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Does Classroom Separation Affect Twins' Reading Ability in the Early Years of School?

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Abstract

In this article we report on reading ability of twin children in kindergarten to Grade 2 as a function of whether members of the pairs are assigned to the same or different classrooms. All analyses were run using mixed model regressions to account for the interdependence between twin pairs. The samples, total $N = 1505$, are from Australia and the United States. We found a close-to-significant difference in favor of same-class children in kindergarten and Grade 1. However, when results were adjusted to take account of pre-existing differences in disruptive behavior and in preliteracy ability, the class assignment effects disappeared. We suggest that these pre-existing differences, particularly disruptive behavior, are influencing decisions about whether to separate twins or not and also affecting early reading performance, a conclusion supported by significant correlations between the behavioral measures, preliteracy, and school-based reading. We conclude that, on average, early literacy in twins is not directly affected by their assignment to the same or different classrooms.

Keywords

reading; classroom; separation; twins; children; school

The question of whether to place members of twin pairs in the same or different classrooms in school is one that their parents often face. In some educational jurisdictions, policy dictates that twins be separated, in others, kept together, and in yet others, parents have the choice, often in consultation with teachers (Segal & Russell, 1992; Tully et al., 2004; Webbink et al., 2007). Alternatively, individual schools may have the authority to define a policy or they may be allowed to leave the decision to the parents (Hay et al., 2004). School policy can vary across countries, with, for example, Scandinavian countries keeping multiples together in most cases and the Netherlands more often tending to separate twins. In view of the wide range of practices and of the need for parents to make informed decisions, evidence on academic achievements of twins as a function of classroom placement is of value. In this paper, we report data on the early literacy development of twins in same versus different classrooms from kindergarten to second grade. The samples come from Australia and the United States, and are from a larger longitudinal study that also includes twins from Norway and Sweden. The Scandinavian children are not part of this

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report because almost all pairs are assigned to the same class, as per the policy described earlier.

We feel it is important to point out from the outset that our data do not come from a randomized controlled trial (RCT) of twin placement. As far as we are aware, no such study has ever been conducted, and ethical considerations make it unlikely that it ever will be. Because an RCT offers the best prospects for imputing causality, conclusions from this study must be constrained. But our data do at least have the advantage of including observations taken prior to the start of formal schooling, and so we are in a position to indicate if any pre-existing characteristics of the children themselves might influence the decision to separate them or not and to take any such characteristics into account in evaluating school-based data.

Previous Studies

Tully et al. (2004) investigated reading abilities in 878 pairs of 7-year-old twins from the Twins Early Development Study (TEDS; Trouton et al., 2002). The twins had either been separated from early in school at age 5, not separated at 5 or 7, or separated late at 7. There was no difference in scores on the Test of Word Reading Efficiency (TOWRE; Torgesen et al., 1999) between the groups separated early or not at all for either monozygotic (MZ) or dizygotic (DZ) twins, but the late-separated MZ group performed more poorly than the never-separated group, though the effect was small. This is the only study we are aware of that specifically assessed reading.

A Dutch study by van Leeuwen et al. (2005) collected data from 843 twin pairs at age 12 on a test known as the *CITO*, comprising multiple-choice items on language, mathematics, information processing, and world knowledge. There was no effect of twin separation when pairs who had either been separated or together for their entire schooling were compared, although the group who had been partly separated scored modestly but significantly higher. No breakdown into the test's four components was supplied. It is assumed that the questions required reading on the part of the children, but the variance accounted for by reading itself is unknown.

An interesting feature of the van Leeuwen et al. (2005) study is that it had data available on internalizing and externalizing behavior at age 3. Internalizing includes anxiety and withdrawal, and externalizing includes aggression and rule breaking. It appeared that long-term effects of separation could be seen for both types of problems (higher levels for separated pairs), but they were fully explained by pre-existing differences between those destined to be separated and those destined to be kept together. Although this is not directly relevant to academic achievement, the design is a good model for research into effects of twin separation in school — pre-existing scores on relevant variables can explain later decisions to separate twins.

