

## **Season of Birth and School Success in the Early Years of Primary Education**

Pieter Verachtert\*, Bieke De Fraine, Patrick Onghena & Pol Ghesquière

*Katholieke Universiteit Leuven, Belgium*

Several studies have reported significant relationships between students' season of birth and different measures of their academic success (i.e., the 'season of birth effect'). Whereas most of these studies were cross-sectional, the current study uses growth curve modeling to analyse longitudinal data on 3,187 children in Flemish primary education. The results indicate season of birth effects on both grade retention and mathematics achievement during the first two years of primary school. Because, in Flanders, children born within the same calendar year start compulsory education at the same moment, children born in the fourth quarter (October – November – December) invariably are among the youngest in their year group. Almost 20% of these children were found to have been retained or referred to special education by the end of Grade 2, whereas for children born in the first quarter (January – February – March), this was only 6.34%. First quarter-born children also showed moderately higher mathematics achievement at the start of first grade. During the next two school years, this achievement gap between children born in the first and the fourth quarter narrowed only slightly. Finally, differentiated instruction was not found to be related to the decrease of the season of birth effect.

*Keywords:* Season of birth; Grade retention; Mathematics achievement; Growth curve model; Differentiated instruction

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\*Corresponding author. Centre for Educational Effectiveness and Evaluation, Department of Educational Sciences, Katholieke Universiteit Leuven, Dekenstraat 2 (PO Box 3773), B-3000 Leuven, Belgium. Email: Pieter.Verachtert@ped.kuleuven.be

## **Introduction**

### *Age differences within classrooms*

In most educational systems, fixed rules apply as to when children are allowed to start compulsory education. These rules often stipulate a minimum age level (e.g., six years old) and one or more prescribed school entry dates (e.g., 1 September). Once children go to school, they are usually grouped in year groups (or grades), containing children who are born within the same period of 12 months. Which children start in which year group depends on the applied cutoff date. In England and Wales, for example, children born between 1 September and next year's 31 August generally belong to the same year group. In Flanders (the Dutch speaking part of Belgium), on the other hand, the applied cutoff date is 1 January. Consequently, Flemish year groups consist of children born within the same calendar year.

These age-based grouping mechanisms are intended to result in homogeneous classes by putting together students with a similar developmental level. Thereby, it is assumed that children within a year group have corresponding levels of maturation and experience. Therefore, they can be educated together. This assumption of homogeneity, however, is not entirely correct, as a year group leaves intact small interindividual differences in age. These age differences may amount to 12 months and even more, as children for different reasons (e.g., delayed school entry, grade retention, grade skipping) may be educated in another year group than can be expected on the basis of their chronological age.

Within their year group, all children take up a certain age position. For most children, this age position is a reflection of their month of birth (Gledhill, Ford & Goodman, 2002). In which month or season children have to be born to take a high or low age position depends on the applied cutoff date. In England and Wales, summer-born children take the lowest age positions, whereas, in Flanders, autumn-born children are the youngest in their year group.

### ***Season of birth effects***

Several studies have reported a clear relationship between students' season of birth and their success in school (Davis, Trimble & Vincent, 1980; Hutchison & Sharp, 1999; Lien, Tambs, Oppedal, Heyerdahl & Bjertness, 2005; Menet, Eakin, Stuart & Rafferty, 2000; Mortimore, Sammons, Stoll, Lewis & Ecob, 1988). Thereby, older children are generally found to outperform younger children within the same year group.

Season (or month) of birth effects have been found for different indicators of school success. Davis et al. (1980) studied a sample of about 54,000 US children and found significant relationships between children's month of birth and their reading, spelling and mathematics achievement in Grades 1 and 4. A number of UK studies also reported that autumn-born children are generally overrepresented in the higher streams of secondary education, whereas the lower streams of secondary education contain higher proportions of summer-born children (Freyman, 1965; Jinks, 1964; Sutton, 1967). Freyman (1965) recorded the birth dates of 364 British children with learning problems and found that half of these children (46.7%) were born between May and August and, thus, were among the youngest in their classes. Similar studies reported disproportionately high numbers of summer-born children in referrals for special educational needs (Bookbinder, 1967; Wallingford & Prout, 2000; Williams, 1964; Wilson, 2000) and for academic or behavioral problems (Drabman, Tarnowski & Kelly, 1987; Tarnowski, Anderson, Drabman & Kelly, 1990). Finally, yet another British study (Gledhill et al., 2002) indicated that summer-born children are at increased risk of being incorrectly identified as having learning difficulties.

There is some evidence that season of birth effects in education diminish as children grow older. Studies involving samples of lower grade children, for example, almost invariably found season of birth effects, whereas studies with higher grade children did not (Armstrong, 1966; Dipasquale, Moule & Flewelling, 1980). Hutchinson and Sharp (1999) reported season

of birth effects to be educationally significant at ages 6, 8 and 10, but not at age 12. Similarly, Davis et al. (1980) found clear relationships between children's month of birth and their achievement in spelling and mathematics in Grades 1 and 4, but not in Grade 8. However, most studies on the persistence of season of birth effects in education were cross-sectional, comparing children from different cohorts.

Finally, season of birth effects have not exclusively been found in education. Instead, they are evident in all kinds of competitive activities in which performance is highly correlated with age and level of maturity, such as sports (Dudink, 1994). Uneven season of birth patterns have, for example, been found in soccer (Helsen, Van Winckel & Williams, 2005), tennis (Edgar & O'Donoghue, 2005) and hockey players (Hurley, Lior & Tracze, 2001).

### ***Explanations for the season of birth effect in education***

Although the present study will not directly address questions about possible causes of the relationship between season of birth and school success, it was considered useful to review some of the explanations previous research has offered for this relationship. These explanations include medical factors, length of schooling and age position effects (Sharp, Hutchinson & Whetton, 1994).

