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# No effect of classroom sharing on educational achievement in twins: a prospective, longitudinal cohort study

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## ABSTRACT

**Background:** A returning dilemma for families with multiple births is whether twins should share the same, or a parallel classroom, or in other words, whether they should be separated at school or not. This study investigated the effects of sharing a classroom during primary school on cognitive achievement in twins.

**Method:** Subjects were 839 monozygotic and 1164 dizygotic twin pairs who were registered at birth at The Netherlands Twin Register. A prospective, longitudinal study design was used with educational achievement at age 12 years, measured with a standardised test (CITO test), as outcome measure.

**Results:** Most twin pairs (72%) shared a classroom during their schooling, 19% were in separate, but parallel, classes, and 9% "partly" shared a classroom. Twins who were in parallel classrooms had higher CITO scores (mean 539.51; SD 8.12), compared to twins who shared a classroom (537.99; SD 8.52). When controlling for socioeconomic status, and externalising problems before starting primary school (age 3), there was no significant difference in educational achievement between separated and non-separated twin pairs ( $p = 0.138$ ). In addition, there was no interaction with sex or zygosity of the twins ( $p = 0.798$ ).

**Conclusion:** There is no difference in educational achievement between twins who share a classroom and twins who do not share a classroom during their primary school time. The choice of separation should be made by teachers, parents and their twin children, based on individual characteristics of a twin pair.

Being part of a twin pair has benefits such as always having a friend and companion around, and being part of a unique and special relationship that is not available for singletons. Having a co-twin may, however, also have possible detriments such as the inability to develop as a unique and independent individual. Families with multiple births naturally want to offer the optimal conditions in which twins can function effectively, both as multiples as well as individuals. A returning dilemma for them is whether twins should share the same, or a parallel classroom, in other words, whether or not they should be separated at school.

A survey in the UK showed that only 1% of schools had written policies about the education and management of multiple birth children. Also, the decision to separate or not, was often made by educators alone, without the input of parents.<sup>1</sup> Most twins spent their schooling years together and 7% of schools reported they always separated

twins. In The Netherlands an increasing practice of separating twins is reported,<sup>2,3</sup> whereas in Scandinavian countries multiples almost always share the classroom.<sup>4</sup> Educational policies and practice – independent of a focus on sharing or separation – seem to be based on popularised stereotypical depictions of twins (in general monozygotic pairs) rather than on empirical research.<sup>5</sup> Hay and Preedy<sup>6</sup> emphasise a clear and evidence-based recommendation on which school policies and even ongoing legislative initiatives in the USA<sup>7</sup> can be based, as “teachers and parents should be aware of particular issues that may affect the physical, intellectual, personal, social, and emotional development of multiple birth children”. Given this argument and the growing multiple birth rate,<sup>8,9</sup> it is surprising that only three studies have investigated whether or not classroom separation at the primary school is beneficial or detrimental for the behavioural and cognitive development of twins. Two studies concentrated mainly on the behavioural and emotional implications of the separation of twins at school,<sup>3,10</sup> and one study focused on cognitive abilities.<sup>11</sup> All studies were based on rather large twin samples: a British sample of 878 twin pairs,<sup>10</sup> a Dutch sample of 5128 twin pairs,<sup>3</sup> and a Dutch sample of 2878 twin pairs.<sup>11</sup> Both Dutch studies (only little overlap in samples; 3.92%) had longitudinal data covering the complete primary school period (ie grade 1–8), whereas the study of Tully *et al.*<sup>10</sup> was limited to the first three years of school (age 5–7).

The major finding of the first two studies was that internalising problems in young twins could be attributed to separation of the twins at the beginning of their schooling. However, the effects sizes were small and in the Dutch sample the effects had disappeared in grade 8. For externalising problems Tully *et al.*<sup>10</sup> found no differences, whereas van Leeuwen *et al.*<sup>3</sup> found an effect of separation. Externalising problems in separated twins were explained by pre-existing differences between twins, suggesting that the externalising problems could have been a motivation for parents and teachers to separate the twins. In addition, van Leeuwen *et al.*<sup>3</sup> found that socioeconomic status (SES) was significantly associated with the classroom placement of a twin pair (ie separated or together); families with lower SES had their twins more often placed together.

