This is a preprint of an article published in Australian Journal of Education.

Fergusson DM, Horwood LJ, Boden JM. Birth order and educational achievement in adolescence and young adulthood. *Australian Journal of Education*, 2006; 50(2): 122-139.

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Birth Order and Educational Achievement in Adolescence and Young Adulthood

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Acknowledgements: This research was funded by grants from the Health Research Council of New Zealand, the National Child Health Research Foundation, the Canterbury Medical Research Foundation and the New Zealand Lottery Grants Board.

Abstract

This paper examined the relationship between birth order and later educational outcomes in a birth cohort of over 1,000 New Zealand young adults studied to the age of 25. Being later born was associated with gaining fewer educational qualifications at secondary level and beyond. The use of nested models to control for the confounding effects of family size on birth order revealed that birth order effects on educational attainment were not disguised by family size effects. Following adjustment for potentially confounding factors, there remained a statistically significant association between being later born and a lower likelihood of obtaining educational qualifications. It was concluded that the intra-family dynamics initiated by birth order may have a lasting effect on the individual in terms of later educational and achievement outcomes.

Key words: birth order, longitudinal study, education, achievement

Birth Order and Educational Achievement in Adolescence and Young Adulthood

A large body of research has examined linkages between birth order and later psychological outcomes including mental health, intelligence, academic achievement, and personality (for reviews see Elliott, 1992; Heer, 1985; Steelman et al., 2002; Stewart & Stewart, 1995; Zajonc, 2001; Zajonc & Mullally, 1997). One aspect of this research has been an examination of the linkages between birth order and educational achievement. In general, this research has led to the conclusions that later birth position is associated with lower educational achievement and career outcomes. For example, Black, Devereux, and Salvanes (2005) examined the effects of birth order on educational achievement, using a sample consisting of the population of Norway, and found that earlier birth position was associated with a significantly greater number of years of education. Similarly, Herrera and colleagues (2003), using data from a large representative cross-sectional sample in Poland, found that first- and earlier born respondents reported a significantly greater number of years of schooling and higher levels of occupational prestige. Also, Travis and Kohli (1995) reported that earlier birth order was related to the total number of years of education, particularly for those individuals from middle-class families. These results were replicated using a prospective design in an Australian sample by Marjoribanks (1997). The evidence also suggests that this effect can be observed whilst children are still in school. For example, Sputa and Paulson (1995) found a relationship between earlier birth order and school achievement (grades and test scores) in a sample of adolescents. Also, Cherian (1990) reported a similar finding for adolescents in South Africa.

Supporting these findings are studies that have examined the birth order status of individuals in leadership positions. For example, Newman and colleagues (Newman, Pettinger, & Evan, 1995; Newman & Taylor, 1994) found that amongst state governors and

town supervisors in the United States, and amongst Australian prime ministers, there were more individuals who were first born than would be predicted by chance. Andeweg and Van Den Berg (2003) reported similar findings for a full list of incumbent politicians in the Netherlands. These findings also extend to more general measures of achievement, including the ratings of other family members. For example, Paulhus, Trapnell, and Chen (1999) found in a series of four studies that individuals consistently reported first- and earlier-born children from their own families as being the highest achievers, even after controlling for participants' beliefs about birth order.

These linkages between educational achievement and birth order may be explained in a number of ways. One explanation for these findings may be referred to as the "family resources" explanation (Hertwig, Davis, & Sulloway, 2002; Marjoribanks, 2001; Travis & Kohli, 1995). Under this explanation, any family has a given set of resources, and with increasing family size, families have decreasing resources to provide for the education and development of children. Later born children are therefore necessarily accessing a dwindling pool of resources, taking slices of an ever-shrinking pie. A second explanation may be referred to as the "family niche" explanation, in which successive siblings tend to differentiate themselves from other siblings in an attempt to maximize outcomes and create a unique identity within the family (Feinberg et al., 2003; Schachter & Stone, 1985; Sulloway, 1996; Super & Harkness, 1986; Wachs, 1996). On this view, if older siblings tend to favour scholastic and educational activities, then younger siblings would be more likely to favour an alternate life course.