First, researchers in psychopathology have suggested that increased frequency of infections and vitamin D deficiency during the winter months may lead to a relatively higher frequency of neurological problems in children who are born in the late spring or summer (Martin, Foels, Clanton & Moon, 2004). Contrary to this hypothesis, however, a recent large-scale study by Lawlor, Clark, Ronalds and Leon (2006) concluded that the effect of season of birth cannot be explained by seasonal differences in temperature, maternal nutrition, or frequency of infections during critical periods of brain development. Additionally, the fact that season of birth effects can equally be found in educational systems where autumn-born children are

the youngest within their year groups (e.g., Bedard & Dhuey, 2006) does not support this hypothesis.

Second, several researchers have argued that differences in length of schooling may contribute to the relationship between season of birth and school success (Fogelman & Gorbach, 1978). In England and Wales, summer-born children tend to enter infant school one or two terms later than many of their peers (Gledhill et al., 2002). This difference in amount of schooling may cause summer-born children to perform less well on achievement measures than do children born in a different season. Although most studies found season of birth effects regardless of length of schooling (Bell & Daniels, 1990; Berglund, 1967; Daniels, Shorrocks-Taylor & Redfern, 2000; Williams, 1964), Sharp et al. (1994) showed that, in a national representative sample of UK children at the end of Year 2, length of schooling was uniquely and positively related to children's Standard Assessment Task scores, at least for those children who were above 4;4 years old upon school entry. Likewise, length of schooling might account for season-bound achievement differences in Flemish education, as winter-born children (January – February – March) may spend up to one full year more in preschool education than their autumn-born peers (October – November – December).

Finally, the most reasonable hypothesis is that of the age position effect. This hypothesis states that the youngest children within a class are disadvantaged when compared to their older classmates. Several possible reasons could be given for this disadvantage. First, younger children might be developmentally less mature than their older classmates (Martin et al., 2004). Various neurocognitive functions (e.g., attention, self-control) are known to become more efficient as children grow older. Hence, younger children might be less well equipped than their older peers to meet the cognitive demands in school. Additionally, there is some evidence that teachers tend to underestimate younger children's academic and social skills, because they see them as developmentally immature (Mortimore et al., 1988). These

lower teacher expectations might, in turn, influence younger children's actual achievement. Furthermore, the level of instruction adopted in the classroom is often tailored to the ability level of the 'average' child. Therefore, instruction might sometime be too difficult for the youngest children, which causes them to miss more learning opportunities than their older peers. Most studies that attempted to unravel the relative importance of the age position versus the length of schooling found that the age position of a child is the main explanatory factor for the relationship between season or month of birth and school success (Bell & Daniels, 1990; Berglund, 1967; Daniels, Shorrocks-Taylor & Redfern, 2000; Williams, 1964).

### ***The current study***

Most research on the relationship between season of birth and school success has been conducted in the UK. In Flanders, on the other hand, research on this topic is scarce. In addition to the different cutoff date, the Flemish educational system differs from those in the UK on at least two other important aspects. First, UK children rarely repeat a grade. Consequently, the relationship between children's month of birth and their age position within the year group is rather straightforward. In this respect, UK studies often use the term 'relative age effects' to refer to achievement differences related to children's month of birth. In Flanders, however, many children are retained in kindergarten or first grade. As a result, season of birth may not only be related to achievement differences within a year group, but also to differences in retention rates. Furthermore, retained children necessarily take the highest age positions in their class, regardless of their month of birth. Therefore, grade retention should be taken into account when studying season of birth effects. Second, Flemish children differ significantly more from each other in terms of (pre)school experience than do UK children. As mentioned before, some Flemish children have spent almost one year longer

in preschool when they enter first grade than some of their first grade classmates. If length of schooling indeed (partially) explains the season of birth effect, then the size of the relationship between season of birth and achievement might be larger in Flanders than in other countries or regions.

In addition to the fact that this study investigates season of birth effects in Flanders, it intends to extend the existing research in two other important ways. First, no available studies have used longitudinal data to study the persistence of the season of birth effect over time. Instead, cross-sectional data from different cohorts were used to address this issue. In this study, however, longitudinal data from a single cohort will be employed to investigate the size of the season of birth effect between the start of Grade 1 and the end of Grade 2. Second, as to possible interventions to prevent or diminish the season of birth effect, studies have often focused on structural changes in school entry policies (e.g., Reijneveld et al., 2006). The present study, however, examines differentiated instruction as a possible means to reduce the impact of children's season of birth on their achievement.

Specifically, the analyses performed in this study were guided by the following main research questions. First, can we find a relationship between season of birth and grade retention? Considering the timing of primary school entry in Flanders, we hypothesized that children born in the last quarter (October – November – December) would more often be retained than their peers born in the first quarter (January – February – March). Second, do the relatively large age differences between children within the same cohort result in different levels of mathematical abilities at the start of first grade? Here, we hypothesized that non-retained children born in the first quarter would outperform children born in the last quarter. Third, how do these age-related achievement differences evolve between the start of first grade and the end of second grade? Based on the results of previous research, we expected the mathematics achievement gap between younger and older children from the same cohort to

narrow as children grow older. Fourth, does this achievement gap develop differently in classrooms with frequent differentiated instruction practices than in classrooms where there is less attention for children's individual learning needs? Two hypotheses can be formulated regarding the effect of differentiated instruction. First, if classroom differentiation is predominantly used to provide low performing children with additional and more appropriate learning opportunities, it might be expected that this type of support will be especially beneficial for the youngest children and, thus, will reduce the season of birth effect in achievement. On the other hand, if differentiated instruction targets both low and high performing children, only small or no relationships may be found between the use of differentiated instruction and the evolution of the achievement gap between younger and older children.