Regarding cognitive development of twins Webbink *et al.*<sup>11</sup> found no important differences between twins sharing a classroom, or not. Their

results showed a small positive effect for non-separated twins on language and arithmetic in grade 2, but in the higher grades no effects were found. As zygosity of the twins in this study was unknown, the interaction with classroom separation and zygosity was not investigated. Tully *et al.*<sup>10</sup> found lower reading scores for separated twins, but this was only the case for monozygotic (MZ) twins at age 7 who were separated after 1 year of schooling, and this finding did not apply to twins who were separated earlier.

The current study expands on this prior work by examining the effects of classroom separation on educational achievement in a large longitudinal sample of typically developing twins (age 3–12). The large sample enabled examination of whether the effects of classroom separation differed for male and female, and for monozygotic (MZ) and dizygotic (DZ) twins. A standardised Dutch achievement test was used, called CITO test, which is assessed in grade 8 at 93% of the Dutch primary schools. The CITO test highly correlates with IQ performance<sup>12</sup> and plays an important advisory role in the choice of secondary school education. Several confounding factors may bias the true association between classroom separation and the outcome measure. The following factors were taken into account: a) zygosity (MZ or DZ), b) socioeconomic status, c) urbanisation (as schools situated in low urbanised areas might not offer the opportunity to separate twins because only one classroom for a specific grade is available), and d) pre-existing and current externalising problems.<sup>3</sup>

## METHODS

### Sample

All twins were registered with the Netherlands Twin Register (NTR), established in 1986 by the Department of Biological Psychology at the VU University in Amsterdam. Of all multiple births in the Netherlands, about 50% are registered in the NTR.<sup>13 14</sup> Data of twins from the 1986–1993 birth cohorts were used in this study. Surveys on development, health, psychopathology and sociodemographic characteristics have been collected longitudinally at the ages of 1, 2, 3, 5, 7, 10 and 12 years. Response rates at ages 3, 7, 10 and 12 years were 72%, 66%, 64% and 64% respectively (note that if a family did not participate at a particular age, they were approached again for the next mailing).<sup>15</sup> For this study, information from surveys completed by mothers of twins at ages 3, 5, 7, 10 and 12 years was used.

### Together or separated

The surveys sent to the mothers of twins at ages 5 and 12 years contained questions on whether the twins were in the same class. In the Netherlands, most children start primary school at the age of 4 years; compulsory education, however, starts at the age of 5 years. Nearly all children attend primary school for 8 years and go to secondary school around the age of 12 years. The separation of twin pairs can occur when children first start school or during primary school. Mothers of twins who were 12 years of age were asked “Which statement applies best to the school history of your twins?”: a) “same school, same classroom”; b) “same school, parallel classes” (ie same level); c) “same school, different levels”; d) “different schools”; or e) “partly same class, partly separated”. When the twins were 5 years old, the mother was asked whether “the twins are now”: a) “together in the same school in the same classroom”; b) “together in the same school but not in the same classroom”; or c) “at different schools”.

### Outcome measure

Educational achievement of the twins was assessed with the Dutch CITO-elementary test (Eindtoets Basisonderwijs, 2002, www.cito.nl). The CITO consists of 240 multiple-choice items assessing four different intellectual skills: Language, Mathematics, Information Processing, and World Orientation. Together the performance scales result in a standardised score between 501 and 550. The test is usually administered on three consecutive days in January or February when the children are in the final class of elementary school (grade 8), and approximately 12 years old. The CITO data were collected by mail from teachers after informed consent was obtained from the parents, from the parents at age 12 of the twins, and/or by self-report of the twins at age 14 or 16 years. There was a substantial agreement among the scores from different sources (correlations in the range of 0.93 to 0.99). Bartels *et al.*<sup>12</sup> showed that CITO scores are moderately to highly correlated to IQ (correlations of 0.41, 0.50, 0.60, and 0.63 between CITO scores assessed at age 12 and IQ performance at age 5, 7, 10, and 12 respectively).