Another Dutch study investigated the effects of separation on language, arithmetic, and IQ in Grades 2, 4, and 6 (Webbink et al., 2007). Language was assessed through the 'understanding of words and concepts' (p. 576). There was an effect in favor of nonseparated twins at Grade 2 on language, though not on arithmetic or IQ, and the effect was larger for same-sex than opposite-sex twins. This was about the age when Tully et al. (2004) observed similar effects in MZ twins for reading (though they referred to this effect as being with the late-separated group). Webbink et al. found that for twins separated for three years or more, separation actually increased language performance from Grades 6 to 8, but only for opposite-sex pairs. This study reported no preschool measures of variables commonly linked to later language levels.

Thus, the available evidence points to some possible differences in language and reading according to whether twins are separated or not, with separation associated with lower scores in the early grades (Tully et al., 2004; Webbink et al., 2007). Partial separation increased language scores in one study (van Leeuwen et al., 2005). However, the absence of preschool data in the Webbink et al. (2007) and Tully et al. (2004) studies ruled out the investigation of pre-existing differences as possible contributors to later effects of separation on academic achievements. The only gender differences reported were a larger effect for opposite- than same-sex pairs in the Webbink et al. (2007) study.

Current Study

This report focuses on reading ability in twins from kindergarten to Grade 2 and on preschool measures of disruptive behavior and of preliteracy abilities in a longitudinal study. We were firstly interested in knowing whether reading performance was affected by the cumulative separation of a duration of 1, 2 or 3 years, assessed at kindergarten, Grades 1 and 2 respectively. We were also interested in whether reading performance was affected by later separation in Grades 1 or 2 (equivalent to the Van Leeuwen et al. (2005) partly-separated group and the Tully et al. (2004) late-separated group). See Figure 1.

Method

Participants

The participants comprised 1,505 children who were either same-sex twins or triplets (50% MZ; 51% males), all with data at preschool and with 1, 3 and 9% missing data at kindergarten, Grade 1 and Grade 2 respectively. In the final wave of testing later this year we will collect most of data missing at grade 2. Figure 1 presents the number of participants in each analysis. Mean age at preschool assessment was 59 months, and the children were approximately 18 months older at kindergarten assessment and one year older again for each of the two subsequent assessments. The Australian twins were recruited from the National Health and Medical Research Council's Australian Twin Registry. Twins in the United States were recruited from the Colorado Birth Registry. The Australian families were approached by mail, with a 62% participation rate. In the US, the families were approached by phone, with 88% of the 60% of families who could be contacted when the twins were 4 agreeing to participate. The zygosity of 81% the pairs was determined by DNA analysis, collected via a cheek swab, and in the remaining cases by items from the Nichols and Bilbro (1966) questionnaire.

Materials

Disruptive behavior—The Disruptive Behaviour Rating Scale (DBRS; Barkley & Murphy, 1998) was the measure used to identify traits of inattention, hyperactivity–impulsivity and oppositional–defiant behaviors (Friedman-Weieneth et al., 2009). The DBRS uses a 4-point scale: *never or rarely* — 0, *sometimes* — 1, *often* — 2, *very often* — 3. The DBRS has previously been shown to be a valid predictor of ADHD symptoms in young children (Lahey et al., 2004). Test–retest reliability has ranged from .49 to .75 for periods of one and two years (Willcutt et al., 2007), indicating moderate to high stability. The composite used throughout was an average of the tester and parent ratings.

Preschool print knowledge—At preschool, we used a composite measure of print knowledge as the best proxy of reading in later years. It correlates .56 and .45 with reading at kindergarten and Grades 1 respectively. Print knowledge comprised four tasks: Letter recognition from names and from sounds, concepts about print (Clay, 1975), and a test of environmental print exposure, using common words like *stop* and *exit*. Cronbach's alphas

were .92 and .87 for letter recognition from names and sounds, .83 for concepts about print, and .46 for environmental print (see Samuelsson et al. 2007 for full details).

Word identification—At kindergarten and Grades 1 and 2 we elected to use the Test of Word Reading Efficiency (TOWRE; Torgesen et al., 1999) as the signature measure of literacy for consistency with Tully et al. (2004). The choice is also justified by the high correlations between it and the other measures of literacy that we have administered. In a Principal Components Analysis of the two subtests of the TOWRE, sight-word identification and nonword identification (see Method), a spelling measure, and a reading comprehension measure, we identified just a single factor, accounting for over 80% of the variance (Byrne, et al., 2009). Within each subtest the children were required to read as many real words (sight words) or nonwords (phonemic decoding) as they could from a list within 45 seconds. Each subtest has two forms; we used both for more reliable estimation and averaged the sight-word and phonemic decoding scores for each child, justified by the correlation of .88 between them (Byrne et al., 2009). The published test–retest reliability for 6 to 9 year olds is .97 for word and .90 for nonword reading.