## **Data and method**

### ***Participants***

The present study was part of a large-scale longitudinal survey in Flemish primary education (SiBO<sup>1</sup>), in which a single cohort of children is followed longitudinally between kindergarten and sixth grade. Purpose of this umbrella study is to describe and explain differences in children's educational careers throughout primary education (Maes, Ghesquière, Onghena & Van Damme, 2002). Therefore, a nationally representative random sample of 122 Flemish primary schools were selected. The ongoing SiBO data collection started in September 2002 and involved all children who were in their last year of kindergarten<sup>2</sup> during school year

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<sup>1</sup> 'SiBO' is a Dutch acronym for 'Schoolloopbanen in het BasisOnderwijs' (School Careers in Primary Education).

<sup>2</sup> Flemish elementary education is composed of three preprimary and six primary grades. Children normally enter first grade (i.e., the first year of primary school) on September, 1 of the calendar year they turn six years old. Consequently, children in the last year of kindergarten are typically between 5 and 6 years old.

2002-2003. In the present study, data were used from the second and third year of the SiBO study, during which most of the children in the SiBO sample were in first and second grade.

The initial data set for the present study comprised all children ( $N = 3,990$ ) who were in first grade in one of the participating schools during school year 2003-2004. At the start of that school year, children were between 4;8 and 9;8 years old ( $M = 6.29$ ,  $SD = 0.44$ ). Furthermore, the data set contained 50.71% boys and 49.29% girls. Additionally, descriptive information was available for most children on their mothers' highest educational degree (9.87% missing), their parents' nationality at birth (13.88% missing) and the language they spoke at home with their parents and siblings (4.31% missing). About 41% of the mothers were found to have a degree in postsecondary education, 37% had a high school diploma and 22% had not completed high school. With regard to their ethnic-cultural background, 89.05% of the children in our sample were found to have Belgian or Western European parents, 5.56% had Turkish or Moroccan parents and the remaining 5.38% had parents born in other countries. Finally, 79.52% of the children were strictly native speakers (Dutch), 11.60% spoke both Dutch and a foreign language and 8.88% spoke no Dutch at home. Because our random school sample was found to be nationally representative, it was assumed that the characteristics of the children in our data set offered an adequate description of the whole population of Flemish first graders.

### ***Measures***

**Mathematics achievement.** During the studied two-year period, children's general mathematics achievement was assessed at three different time points: at the beginning of Grade 1, at the end of Grade 1 and at the end of Grade 2. For that purpose, age-appropriate mathematics achievement tests were used. These tests were part of a larger longitudinal battery of mathematics tests which were constructed for use in the SiBO study. Each of the

mathematics tests had a number of items in common with the preceding and following tests. Hence, all tests could be vertically equated using a three-parameter item response theory (IRT) model (Lord, 1980). Based on this equation, observed test scores were converted into scale scores with a common metric, allowing us to model children's mathematics growth between first and second grade.

Because most Flemish children are not very familiar with the Arabic number system until they are in first grade, the mathematics achievement test for the beginning of first grade did not contain items involving numeric symbols (Verachtert, Ghesquière, Hendrix, Maes & Van Damme, 2005). The test consisted of 40 items, clustered in four subtests: Magnitude Comparison (15 items; e.g., "These are my bottles. Which picture contains one bottle more than I have?"), Seriation (10 items; e.g., "Look at this row of cars. Which car is the third car in the row?"), Counting (5 items; e.g., "Draw nine dots in this fungus.") and Mathematical Concepts (10 items; e.g. "My figure has five angles. Which of these figures also has five angles?"). Internal consistency for the whole test, as measured by Cronbach's alpha coefficient, was considered high and satisfactory ( $\alpha = .90$ ).

The mathematics test administered at the end of first grade equally consisted of 40 items, involving numbers ranging between 0 and 20 (Verachtert et al., 2005). These items were clustered in five subtests: Number Sense (10 items; e.g., "Which number is halfway between 12 and 16?"), Arithmetic Word Problems (10 items; e.g., "A chicken has two legs. How many legs do four chickens have?"), Estimation (5 items; e.g., "How tall is our teacher? He is a little shorter than [multiple choice]."), Number Decomposition (10 items; e.g., " $10 = 2 + 4 + ?$ ") and Number Series (5 items; e.g., "10, 13, 16, ?"). Again, Cronbach's alpha coefficient indicated that the test's internal consistency was high ( $\alpha = .92$ ).

Finally, the mathematics achievement test for the end of second grade (Hendrikx, Verachtert, Ghesquière, Maes & Van Damme, 2005) had 50 items, divided into five subtests: Number

Sense (10 items; e.g., “By how much is 44 less than one hundred?”), Arithmetic Word Problems (10 items; e.g., “Vicky has 22 building blocks. How many towers of five can she build with these?”), Computational Problems (10 items; e.g., “ $40 = [6 \times 5] + [? \times 5]$ ”), Number Series (5 items; e.g., “85, 65, 45, ?”) and Measurement and Geometry (15 items; e.g., “Mark the geometric figure that is not a quadrangle [multiple choice].”). The range of Arabic numbers used in this test (0 to 100) was considerably wider than for the mathematics test administered at the end of first grade. The size of Cronbach’s alpha coefficient was similar to those for the other tests ( $\alpha = .92$ ).

**Differentiated instruction.** In an extensive questionnaire on teachers’ opinions and classroom practices, a number of questions were included which assessed the extent to which teachers took into account interindividual differences in mathematical abilities in their classrooms. Teachers were asked to focus on the mathematics lessons they had given during the most recent standard school week. It was assumed that these lessons would be representative for the lessons that were given during the whole school year. First, teachers had to indicate how frequently they had used whole-classroom instruction, had organized activities in smaller groups or pairs and had given individual tasks. Specifically, they were asked to mention the proportion of instructional time devoted to each of these teaching methods. The proportion of whole-classroom mathematics instruction was then used as a (negative) measure of differentiated instruction (WholeClass).