### Subjects included

Survey data at age 12 and CITO scores were present for 4929 twins. Twins were excluded: a) because of a handicap (n = 76); b) because they needed special education (n = 15); c) because twins were in different schools (n = 86); d) because twins were in different classes (n = 513) that represented different levels/grades; e) because data on classroom placement were missing or incomplete (n = 88); or f) when the CITO score of one twin of a pair was missing (n = 145, there is no information on the reason for the incomplete data); leaving 4006 twins (2003 twin pairs) in the sample. Of these, 370 pairs were monozygotic male pairs (MZM), 269 were dizygotic male pairs (DZM), 469 were monozygotic female pairs (MZF), 302 were dizygotic female pairs (DZF) and 593 were dizygotic opposite sex pairs (DOS). Zygosity was determined by DNA or blood group polymorphisms for 702 pairs. For the remaining same sex twin pairs (n = 708), zygosity was based on questionnaire items. Zygosity determination using this questionnaire is 93% accurate.<sup>16</sup>

Thus, the 2003 twin pairs used in the analyses were healthy, typically developing 12-year-old (complete) twin pairs who were during primary school *non-separated* (same school, same classroom), *separated* (same school, parallel class) or *partly separated* (partly same classroom, partly separated; there is no information about when and how long these twins were separated).

Information was available on separation at the beginning of primary school (age 5) for 1768 twin pairs (for 233 pairs the survey at age 5 was not completed, for two pairs the survey was completed but the item on classroom separation was incomplete or missing). These 5-year-old twin pairs were at that time *non-separated* (same school, same classroom) or *separated* (same school, but parallel class).

### Possible confounding factors

#### Socioeconomic status (SES)

Data on socioeconomic status (SES) from the survey mailed out when the twins were 3, 7 and 10 years old were included in the analyses as van Leeuwen *et al.*<sup>3</sup> reported less separated twins in low SES families. SES data were available for 1752 (assessed at age 3), 1762 (assessed at age 7) and 1766 (assessed at age 10) families. As SES scores between ages 3, 7 and 10 correlated highly (varying from 0.70 to 0.78), the SES score of age 7 was

used when age 10 was not available and the SES score of age 3 when scores at age 7 and 10 were not available. This provided a SES score for 1972 families.

Socioeconomic status was based on a full description of the occupation of the parents and classified using a five-point scale (1 = lowest, 5 = highest), according to the system used by Statistics Netherlands.<sup>17</sup> For SES assessment at age 10 the EPG-classification scheme was used; this combines occupation with information on parental education.<sup>18</sup> In both cases the highest SES score of the two parents determined the SES of the twin pair. The distribution of SES (from low to high) was 1%, 14%, 43%, 27% and 15%.

### Urbanisation level

Smaller villages may not offer the possibility to separate twins into parallel classes, and therefore it was tested whether urbanisation level was associated with placement of twins. Urbanisation level was determined by linking the participants' zip codes at age 12 to the 2004 zip code information provided by Statistics Netherlands (Centraal Bureau voor de Statistiek, 2001). Statistics Netherlands manages a public national database that covers a wide variety of societal and economical aspects of the Dutch society. For each zip code, Statistics Netherlands provides an urbanisation level (scale of 0–4: very high, high, moderate, low, very low/none). When no data were available on zip codes at age 12, data at age 14 or 16 were used. Data on urbanisation were available for 1981 families. Missing data (22 families) were due to the fact that some families had moved to new areas with zip codes that were introduced after 2004. The distribution of urbanisation (from low to high) was 29%, 23%, 17%, 23% and 8%.