Procedure

Informed consent was obtained from parents prior to their child's participation and children gave verbal assent. Testing in the preschool phase took place over five sessions, either in the home or a quiet part of the child's preschool, and one of the parents (the mothers in 93% of cases) was asked to complete the DBRS on the first day, with testers completing the scale at the end of each days' testing. Kindergarten, Grade 1 and Grade 2 data were collected from the children during an assessment that lasted approximately one hour in a quiet room at school or home. For further detail on the testing procedure see Byrne (2005, 2009). The tests included measures other than the TOWRE, but in this report we use only the TOWRE results. For a description of the full testing protocol, see Byrne et al. (2006; 2007; 2008). Each twin within a pair was examined by a different tester, with both assessments conducted simultaneously. In each year of the study, parents supplied information as to whether the twins were in the same or separate classes.

Data Preparation

We treated the DBRS ratings as a continuous scale. In clinical practice, children are given categorical diagnoses of attention deficit and/or hyperactivity/impulsivity disorder, based on a child being ascribed a particular minimum number of symptoms. However, there are good reasons to consider the clinical states as the extremes of continuous distributions (Barkley, 1997; Hay et al., 2007; Willcutt et al., 2000), and we wished to take advantage of the greater statistical power and the information in subthreshold symptomatology afforded by using the entire score range.

We standardized the reading measures within country because there is evidence that the Australian children were better readers than their US counterparts (Byrne et al., 2007). For consistency, we also standardized the behavior measures. Following usual practice, we also adjusted the variables for effects of age and sex. We present the standardized values throughout for all measures.

Data Analysis

Both members of the twin pairs were included in all analyses. To correct for their interdependence, we ran linear mixed model regressions in SPSS, which were estimated with restricted maximum likelihood (REML) and included both fixed and random effects. The random effects were uncorrelated and included (1) a variable specifying the twins as pairs (i.e., each pair of twins had their own id number), and (2) another specifying the effect

shared by MZs but not DZs (i.e., each MZ pair had their own id number and all DZs were treated as individuals who were unpaired, each having their own ID number; Visscher et al., 2004).

Results

Zygosity did not interact with class status in any of our analyses, so we report class status just as a main effect. In kindergarten, class status was simply Same (S) or Different (D). In Grades 1 and 2 we subdivided the group into those who were in the same class throughout and those who were in different classes throughout. This allowed us to consider the effects of the never versus always separated groups and we present these results below. To assess the effects of late separation, we also compared those separated for the first time in Grades 1 or 2 against those not separated in these years. We present the means, standard deviations and *N*s for these groups in Figure 1, and the statistics from all regression analyses in Table 1.

For kindergarten the regressions showed a trend toward higher scores on reading for children in the same class, $t(700) = 1.68$, $p = .094$. The effect size for the difference, calculated using Cohen's *d* statistic (Cohen, 1988), was .12. Although the mean difference did not reach conventional levels of statistical significance, we nevertheless considered the implications of even a trend in that direction to be important enough to examine the pattern further.

A regression of both disruptive behaviors and pre-reading ability revealed pre-existing differences, with children assigned to different classes in kindergarten being rated at preschool as having significantly more disruptive behavior, $t(702) = -5.63$, $p < .001$, Cohen's $d = .40$; $M = 0.25$, $SD = 1.03$, than the others ($M = -0.15$, $SD = .96$), and as having significantly lower print knowledge, $t(711) = 2.72$, $p = .007$, Cohen's $d = .21$; $M = -.14$, $SD = .99$, than the others ($M = .07$, $SD = 1.01$). When we covaried the kindergarten TOWRE scores on disruptive behavior, the *p* value for the adjusted mean difference was .56, showing that the reading difference had disappeared. The Sobel test (Sobel, 1982) measures whether the indirect path between reading and class status via behavior is significant: thereby suggesting the direct path between reading and class status is actually mediated, or explained, by this indirect path. This test confirmed this above result and showed that disruptive behaviors significantly mediated the association between class assignment and kindergarten reading (*z* score = 4.81, $p < .001$). Hence, those children separated in kindergarten were close to being significantly poorer readers at the end of kindergarten, but these same children also exhibited higher levels of disruptive behavior in preschool. When we covaried for just print knowledge in preschool we again found the association between reading in kindergarten and class status disappeared ($p = .658$). The Sobel test again confirmed print knowledge was a significant mediator (*z* score = 2.69, $p < .01$). Preschool print knowledge and the DBRS correlated $-.281$, $p < .01$.