Second, teachers had to indicate how frequently they had used differentiated instruction geared toward the lowest or highest achieving children in their classrooms. Two items assessed the use of extended or remediating instruction, directed at children achieving low in mathematics. Another two items assessed how frequently teachers had used extra high-level instruction and offered additional exercise opportunities to children showing high

mathematics performance. All four items were rated on a four-item Likert scale, ranging from 1 (*never*) to 3 (*at least 5 times*). Two continuous variables, DiffLow and DiffHigh, were constructed for use in the analyses by averaging the individual item scores for each pair of items.

**Age-related variables.** For three children, no birth dates could be recorded because they left their school in a very early stage and moved to an unknown destination. Based on the available data, a number of binary age-related variables were constructed. A first variable, IsDelayed, indicated whether or not children were below their age-appropriate grade level at the start of first grade (e.g., due to grade retention or delayed school entry). As successfully promoted children in our sample were typically born in 1997, the children in the delayed group were born in 1996 or earlier. A small number of children, born in 1998, were found to have skipped a grade and, thus, were above the grade level expected on the basis of their chronological age. These children were marked by a second variable, IsAdvanced. Finally, four binary variables indicated whether children were born in the first quarter (January – February – March), second quarter (April – May – June), third quarter (July – August – September), or fourth quarter (October – November – December) of their year of birth.

### ***Procedure***

The mathematics achievement test for the beginning of first grade was administered in the second week of September 2003, when children had already spent one full week in their first grade classrooms. Tests for the end of first and the end of second grade were administered during the last week of May 2004 and the last week of May 2005, respectively. All tests were administered simultaneously to all children in each classroom.

Teacher questionnaires were sent to the participating schools in November 2003 (first grade) and in November 2004 (second grade). If two teachers were assigned to a single classroom, both teachers were asked to complete a questionnaire. Teachers who did not return their questionnaires within a reasonable period of time were contacted again in an attempt to maximize response rates.

## **Results**

### ***Grade retention and season of birth***

Not all children from our initial sample of first graders ( $N = 3,990$ ) progressed successfully through the early years of education. First, 283 children (7.09%) were found to be repeating first grade during the first year of the study (2003-2004). Additionally, based on their birth dates, 208 of the first-time first graders (5.21%) were found to have been delayed earlier in school (e.g., in kindergarten). In sum, 12.30% of the 3,990 children in first grade were delayed. At the end of first grade, not all children were promoted to second grade: 60 were referred to special education (1.50%) and 294 were retained in first grade (7.37%). In sum, only 3,193 children (80.03%) from our initial sample were still in the age-appropriate grade at the end of the second year of the study (2004-2005). To investigate the relationship between season of birth and grade retention, we used data from the children who were in first grade for the first time during the first year of the study and who were not referred to special education after first grade ( $N = 3,644$ ). Within this group, birth quarter frequencies were compared for the children who were still in the age-appropriate grade and those that were not. For both groups, Table 1 displays the number of children born in each quarter.

< TABLE 1 about here >

Results of a chi-square test of independence indicated that a significant relationship existed between season of birth and school delay ( $\chi^2(3, N = 3,644) = 81.01; p < .001$ ). Most children in the delayed group (38.58%) were born in the last quarter of their year of birth, whereas only 12.64% were born in the first quarter. Additionally, about 20% of the children in our initial sample who were born in October, November, or December were found to be delayed by the end of the study. For children born in January, February, or March, this proportion was only 6.43%. Analogous proportions for the children born in the second and third quarter lay between those for both other groups.

### ***Season of birth and initial mathematics achievement***

The second research question that guided this study concerned the relationship between season of birth and mathematics achievement at the start of primary education. In order to avoid estimation bias, these analyses included only children who were in first grade for the first time during school year 2003-2004 ( $N = 3,707$ ). Initial mathematics achievement scores were available for 3,593 first-time first graders in 119 schools. Two schools failed to administer the test to their pupils ( $N = 34$ ) and, as far as information on individual nonresponse was available, it was concluded that missing achievement scores for the remaining children ( $N = 80$ ) were due to a variety of reasons (e.g., illness). Because the proportion of missing mathematics scores was only small, it was assumed that the possible bias in the estimation of the population parameters due to missing data would be trivial.

To investigate whether group differences in mathematics performance at the start of first grade existed between the four birth groups, a two-level regression analysis was performed in MLwiN (version 2.02; Rasbash, Browne, Healy, Cameron & Charlton, 2005), thereby taking into account the clustering of students in schools. All models were adjusted for measurement

error using the method<sup>3</sup> outlined by Raudenbush and Sampson (1999). The results are summarized in Table 2.

< TABLE 2 about here >

Children who were born in January, February, or March showed, on average, significantly higher mathematics achievement at the start of first grade than later-born children. Not surprisingly, the largest achievement difference was found between children from the first and the fourth quarter of their year of birth ( $b = -3.27$ ). Expressed in terms of Cohen's  $d$  (Cohen, 1992), this difference represented a moderate effect ( $d = .45$ ). The achievement gaps between the oldest group and both intermediate groups, on the other hand, were small at most ( $d < .30$ ).

These results, however, did not take into account the fact that a considerable number of children in our sample were retained in kindergarten before they entered first grade. Because grade retention was found to be related to season of birth, it was considered useful to examine whether season of birth effects on achievement were different for delayed than for regularly promoted children. Delayed children born in the first quarter scored, on average, 6.70 points lower on the mathematics test at the start of first grade than children born in the first quarter who had progressed regularly. This difference represented a large effect ( $d = .89$ ). More importantly, however, our data suggested an opposite relationship between season of birth and mathematics achievement within the delayed group, with younger delayed children tending to score higher on the initial mathematics test than older delayed children. Because the standard errors for the parameters involving the relevant variable, *IsDelayed*, were rather

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<sup>3</sup> Because the mathematics score used in the present study were obtained through an IRT analysis, they were assumed to represent children's true mathematical abilities. Additionally, the IRT model produced estimated standard errors for all individual mathematics scores. In all models in this study, it was assumed that the level-1 variance was known and equal to the square of those standard errors.

large due to the small numbers of delayed children in each birth quarter, only the mathematics achievement difference between delayed children born in the first and the fourth quarter was found to be statistically significant. Finally, within the regularly promoted group, achievement differences between the four birth groups were about equal to those found in the analysis that did not take grade retention into account. The average achievement difference between regularly promoted children born in the first and the fourth quarter was still moderate ( $d = .43$ ).