### Externalising problems

It was examined whether externalising problems at age 3 predicted separation at the beginning of the twins' school career. As part of the twins' change in their school placement, externalising problems at age 10 were also examined, as they possibly caused classroom separation later in school. Externalising problems were assessed with a broad band scale of the Child Behavior Checklist (CBCL) completed by the mother. The externalising scale is based on the Aggressive and Rule Breaking Behavior subscales of the CBCL.<sup>19</sup> Items are scored on a three-point scale (ie not true (0), somewhat or sometimes true (1) and very true or often true (2); ratings are based on the occurrence of the behaviour during the preceding 6 months.

The highest externalising score from a twin pair was used. Data were available for 1682 complete twin pairs at age 3 (for 260 pairs the survey at age 3 was not completed, for 61 pairs the survey was completed but the items on externalising problems were incomplete or missing for at least one twin). At age 10 there were externalising problem scores for 1781 twin pairs (for 192 pairs the survey at age 10 was not completed, for 30 pairs the survey was completed but the items on externalising problems were incomplete or missing for at least one twin).

### Statistical analyses

Data analyses were performed in SPSS 15.0 (SPSS Inc., Chicago, Illinois). First it was tested at family level whether SES and urbanisation levels differed between twin pairs that shared a classroom and twin pairs who were in separate classrooms ( $\chi^2$ -tests). In addition the possibility that externalising problems at age 3 differed between both groups at the start of school or later

in school was tested (one-way Anova; at age 12 with Bonferroni post-hoc comparisons as in this case data from three groups were analysed: separated, non-separated and partly separated twins).

Secondly, significant differences in CITO scores were tested between twins who shared a classroom the entire school period and twins who were in separate classrooms during their schooling. Because twin data consist of non-independent observations, for these analyses the Mixed Modeling option in SPSS was used, in which a correction for family dependency is applied.<sup>20, 21</sup> In the full model CITO scores were the dependent variable, whereas classroom separation, zygosity, sex, and an interaction effect between classroom separation and zygosity were included as fixed effects. Significant predictors for classroom separation at age 5 and at age 12 were also included as fixed effects. Family and zygosity status were incorporated in the model as random effects. Parameter estimation was by maximum likelihood. The type-I error rate was set at 0.01 to accommodate multiple testing.

## RESULTS

### Descriptives

The mean CITO score was 538.39 (8.39). Boys scored higher than girls (boys mean 539.13 (8.08), girls mean 537.74 (8.60);  $F(1, 4004) = 27.862, p < 0.001$ ), so corrections were made for sex in the subsequent analyses. At age 12 most twin pairs (72%) had shared a classroom during their schooling, 19% were in parallel classes most of the time and 9% of the mothers reported the twins had "partly" shared a classroom. This pattern was the same in male and female, MZ and DZ twins. The history of separation (ie classroom placement at age 5 compared to age 12) showed that 96 pairs (8%) that were non-separated at age 5 were separated at age 12, and 187 pairs (37%) that were separated at age 5 were non-separated at age 12. Overall, 16% of twin pairs had changed their placement during primary school.

### Confounding factors

Classroom separation at age 5 and at age 12 was significantly associated with SES ( $\chi^2 = 22.909, df = 4, p < 0.001$  and  $\chi^2 = 38.028, df = 4, p < 0.001$  respectively) and with urbanisation ( $\chi^2 = 55.257, df = 4, p < 0.001$  and  $\chi^2 = 80.118, df = 4, p < 0.001$  respectively). Twins from lower SES families and lower urbanisation levels were more likely to share a classroom. Also, externalising problems at age 3 were significantly associated with classroom separation at age 5 ( $F(1, 1583) = 8.747, p = 0.003$ ). Externalising problems at age 10 and classroom separation at age 12 showed a trend for association ( $F(2, 1794) = 3.939, p = 0.020$ ) but the Bonferroni post-hoc test showed that this reflected a difference between non-separated twins and partly separated twins ( $p = 0.034$ ) and not between non-separated and separated twins ( $p = 0.341$ ). Hence, the covariates that were used in the Linear Mixed Modeling procedure were urbanisation, externalising problems at age 3, and SES.

