation may be causally linked to the development of internalizing problems among MZ twins (Rutter et al., 2001). It should be noted, however, that while the effects of separation were statistically significant, they only represented small effect sizes. Second, there was some evidence that separated twins experienced more academic problems than non-separated twins since later-separated MZ twins, but not early-separated twins, had poorer reading abilities than non-separated twins. However, this finding also represented a small effect size. Third, despite significant group differences in relation to internalizing problems and reading abilities, there were no group differences in externalizing

problems, ADHD, or prosocial behaviors. Fourth, this study revealed only one instance in which separated twins showed more favorable outcomes than non-separated twins: DZ twins who were separated after the first year of school were rated as working harder when compared to DZ twins not separated.

Overall, the pattern of findings in the present study calls into question the implementation of school-wide practices about the separation of twins. Preedy's (2001) survey found that only one in four schools consulted parents about the decision to separate twins and almost one in three schools implemented practices that applied to all twins (7% of schools always separated twins and 23% always kept twins together). Support for school-wide practices would require two pieces of evidence similar to the evidence adduced for other psychoeducational interventions. First, interventions must be shown to be helpful and second, above all, interventions should do no harm. The findings of the present study demonstrate that school-wide practices, especially those encouraging the separation of twins, have the potential to lead to adjustment problems for at least some children and that a more family-focused approach that takes into account the views of parents, may be required.

The finding that early separation of twins in school resulted in more internalizing problems suggests that many twins may benefit from remaining in the same class, at least for the first few years of

Table 5

Is Late Separation also Damaging? If Yes, at Follow-up (Age 7 years) the Separated Late (SL) Group Should Have Significantly More Problematic Outcomes than the Not Separated (NS) group

	Monozygotic twins		Dizygotic twins	
	<i>t</i> test	<i>p</i> value	<i>t</i> test	<i>p</i> value
Externalizing behavior problems, age 7 years	0.80	0.42	0.49	0.63
Internalizing behavior problems, age 7 years	3.37	0.01	1.08	0.28
Prosocial behavior, age 7 years	1.93	0.06	0.33	0.79
ADHD symptoms, age 7 years	0.82	0.42	0.19	0.85
How hard is s/he working? age 7 years	1.26	0.21	1.06	0.29
How much is s/he learning? age 7 years	0.34	0.73	1.74	0.08
Standard reading scores, age 7 years	2.63	0.01	0.14	0.89

Table 6

Is it Possible that the Separated Late group Was Separated Because they Already Had Problems? If Yes, the Separated Late (SL) Group Should Have Significantly More Problematic Outcomes at Age 5 years than the Not Separated (NS) Group

	Monozygotic twins		Dizygotic twins	
	<i>t</i> test	<i>p</i> value	<i>t</i> test	<i>p</i> value
Externalizing behavior problems, age 5 years	1.75	0.07	0.15	0.88
Internalizing behavior problems, age 5 years	0.00	1.00	1.40	0.16
Prosocial behavior, age 5 years	1.98	0.05	0.83	0.41
ADHD symptoms, age 5 years	1.23	0.22	0.19	0.85
How hard is s/he working? age 5 years	0.07	0.95	0.70	0.49
How much is s/he learning? age 5 years	0.34	0.73	1.74	0.08

Table 7

Does the Experience of Separation Increase Problems Over and Above any Problems Before Separation? If Yes, the Separated Late (SL) Group Should Show Increases in Problems from School Entry (age 5 years) to Follow-up (age 7 years), Relative to the Not Separated (NS) group

	Monozygotic twins		Dizygotic twins	
	<i>t</i> test	<i>p</i> value	<i>t</i> test	<i>p</i> value
Externalizing behavior problems, age 7 — age 5 years ^a	1.50	0.14	0.71	0.48
Internalizing behavior problems, age 7 — age 5 years ^a	3.05	0.00	0.35	0.72
Prosocial behavior, age 7 — age 5 years ^a	0.08	0.94	1.11	0.27
ADHD symptoms, age 7 — age 5 years ^a	0.45	0.65	0.48	0.63
How hard is s/he working? Age 7 — age 5 years ^a	1.20	0.23	2.26	0.02
How much is s/he learning? Age 7 — age 5 years ^a	1.14	0.25	0.81	0.42
Standard reading scores, age 7 years, controlling for age 5 IQ ^b	2.44	0.02	0.14	0.89

Note: ^aThe dependent variable is the change score from Phase 5 to Phase 7

^bThe dependent variable is the reading score at Phase 7, controlling for IQ at Phase 5

school. School separation may be a stressful event for twins, and while it would be considered normal and developmentally appropriate for twins to experience a short period of anxiety when required to separate for the first time, the findings of this study suggest that this initial anxiety is not temporary.