### ***Season of birth and mathematics growth***

After the initial assessment of children's mathematical skills at the start of first grade, children were retested at the end of first grade and at the end of second grade. The mathematics test for the end of first grade was administered to 3,574 children in 120 schools. One school, with 44 pupils, did not administer this test to any of its pupils. The other children with missing achievement data for the end of first grade ( $N = 89$ ) were spread over the participating schools. As indicated before, a substantial number of children left the study at the end of school year 2003-2004 because they were retained in first grade or were referred to special education. An additional group of children left the study because their school ended its participation in the study ( $N = 6$ ) or because they moved to a nonparticipating school ( $N = 116$ ). Eventually, 3,231 children from our sample were found to be in second grade during school year 2004-2005. At the end of that school year, the mathematics test for the end of second grade was administered to 3,156 children in 120 schools. Again, children with missing achievement data ( $N = 75$ ) were spread over numerous different schools.

To model children's mathematics achievement growth between the start of first grade and the end of second grade, achievement data were used from all children who were not retained in first grade, who had not changed schools during the studied two-year period and for whom

mathematics scores were available for at least one of the three measurement occasions (N = 3,187 in 120 schools). Multilevel growth curve modeling (Singer & Willett, 2003) was used to estimate separate linear growth curves for all selected children and their schools. Thereby, a time variable was used with values 0.33, 8.81 and 20.76, representing the difference in months between 1 September 2003, and the prescribed test administration dates for the measurement occasions at the beginning of first grade, the end of first grade and the end of second grade, respectively. Consequently, the intercept of each growth model represented children's mathematics achievement level at the start of first grade. Intercepts and slopes were allowed to vary between schools and between pupils within schools. In a first model, an overall growth rate was estimated, whereas a second model estimated separate growth rates for children born in different quarters. A final model investigated whether the relationship between season of birth and mathematics growth was different for children who were retained before they entered first grade. Table 3 contains parameter estimates and standard errors for all relevant variables included in each of these three models, as well as estimates of the multilevel variance components.

< TABLE 3 about here >

Children's mathematics scores were found to increase, on average, 14.43 points per year between the start of first grade and the end of second grade. Of principal interest, however, was the relationship between children's mathematics growth and their season of birth. No difference was found between the growth rates for children from the first and the second birth quarter. Children born in the last two quarters, on the other hand, showed a significantly faster growth in mathematics achievement than children born in the first quarter. These results indicated that the size of the season of birth achievement gap decreased significantly

during the first two years of primary education. The fact that the estimates involved reached high significance levels ( $< .001$ ), however, did not provide solid information on the size of this decrease. Therefore, two types of effect sizes were calculated. First, in terms of the standard deviation of the individual-level growth rates ( $SD = \sqrt{6.62} = 2.58$ ), the growth differences between children from the first birth quarter and children from the third and fourth birth quarter had effect sizes of only .22 and .32, respectively. Second, between the start of first grade and the end of second grade, the achievement gap between children from the first and the fourth birth quarter narrowed from 3.27 to 2.35 points, representing a decrease of merely 28%. Figure 1 depicts the significant but small reduction of this achievement gap over the studied two-year period. Finally, the relationship between season of birth and mathematics achievement growth was not found to be different for children who were retained before they entered primary education, as compared to regularly promoted children.

< FIGURE 1 about here >

### ***Differentiated instruction as a mitigating factor?***

A final set of models investigated whether several forms of differentiated instruction were related to (the evolution of) the mathematics achievement gap between children born in different birth quarters. Information on differentiated instruction practices was derived from the teacher questionnaires administered in first and second grade. Because many children changed classes (within schools) between first and second grade, it was difficult to include class as an extra level in the multilevel model. Therefore, first and second grade values for each variable on differentiated instruction (WholeClass, DiffLow and DiffHigh) were averaged. The three resulting variables, with similar names, were included as pupil-level

variables in the multilevel growth models. Within the group of children selected for the growth analyses ( $N = 3,187$ ), values of WholeClass, DiffLow and DiffHigh were recorded nonmissing for 2,397 (75.21%), 2,635 (82.68%) and 2,675 children (83.93%), respectively. As a result, the growth models including the differentiated instruction variables differed slightly in terms of sample size. Table 4 presents parameter estimates, standard errors and variance components for the three final growth models, each including one of the variables on differentiated instruction.

< TABLE 4 about here >

Not very surprisingly, the amount of differentiated instruction children were offered in the first two years of primary education was not related to children's mathematics achievement at the start of first grade. Furthermore, only one significant relationship effect was found between children's mathematics growth and the use of differentiated instruction. Children who attended classrooms with high levels of whole-class mathematics instruction showed significantly less mathematics achievement growth over the studied period of time. The size of this effect, however, was minimal ( $d = |-.04|/\sqrt{6.66} = .02$ ). Analogous parameter estimates for DiffLow and DiffHigh were not significantly different from zero. Although almost no relationships were found between the differentiation variables and mathematics achievement, it was examined whether significant effects could be found if these relationships were allowed to vary between birth groups. For example, spending some regular classroom time to extra remedial instruction for low achieving children (with a large proportion of children from the last birth quarter), might increase these children's mathematics growth and, at the same time, decrease the growth of high achieving children (with a large proportion of children from the first birth quarter), because they receive less appropriate instruction. In

such a case, an effect of differentiated instruction might only be found if the three-level interaction between season of birth, mathematics growth and differentiated instruction is studied. However, none of the three-level interaction parameters was found to be significantly different from zero.