### Classroom separation and educational achievement

Without adjusting for the confounding factors, a significant association between classroom separation and CITO scores was present ( $F(2, 1931) = 7.200, p = 0.001$ ). The effect size ( $r$ ) of classroom separation was 0.08. After adjusting for confounding effects, there was no significant effect of classroom separation on CITO scores ( $F(2, 1653) = 1.985, p = 0.138$ ), and the effect size decreased to 0.04. In addition, there was no interaction



effect between classroom separation and zygoty ( $F(8, 686) = 0.576, p = 0.798$ ), thus the association between classroom separation and CITO scores is the same for male and female MZ, male and female DZ and opposite-sex twins. Externalising problems at age 3 ( $B = -0.05, t(1659) = -3.40, p = 0.001$ ) and SES ( $B = 2.55, t(1647) = 13.70, p < 0.000$ ) were significant covariates in the association between CITO scores and classroom separation. Urbanisation was not a significant confounder ( $B = -0.07, t(1639) = -0.54, p = 0.59$ ). Effect sizes ( $r$ ) of the covariates were 0.08, 0.32 and 0.01 respectively.

Table 1 presents the mean CITO scores for separated and non-separated twin pairs per zygoty group, before and after adjusting for significant covariates.

## DISCUSSION

This is the first study that investigated, as a function of male and female, MZ and DZ twin pairs, whether classroom separation has costs or benefits for their educational achievement. Twin pairs who had different educational levels due to other factors like repeating a class, handicaps or special education were excluded from the study. Thus, by keeping the cognitive level within pairs equal for twin pairs who were separated and who were not, the focus was on the true association between classroom placement and cognitive achievement, in typically developing twins. The present findings indicate that there is no difference in the educational achievement between twins who are together in a classroom and twins who are separated. Important covariates in the relation between classroom separation and CITO scores were socioeconomic status and externalising problems. The present results confirm those of Webbink *et al.*<sup>11</sup> who also found no effect of classroom separation on cognitive abilities. The present study further shows that these results are the same for male and female, and MZ and DZ twins. The question of whether separation has an influence on internalising or externalising

problem behaviours of twins was already answered by van Leeuwen *et al.*<sup>3</sup> Also, for these outcomes there was no important effect of separation.

A remaining question is whether social development interacts with sharing a classroom with your co-twin. Because twins share their age and developmental needs, they do share friends more often than other siblings.<sup>22</sup> An often used argument of schools in The Netherlands is that separation stimulates the individual development of cognition as well as in social contacts. In the present study, a small subsample of 12-year-old twins (from cohorts 1990–1992,  $N = 169$  pairs) answered the question “Do you share the same friends?”. For twins who shared a classroom 74% reported “Yes, we share the same friends”, 20% answered “No, we have different friends”, and 6% reported sharing “Some friends”. For twins who were in separated classrooms this was, respectively, 25%, 50% and 25%, and for twins who partly shared a classroom 50%, 38% and 12%. These outcomes indicate that twins who share a classroom have more mutual friends. However, these results only apply to the primary school period. In this phase friendships might predominantly be based on classroom mates and therefore classroom separation explains the difference in the sharing of friends. Whether or not these shared friendships continue in life needs to be investigated.

## Methodological considerations

Methodological strengths of this study were the prospective, longitudinal design, the large sample size and the correction for confounding effects like externalising problems in the twins, and urbanisation levels and SES of the family. The large sample size made it possible to test for interaction effects of separation with sex and zygoty. Lastly, the sample in this study was population-based, which makes the results representative of the normal twin population in The Netherlands and probably most Western countries.