A similar pattern held for Grade 1. There was a close-to-significant difference in TOWRE scores across the three groups, $t(471) = 1.96$, $p = .050$, Cohen's $d = .17$, with children in the same class scoring higher, as in kindergarten. However, after covarying on either preschool behavior, or preschool print knowledge, the difference between children placed in the same versus different class for two consecutive years disappeared.

In Grade 2 the means for children placed in either the same or different class for three consecutive years showed less of a trend toward significance. The regression yielded, $t(303) = 1.61$, $p = .108$, Cohen's $d = .18$. We did not analyze this grade further. These findings suggest that, irrespective of the duration of separation (1, 2 or 3 years), the effects of

separation on reading are small at best, and can be explained entirely by behavior or reading differences clearly evident prior to separation.

We also assessed whether late separated pairs, versus those never separated, were associated with reading, and irrespective of the grade in which late separation first occurred (1 or 2), there were no associations between being separation status and reading at the end of that year, $t(967) = 0.196$, $p = .845$, Cohen's $d = .11$ for Grade 1; and $t(472) = 0.767$, $p = .444$, Cohen's $d = .08$ for Grade 2.

Discussion

There was a trend in the data for twins who had been assigned to the same class to be better readers than those assigned to different classes in kindergarten and Grade 1. We found that differences in preschool in either the measure of the disruptive behaviors exhibited or prereading ability distinguished those who were subsequently separated in kindergarten from those kept together, with higher levels of disruptive behavior and lower prereading ability in those separated. Covarying the kindergarten and Grade 1 reading results on either preschool behavior or pre-reading ability eliminated group mean differences in reading, suggesting that both pre-existing behavioral patterns and prereading ability account for the differences. The significant though modest correlation between the DBRS and prereading ability is consistent with the pattern of results. For behavior, this hypothesis is plausible given the known relationship between disruptive behaviors and reading, something that is further confirmed within our sample. Ebejer et al. (in press) showed that in each of the grades from kindergarten to second, inattention and hyperactivity /impulsivity (based on parent ratings in each year) correlated to a small-to-modest extent with TOWRE performance levels (inattention from .24 to .31, hyperactivity/impulsivity from .12 to .13, all significant because of large sample sizes of up to 743, with inattention and hyperactivity/ impulsivity correlating .56–.58 across the three years). The correlations between prereading ability and school-level reading (being .56 and .45 for reading at kindergarten and Grades 1 respectively) are also consistent with the elimination of class status effects once the preschool data are entered as a covariate.

We submit that one or both of these factors, levels of disruptive behavior and prereading ability, are influencing parental decisions about kindergarten class assignment insofar as parents have the power to decide. We further submit that it is more plausible that it is behavior levels that affect their decisions than it is preliteracy ability, though our evidence is entirely anecdotal. Parents whose children are showing high levels of disruptive behavior have sometimes volunteered to us that placing such twins in the same class could present problems for the teacher and for other children. In contrast, none has indicated that their assessments of the twins' preliteracy skills have affected their classroom placement decisions. In any case, it appears that subsequent levels of reading appear to be more affected by these pre-existing characteristics than by classroom separation per se.

Overall, our results are broadly in line with those of Tully et al. (2004), the other study to have used the TOWRE. They showed a small effect of separation (late separation in their case), as we did if we ignore conventional significance levels. What is not known is whether Tully et al.'s effect could also be accounted for by differences pre-existing at preschool. With regard to these, we found it necessary to separately control for the effects of pre-reading ability in addition to disruptive behaviors to be comfortable the less proficient reading in kindergarten was not a consequence of classroom separation in that year. To explain, while it is possible for children who were both separated in kindergarten and were less proficient readers in that year to have exhibited more disruptive behaviors in preschool, this does not guarantee they were also less proficient at pre-reading in preschool. In fact,

they could have been equally proficient in their preschool pre-reading as those separated a year later but have exhibited less proficient reading a year later in kindergarten *as a consequence* of having been separated. Hence, we controlled for pre-reading at preschool, and the fact that this accounts for the less proficient reading ability in those separated in kindergarten confirms that their separation in no way contributed to their less proficient reading.