### ***Conclusion***

In the present study, two types of relationships were found between children's season of birth and their school achievement in the early years of education. First, younger children (i.e., children born in the last months of the calendar year) were more often subject to grade retention than older children (i.e., children born in the first months of the calendar year). Second, among children who entered first grade for the first time, small to moderate mathematics achievement differences were found between children from different birth quarters. As to the evolution of these differences, it was concluded that, although the season of birth achievement gap narrowed significantly during the first two years of primary education, important achievement differences remained at the end of second grade. Finally, classroom differentiation did not accelerate the closing of the mathematics achievement gap between younger and older children.

### **Discussion**

Because most research on season of birth effects in education has been conducted in the UK and grade retention is an almost non-existing practice there, this study provided an excellent opportunity to investigate the potential relationship between season of birth and grade retention frequency. Therefore, we subdivided the children in our sample into birth groups and compared these groups on the proportions of children who were retained at least once before they reached the end of second grade. The results showed that, in Flanders, autumn-born children, which generally are among the youngest in their year groups, were retained

more than three times as frequently as winter-born children. In this, our results parallel those of similar research conducted in the US, where Martin et al. (2004) found that about 25% of the summer-born fifth graders in their sample was no longer in the age-appropriate grade, whereas for their autumn-born classmates this proportion was only near 9%. Given the fact that early grade retention is likely to have a negative impact on children's future academic achievement (Gadeyne, Onghena & Ghesquière, 2007; Mantzicopoulos & Morrison, 1992) and psychosocial functioning (Jimerson, 2001; Pagani, Tremblay, Vitaro, Boulerice & McDuff, 2001), our findings raise strong concerns about the educational inequalities that may stem from a trivial fact like month of birth. Although our study did not investigate possible causes of these inequalities, some potential causes may be identified. First, as outlined before, teachers may underestimate the developmental level of the youngest children in their classrooms and, therefore, too often recommend that autumn-born children would be retained. Additional research is necessary to clarify this issue. Second, the cognitive standards children have to meet in order to be allowed to enter first grade may be too high for autumn-born kindergartners. A practice, often applied in the US (Graue & DiPerna, 2000), whereby summer-born children's kindergarten entry is deliberately postponed to ensure that they take a more favourable age position within their kindergarten classroom (i.e., academic redshirting), does not exist in Flanders and, therefore, can not function as an explanation for the relatively high proportion of autumn-born children in the delayed group.

In this study, not only a relationship was found between season of birth and grade retention, but also between season of birth and mathematics achievement at the start of primary education. Children born in different seasons enter first grade with different levels of mathematics abilities. For regularly promoted children, the mean achievement difference between autumn- and winter-born children at the start of first grade was equivalent to the effect of over two months of mathematics education. At first sight, this achievement

difference might seem rather easy to overcome. The results of our growth analyses, however, showed that 22 months after children had entered first grade the mathematics achievement gap between autumn- and winter-born children had decreased by only 28%. If this achievement gap would continue to narrow at the same pace, then the season of birth effect would have disappeared as soon as children reached the end of Grade 6. This result is in accordance with previous cross-sectional studies, which found significant season of birth effects until children are about 10 or 11 years old (Davis et al., 1980; Hutchinson & Sharp, 1999).

Strikingly, we found some evidence for a reversed season of birth effect in the group of delayed children. Within this group, younger (autumn-born) children tended to perform slightly better than older (winter-born) children. An explanation for this finding may lie in the fact that for autumn-born children their relatively lower age and related immaturity might be the main reason for their grade retention, whereas for winter-born children grade retention might be an indication of some other (cognitive) problem, unrelated to age (e.g., learning disability, mental retardation, etc.). As a result, autumn-born children might eventually catch up with their non-retained peers, whereas winter-born children, without appropriate intervention, continue to struggle academically.

Today, a considerable amount of knowledge is available about the mechanisms that lie behind the relationship between season of birth and academic achievement. However, because educational systems apply different school entry regulations, these mechanisms may actually differ between countries and regions. In Flanders, it is very likely that interindividual differences in maturity and length of preschooling cause differences in academic ability level at the start of primary education. Again, future research on this topic would be useful, because information on why children who are born in different seasons have different amounts of school success should enable researchers to look after possible remedies in a

much more goal-oriented way. In this study, we explored the use of differentiated instruction as a means to help autumn-born children to catch up with their 'luckier-born' classmates. Thereby, we reasoned that autumn-born children who were educated in classrooms with large amounts of differentiated instruction targeted at low achieving children would show faster achievement growth than autumn-born children who were educated in classrooms with large amounts of class-oriented instruction. However, none of the three variables on differentiated instruction used in the present study was related to a significant change in the decrease of the mathematics achievement gap between autumn- and winter-born children. Maybe, providing autumn-born children with appropriate levels of instruction is not a good way to tackle the season of birth effect in education. On the other hand, the classroom differentiation measures used in this study certainly had some limitations. First, they were based on a very small number of teacher-rated items. Probably, extensive observational measures would have yielded more detailed and reliable information on the amount and quality of the differentiated instruction practices in the participating classes. Additionally, because differentiation measures were aggregated over time, potential large differences between first and second grade classes were eliminated.

This study was among the first to explicitly study season of birth effects in Flemish education. Therefore, much work on this topic remains to be done. First, we investigated the relationship between season of birth and achievement in mathematics in the first two years of primary education. Future research should be conducted to examine whether the results of the present study extend to other academic domains. Additionally, the data collection in the SiBO survey will enable future analyses on season of birth effects in the higher grades of primary education. Furthermore, this study did not investigate possible underlying causes for the relationship between season of birth and academic success. Future studies should be

undertaken to examine the unique impact of interindividual differences in maturity, length of schooling, teacher expectations and other potential causal factors.