**Table 1** Mean scores of separated and non-separated MZ and DZ, male, female and opposite sex twins, with and without correction of SES and externalising problem at age 3

	CITO score	CITO score including sign. covariates*	N twin pairs
1. Non-separated MZM	539.34 (7.49)	539.38 (7.40)	286
2. Separated MZM	540.82 (8.30)	540.12 (8.76)	60
3. Partly MZM	540.53 (5.82)	540.16 (5.50)	24
Total MZM			370 pairs
1. Non-separated DZM	537.78 (8.31)	538.33 (8.11)	175
2. Separated DZM	539.25 (7.65)	539.06 (7.71)	66
3. Partly DZM	538.96 (7.83)	540.00 (7.62)	28
Total DZM			269 pairs
1. Non-separated MZF	537.38 (9.22)	537.62 (9.16)	339
2. Separated MZF	538.86 (7.49)	538.35 (7.46)	89
3. Partly MZF	538.56 (7.66)	538.39 (7.57)	41
Total MZF			469 pairs
1. Non-separated DZF	537.03 (8.25)	537.38 (8.43)	217
2. Separated DZF	538.50 (8.77)	538.11 (9.20)	59
3. Partly DZF	538.21 (7.43)	538.15 (7.75)	26
Total DZF			302 pairs
1. Non-separated DOS	538.30 (8.62)	538.08 (8.63)	427
2. Separated DOS	539.78 (8.32)	538.81 (8.37)	106
3. Partly DOS	539.48 (7.93)	538.85 (8.11)	60
Total DOS			593 pairs
Total			2003 pairs

Non-separated, same school, same classroom; Separated, same school, parallel classrooms; Partly, Partly the same classroom, partly separate classrooms; MZM, monozygotic males; DZM, dizygotic males; MZF, monozygotic females; DZF, dizygotic females; DOS, dizygotic opposite-sex.

\*SES and externalising problem behaviour at age 3.

### What is already known on this topic

- ▶ Two previous studies on behavioural and emotional problems suggest that early separated twin pairs show more internalising problems compared to non-separated twin pairs in the first grades of primary school.
- ▶ The effect sizes are small, however, and the effects have disappeared at the end of primary school.
- ▶ One study reports no differences between separated or non-separated twin pairs on cognitive development but has no information on zygosity.

### What this study adds

- ▶ Previous findings on cognitive development are replicated using an educational achievement test that has high predictive value for future educational achievement.
- ▶ No differences were found in cognitive scores between separated and non-separated twin pairs.
- ▶ Socioeconomic status and externalising problems interact with classroom separation and educational achievement in twins, but sex and zygosity do not (ie the effects are the same in male and female, MZ, DZ and opposite-sex twins).

This study has some limitations. There was no information on the reason why in some cases the CITO score of one twin was missing. However, inspection of the missing cases gave no indication for any systematic underlying factors that could explain these missing data. Furthermore, the data were of birth cohorts 1986–1993; it is possible that cognitive achievement differs between cohorts, but no cohort effects in CITO scores were found in the current analyses. Data on separation were derived from parental reports and not from a more objective source, like school records. A specific group in the analyses was the “partly separated” group. Nine percent of the mothers reported that their twins had “partly” been separated. Tests were made to find out whether externalising problems at age 10 might be a reason to separate twins later in school; this was not the case. One might think of other, for example, practical reasons such as moving of twin families, or expansion or reduction of a school population that enhances a separation or “coming together” later in school.

### Conclusions

Based on the current study, one can conclude that there is no empirical evidence that cognitive achievement of twins depends on their classroom situation. Thus, the present results support a policy in which there is no blanket ruling. However, based on factors indicated by the parents, teachers, or children themselves, there may be important reasons to separate twins at school, or not. The authors suggest, therefore, that classroom placement of twins should be based on each family’s needs individually, in consultation with teachers, parents and the children themselves.

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**Contributors:** All authors contributed towards the conception and design of the project, interpretation of the results, a critical review of the manuscript, and approved the final version. TJCP, MB and DIB designed the data analysis plan. TJCP performed the data analysis, wrote the manuscript, and is guarantor. CEM managed the data.

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