Twins who were separated later experienced more internalizing problems and poorer reading performance relative to those not separated, suggesting that the later separation of twins in primary school is not any easier than early separation. The finding that internalizing problems were not present before separation, along with longitudinal evidence that problems actually increased among separated twins, lends confidence to our interpretation that separation may be associated with the development of emotional problems. This does not mean that all twins who are separated will experience significant and long-lasting problems, but it does indicate that some twins who experience anxiety on first separation at school will continue to have problems as they develop.

A number of findings from this study suggest that MZ and DZ twins respond differently to the effects of separation at school. Both MZ and DZ twins experienced internalizing problems as a result of early separation, but these problems persisted for MZ twins only. In addition, later separation resulted in more internalizing problems and lower reading performance for MZ twins over and above any problems experienced before separation, but did not appear to affect DZ twins. The finding that MZ twins were more likely than DZ twins to experience persistent difficulties following classroom separation may be accounted for by the fact that MZ twins experience a closer relationship than DZ twins (Segal, 1984, 1988; Segal & Hershberger, 1999). While there is evidence from this study that the negative effects of separation on MZ twins are not temporary, it is important to determine whether the effects persist further into childhood and even into adolescence. In addition, it is also important to identify whether classroom separation of older

MZ twins also has negative outcomes, or whether the effect diminishes as children develop.

There are a number of implications of the present study for the parents of twins and for educators who make decisions about placement of twins in school. First, evidence was found to suggest that separating twins from the start of school might be damaging for some children. Decisions about the need to separate twins in order to enhance their individual development must be balanced by knowledge of the possible negative effects of separation for twins' adjustment. While the findings of this study support the re-evaluation of school-wide practices about the separation of all twins they do not support the implementation of policies about keeping all twins together in school since there was marked variation within the group of separated twins and some children fared well. In general, while twins may benefit from remaining together in the early years at school, it seems apparent that schools need to adopt a more flexible family-focused approach to decisions about separating twins at school which, at the very least, takes into account the characteristics and experiences of each twin as well as the views of parents. Preedy (1999) has developed a checklist as a tool to assist educators and parents with making decisions about whether or not to separate twins at school. This checklist, along with other resources for parents and teachers, is now available on a website about twins and multiples in school (www.twinsandmultiples.org) (Hay & Preedy, 2002).

Second, the findings of this study indicate that any decision to separate twins within the first few years of school should be taken with care and involve considerable planning and follow-up. Educators and parents should monitor separated twins for signs of emotional disturbance or reading difficulties, and intervention may be required for children who experience marked or persistent difficulties. It should be remembered that separation does not have to be permanent and can always be reversed if twins suffer significant adjustment problems.

The final implication from the findings of this study is the need to fully prepare twins for the start of school and for possible separation, if it is likely to occur. In order to assist with a smooth transition into school, twins may benefit from increasing periods of separation prior to the start of school. The UK survey (Preedy, 1999) reported that most parents found it difficult to arrange separate outings or experiences for twins before the start of school, and as a result most children had little or no experience of separation prior to starting school. Educators at preschool level should aim to provide twins with opportunities to spend time apart and parents also need education about the importance of providing twins with early separation experiences. Information about separation experiences during the preschool period should be thoroughly discussed between parents and teachers before the start of school to help inform decisions about school separation (Preedy, 1999).

Future research on the topic of twins in school should focus on the effects of separation of twins in later years, including secondary school. Hay (1999) emphasised that there are additional factors to consider when making decisions about the separation of twins in secondary school, including choice of subjects, choice of schools and decisions about when to leave school. Further research should also address the question about which factors predict the development of internalizing problems in separated twins, since it is evident that some separated twins performed well. While the present study failed to identify any child or family variables that were associated with internalizing problems in separated MZ twins, it is possible that other factors, such as aspects of the twin relationship, may determine the effects of separation, and should be explored.

Four limitations of the present study should be taken into account when interpreting the findings. First, this study did not examine opposite-sex twin pairs, so it is difficult to generalise the findings to this group of twins. Koch (1966) noted that opposite-sex twins may perform at different academic levels. Second, the study was conducted in the UK, and we do not yet know whether the findings will replicate in other settings. However, Preedy (2001) reported that the basis for teacher recommendations for twin separation were often similar in the UK and Australia. Third, we only measured the children's behavioral development and academic progress, but we were not able to explore psychological issues of identity formation. Fourth, we did not ask parents or children for their views about separation. It is possible that twins' response to separation depends on whether or not they wish to be separated and also on their parents' wishes.

Given the increasing birth rate of twins due to assisted reproductive technology and to mothers postponing childbirth to older ages, the decision about placement of twins in school is one that applies to an increasing number of children. For these reasons, it is

fundamental that educators and parents work as a team to make good decisions about classroom separation of twins, to monitor their progress at school and to intervene if problems are identified. It is also essential that research continues to investigate the effects of separation of twins in school, as well as examine strategies to help twins separate successfully.

Acknowledgments

We are grateful to the study parents, the twins, and the twins' teachers for their participation. Our thanks to Hallmark Cards for their support, to Thomas Achenbach, Robert Plomin and Michael Rutter for their contributions, and to members of the E-risk team for their dedication, hard work and insights. Terrie E. Moffitt is a Royal Society-Wolfson Research Merit Award holder. The E-risk Study is funded by the UK Medical Research Council.