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Figure 1. Predicted overall growth trajectories for children born in the first and fourth quarter.

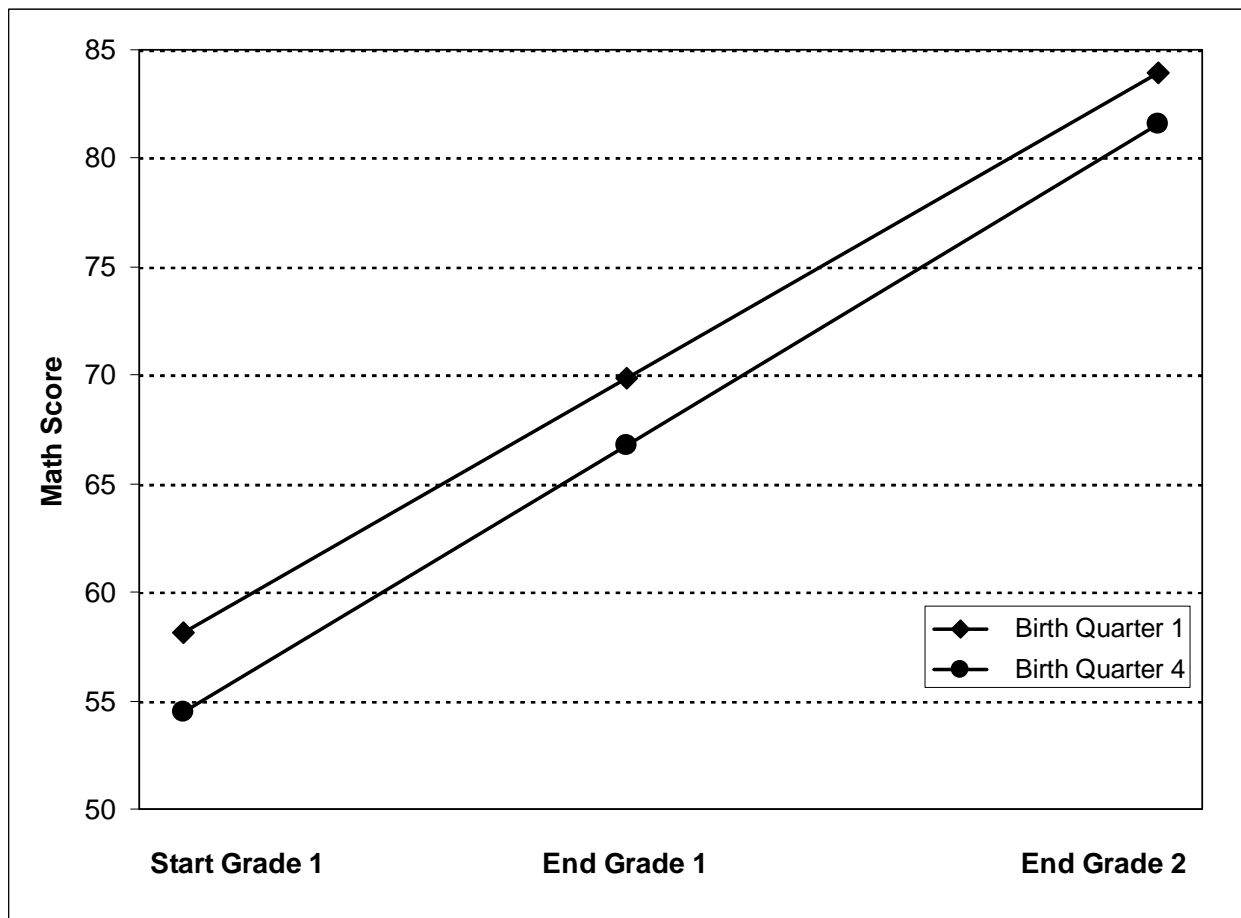


Table 1. Birth quarters for successfully promoted versus delayed first-time first graders.

Group	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	N	%	N	%	N	%	N	%
Successfully promoted (N = 3,193)	830	25.99%	841	26.34%	829	25.96%	693	21.70%
		93.57%		89.85%		86.90%		79.93%
Delayed (N = 451)	57	12.64%	95	21.06%	125	27.72%	174	38.58%
		6.43%		10.15%		13.10%		20.07%
Total (N = 3,644)	887	24.34%	936	25.69%	954	26.18%	867	23.79%
		100.0%		100.0%		100.0%		100.0%

Table 2. Initial mathematics achievement differences between birth quarters.

Parameter	Season of Birth x			
	Season of Birth		IsDelayed	
	Estimate	SE	Estimate	SE
FIXED				
Intercept	56.99***	(0.37)	57.09***	(0.37)
Quarter 2	-0.98**	(0.32)	-0.92**	(0.31)
Quarter 3	-1.94***	(0.30)	-1.90***	(0.31)
Quarter 4	-3.27***	(0.29)	-3.11***	(0.30)
IsDelayed			-6.70***	(1.80)
IsDelayed x Quarter 2			1.40	(2.12)
IsDelayed x Quarter 3			3.08	(2.05)
IsDelayed x Quarter 4			4.43*	(1.83)
RANDOM (variance components)				
School level intercept	9.06	(1.93)	8.55	(1.78)
Pupil level intercept	31.79	(1.09)	31.22	(1.02)
DEVIANCE	24,124.19		24,061.77	

\* p < .05. \*\* p < .01. \*\*\* p < .001.

Table 3. Mathematics achievement growth differences between birth quarters.