In a separate paper (Byrne et al., In press) we use classroom separation or not to assess whether there were differences in teacher ability. Given the overlap with the measures used here, we feel it important to clarify the difference between the two studies. Here, we explore the effects of separation or not on mean reading ability. In Byrne et al., we focused on the degree of similarity between twin pairs, using correlation, for those either separated or not. The similar correlations between the two groups suggested the differences in teacher ability accounted for less than eight percent of the variance in childhood literacy. Importantly, this conclusion is not invalidated by our findings herein of mean differences in reading ability in those either separated or not.

Implications

If our interpretation is correct, parents need not be concerned that separation will, of itself, impede early reading development when they are deciding about twin placement in school. Naturally, we limit ourselves to reading as we assessed it, as against other school subjects. However, our test does correlate highly with other measures of literacy, including reading comprehension in the early grades, and the available research does not point to any consistent, unambiguous effects of separation on academic achievement in general, advantageous or otherwise. We recognize that particular pairs of twins being separated, or kept together for that matter, may cause distress, and anecdotally parents have described such effects to us. Thus, we concur with van Leeuwen et al. (2005, p. 390) when they recommend ‘that the decision about classroom separation of twins should be based on what parents think is best for their twins and for themselves’.

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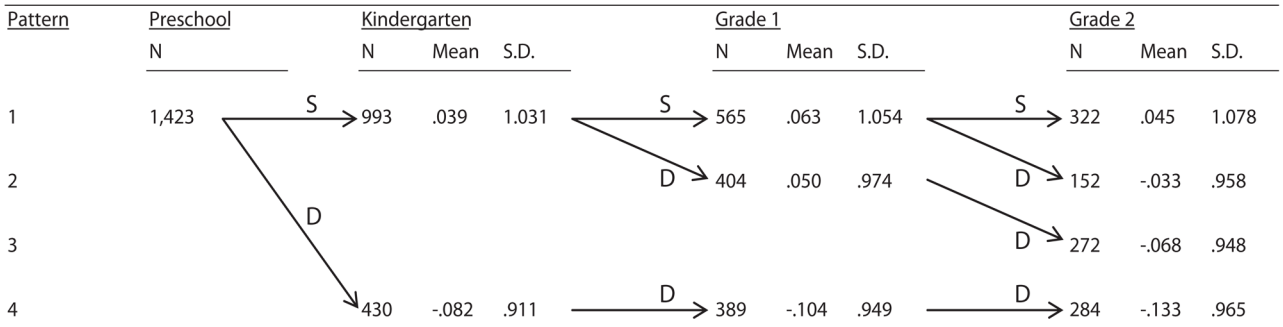

Effects explored	Kindergarten reading compared for:	Grade 1 reading compared for:	Grade 2 reading compared for:
Never V always separated	1 v 4	1 v 4	1 v 4
Never V first separated in each year	1 v 4	1 v 2	1 v 2

Figure 1.

Overview of the comparisons made throughout the paper and the Ns, means and standard deviations (SD) for the TOWRE measure of reading for twin pairs who were either in the same (S) or in a different (D) class. The difference between the number of participants reported here and in the methods is due to missingness primarily on the same/difference class variable.

Table 1

Regressions of the Association Between Reading Ability and Class Status (Whether Twins Were in the Same or Different Class)

	Regression 1: Predicting reading from class status				Regression 2: Predicting reading from class status and behavior				Sobel test: behavior mediating reading and class status		Regression 3: Predicting reading from class status and print				Sobel test: Print mediating reading and class status	
	Beta	***SE***	***t***	***p***	***Beta***	***SE***	***t***	***p***	***Z score***	***p***	***Beta***	***SE***	***t***	***p***	***Z score***	***p***
Kindergarten																
Same/Diff class	.125	.075	1.68	.094	.042	.073	0.58	.564			.027	.061	0.44	.658		
Covariate					−.209	.024	−8.83	.000	4.81	<.001	.485	.023	20.70	.000	4.75	<.001
Grade 1																
Same/Diff class	.166	.085	1.96	.050	.089	.085	1.05	.292			.074	.076	0.98	.328		
Covariate					−.169	.031	−5.41	.000	2.69	<.01	.398	.031	12.80	.000	2.78	<.01
Grade 2																
Same/Diff class	.172	.107	1.61	.108												