References

- Achenbach, T.M. (1991). *Manual for the Teacher's Report Form and 1991 Profile*. Burlington, VT: University of Vermont, Department of Psychiatry.
- American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Bryan, E., & Hallet, F. (2001). *Twins and triplets: The first five years and beyond*. London: The Multiple Births Foundation.
- Gleeson, C., Hay, D. A., Johnston, C. J., & Theobald, R. M. (1990). "Twins in school": An Australia-wide program. *Acta Geneticae Medicae et Gemellologiae*, 39, 231-244.
- Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology & Psychiatry*, 38, 581-586.
- Gould, W., & Sribney, W. (1999). *Maximum likelihood estimation with STATA*. College Station, TX: Stata Press.
- Hay, D. A., & Preedy, P. (2001). Two, four, six, eight: Educating twins, triplets and more. *Twin Research*, 5, 582-583.
- Hay, D. A. (1999). Adolescent twins and secondary schooling. In A. C. Sandbank (Ed.), *Twin and triplet psychology* (pp. 119-142). London: Routledge, 1999.
- Koch, H. (1966). *Twins and twin relations*. Chicago: University of Chicago Press.
- Luke, B., & Keith, L. G. (1992). The contribution of singletons, twins and triplets to low birth weight, infant mortality and handicap in the United States. *The Journal of Reproductive Medicine*, 37, 661-666.
- Moffitt, T.E., & the E-risk Study Team (2002). Teen-aged mothers in contemporary Britain. *Journal of Child Psychology and Psychiatry*, 43, 727-742.

- Office of Population Censuses and Surveys (1991). *Standard Occupational Classification* (Vols. 1–3). London: Her Majesty's Stationery Office.
- Preedy, P. (1999). *Meeting the educational needs of pre-school and primary aged twins and higher multiples*. In A. C. Sandbank (Ed.), *Twin and triplet psychology* (pp. 70–99). London: Routledge.
- Preedy, P. (2001). *Are multiple birth children different from singletons? Meeting the educational needs of multiple birth children upon school entry*. Unpublished dissertation. School of Education, The University of Birmingham, UK.
- Price, T. S., Freeman, B., Craig, I., Petrill, S. A., Ebersole, L., & Plomin, R. (2000). Infant zygosity can be assigned by parental report questionnaire data. *Twin Research*, 3, 129–133.
- Rogers, W. H. (1993). Regression standard errors in clustered samples. *Stata Technical Bulletin*, 13, 19–23.
- Rosenthal, R., Rosnow, R. L., & Rubin, D. (1999). *Contrasts and effect sizes in behavioral research: A correlational approach*. New York: Cambridge University Press.
- Rutter, M., Pickles, A., Murray, R., & Eaves, L. (2001). Testing hypotheses on specific environmental risks. *Psychological Bulletin*, 127, 291–324.
- Sattler, J. M. (1992). *Assessment of children: WISC-III and WPPSI-R supplement*. San Diego, CA: Author.
- Sclare, I. (1997). *The child psychology portfolio*. Windsor, Berkshire: NFER-Nelson Publishing Company.
- Segal, N. L. (1984). Cooperation, competition, and altruism within twin sets: A reappraisal. *Ethology and Sociobiology*, 5, 163–177.
- Segal, N. L. (1988). Cooperation, competition and altruism in human twinships: A sociobiological approach. In K. B. MacDonald (Ed.), *Sociobiological perspectives on human development* (pp. 168–206). New York: Springer-Verlag.
- Segal, N. L., & Hershberger, S. L. (1999). Cooperation and competition in adolescent twins: Findings from a prisoner's dilemma game. *Evolution and Human Behavior*, 20, 29–51.
- Segal, N. L., & Russell, J. M. (1992). Twins in the classroom: School policy issues and recommendations. *Journal of Educational and Psychological Consultation*, 3, 69–84.
- StataCorp (2001). *Stata Statistical Software: Release 7.0*. College Station, TX: Stata Corporation.
- Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1999). *Test of word reading efficiency*. Austin, TX: PRO-ED, Inc.
- Trouton, A., Spinath, F. M., & Plomin, R. (2002). Twins Early Development Study (TEDS): A multivariate, longitudinal genetic investigation of language, cognition, and behaviour problems in childhood. *Twin Research*, 5, 444–448.
- Wechsler, D. (1990). *Wechsler Preschool and Primary Scale of Intelligence — Revised*. London: The Psychological Corporation.
- Ventura, S. J., Martin, J. A., Curtin, S. C., Matthews, T. J., & Park, M. (2000). Births: Final data for 1998. *National Vital Statistics Reports*, 48 (3). *Centres for Disease Control and Prevention, Department of Health and Human Services*.
- Williams, R. L. (2000). A note on robust variance estimation for cluster-correlated data. *Biometrics*, 56, 645–646.
-