Parameter	Growth		Growth x Season of Birth		Growth x Season of Birth x IsDelayed	
	Estimate	SE	Estimate	SE	Estimate	SE
FIXED						
Intercept	58.01***	(0.34)	58.18***	(0.35)	58.20***	(0.35)
Quarter 2	-0.63*	(0.29)	-0.72*	(0.30)	-0.70*	(0.29)
Quarter 3	-1.31***	(0.27)	-1.56***	(0.28)	-1.59***	(0.28)
Quarter 4	-2.47***	(0.27)	-2.80***	(0.28)	-2.94***	(0.29)
IsDelayed	-3.73***	(0.53)	-3.72***	(0.53)	-5.28*	(2.10)
IsDelayed x Quarter 2					0.16	(2.30)
IsDelayed x Quarter 3					1.81	(2.22)
IsDelayed x Quarter 4					2.63	(2.18)
Time	14.43***	(0.15)	14.06***	(0.18)	14.06***	(0.18)
Time x Quarter 2			0.20	(0.17)	0.24	(0.17)
Time x Quarter 3			0.55***	(0.16)	0.56***	(0.16)
Time x Quarter 4			0.75***	(0.19)	0.82***	(0.20)
Time x IsDelayed					0.41	(1.13)
Time x IsDelayed x Quarter 2					-1.72	(1.18)
Time x IsDelayed x Quarter 3					-0.67	(1.25)
Time x IsDelayed x Quarter 4					-1.07	(1.13)
RANDOM (variance components)						
School level intercept	7.20	(1.29)	7.22	(1.29)	7.25	(1.30)
School level slope (Time)	2.09	(0.40)	2.09	(0.39)	2.10	(0.40)
School level intercept x slope	-1.67	(0.44)	-1.68	(0.49)	-1.73	(0.45)
Pupil level intercept	24.27	(0.71)	24.31	(0.71)	24.22	(0.71)
Pupil level slope (Time)	6.71	(0.31)	6.62	(0.30)	6.60	(0.30)
Pupil level intercept x slope	-0.89	(0.38)	-0.88	(0.38)	-0.84	(0.37)
DEVIANCE	100,927.70		100,913.50		100,912.10	

\* p < .05. \*\* p < .01. \*\*\* p < .001.

Table 4. Interactions between mathematics growth, season of birth, and differentiated instruction.

Parameter	Growth x Season of Birth x WholeClass		Growth x Season of Birth x DiffLow		Growth x Season of Birth x DiffHigh	
	Estimate	SE	Estimate	SE	Estimate	SE
FIXED						
Intercept	58.57***	(0.35)	58.22***	(0.35)	58.28***	(0.35)
Quarter 2	-1.04**	(0.32)	-0.60	(0.32)	-0.69*	(0.32)
Quarter 3	-1.86***	(0.30)	-1.42***	(0.30)	-1.43***	(0.29)
Quarter 4	-3.06***	(0.33)	-2.70***	(0.32)	-2.70***	(0.30)
IsDelayed	-3.24***	(0.67)	-3.22***	(0.63)	-3.33***	(0.62)
WholeClass	-0.00	(0.02)				
DiffLow			-0.17	(0.41)		
DiffHigh					0.34	(0.34)
Time	14.04***	(0.21)	14.02***	(0.19)	14.05***	(0.19)
Time x Quarter 2	0.23	(0.19)	0.15	(0.19)	0.17	(0.19)
Time x Quarter 3	0.55**	(0.17)	0.58***	(0.16)	0.55***	(0.16)
Time x Quarter 4	0.63**	(0.21)	0.71***	(0.20)	0.66***	(0.20)
Time x WholeClass	-0.04*	0.01				
Time x DiffLow			0.57	(0.34)		
Time x DiffHigh					0.15	(0.27)
RANDOM (variance components)						
School level intercept	5.75	(1.16)	5.61	(1.04)	5.68	(1.04)
School level slope (Time)	2.38	(0.47)	1.86	(0.38)	1.98	(0.42)
School level intercept x slope	-1.52	(0.52)	-1.09	(0.39)	-1.25	(0.39)
Pupil level intercept	24.11	(0.80)	23.76	(0.79)	23.84	(0.77)
Pupil level slope (Time)	6.66	(0.39)	6.70	(0.35)	6.63	(0.35)
Pupil level intercept x slope	-1.11	(0.43)	-0.76	(0.41)	-0.72	(0.40)
DEVIANCE	77,051.28		83,230.71		85,843.88	
N	2,397		2,635		2,675	

\* p < .05. \*\* p < .01. \*\*\* p < .001.

## **Season of Birth and School Success in the Early Years of Primary Education**

Pieter Verachtert, Bieke De Fraine, Patrick Onghena & Pol Ghesquière

*Katholieke Universiteit Leuven, Belgium*

**Pieter Verachtert** is Doctoral Researcher at the Centre for Educational Effectiveness and Evaluation, Katholieke Universiteit Leuven (Belgium). His research interests include the study of educational inequalities, the assessment and prediction of academic achievement and the measurement of school effectiveness.

**Bieke De Fraine** is lecturer at the Subfaculty of Psychology and Educational Sciences in Kortrijk, Belgium, and post-doctoral researcher at the Centre for Educational Effectiveness and Evaluation at the Katholieke Universiteit Leuven, Belgium. Her research focuses on educational effectiveness and growth curve models.

**Patrick Onghena** is Professor at the Faculty of Psychology and Educational Sciences, Department of Educational Sciences at the Katholieke Universiteit Leuven, Belgium, and is director of the Centre for Methodology of Educational Research. His research interests include applied statistical modeling, single-case experimental designs and statistics education.

**Pol Ghesquière** (PhD) is Professor at the Centre for Parenting, Child Welfare and Disabilities, Katholieke Universiteit Leuven (Belgium). His research focuses on the cognitive aspects of dyslexia and dyscalculia and their neurobiological basis, the assessment of specific learning disabilities, effective instruction and remedial teaching of children with learning problems.