Despite the existing evidence for the links between birth order and educational achievement and outcomes, there are a number of limitations to the existing literature. One major issue concerns the potentially confounding role of family size on the effects of birth order. In particular, family size sets the upper limit of an individual's birth order, with the

result that later born children will tend to come from larger families than earlier born children. In turn this raises the possibility that the apparent associations between birth order and educational achievement may be a disguised association between family size and educational achievement. The methods by which family size has been controlled in studies of birth order have varied. Many studies have failed to take family size into account (Andeweg & Van Den Berg, 2003; Herrera et al., 2003; Marjoribanks, 1997; Newman et al., 1995; Newman & Taylor, 1994; Travis & Kohli, 1995). In some studies family size has been introduced as correlated covariate factor (Black et al., 2005; Cherian, 1990; Sputa & Paulson, 1995). Finally, Paulhus et al. described the use of a within-family design which compared ratings of achievement for individuals from the same family using data on all family members (Paulhus et al., 1999). The current study aimed to illustrate how control for the effects of family size can be achieved using nested regression models (see Method).

Further limitations in the literature include the fact that a number of studies have employed a cross-sectional design (Cherian, 1990; Herrera et al., 2003; Paulhus et al., 1999; Sputa & Paulson, 1995), and have used retrospective recall to estimate the influence of family and other risk factors in determining educational outcomes (Marjoribanks, 1997; Travis & Kohli, 1995). Other studies have not controlled for a range of personal and family-related factors that may affect children as they develop into adulthood and that may be confounded with birth order (Black et al., 2005; Herrera et al., 2003; Marjoribanks, 1997; Paulhus et al., 1999). Further studies have employed small sample sizes or examined achievement in selected samples or specialized populations (Andeweg & Van Den Berg, 2003; Marjoribanks, 1997; Newman et al., 1995; Newman & Taylor, 1994).

Taken together, these considerations suggest that the ideal study design to examine linkages between birth order and educational outcomes is a longitudinal design in which a representative cohort is studied from infancy to adulthood. In such a study measures of birth

order and family, social, and emotional context can be collected at various points along the life span, and a wide range of measures can be employed to effectively control for covariates. Furthermore, the use of a large representative sample would allow for the use of nested models in which the effects of birth order on educational outcomes can be estimated for each strata of family size in order to effectively control for the confounding of birth order and family size.

The present research uses data gathered over the course of a 25-year longitudinal study to examine the linkages between birth order and subsequent educational achievement over the life course. The aims of this study were:

1. To examine linkages between birth order and educational achievement over the period from 16-25 years.
2. To control linkages between birth order and educational outcomes for a series of confounding factors. These factors included family size, maternal age, maternal education, single parenthood, family socio-economic status, average family income, family standard of living, breastfeeding, birth weight, child IQ and child achievement test scores.

More generally the aims of the study were to use extensive longitudinal data to further explore the linkages between birth order and educational outcomes.

Method

The data for this investigation were gathered as part of the Christchurch Health and Development Study (CHDS). The CHDS is a longitudinal study of a birth cohort of 1,265 children born in the Christchurch (New Zealand) urban region in mid-1977. The cohort has been studied at birth, 4 months, 1 year and at annual intervals to age 16 years, and again at ages 18, 21, and 25. The study has collected information from a variety of sources including:

parental interviews, teacher reports, self-reports, psychometric assessments, medical, and other record data. An overview of the study design, methodology, and major findings can be found in Fergusson, Horwood, Shannon, and Lawton (1989) and Fergusson and Horwood (2001). The present analysis used the following measures:

Birth order – At the point of the survey child's birth, parents were questioned as to the number of live births of children into the family prior to the birth of the survey child, and the ages of these children. All participants were assigned a birth order status on the basis of this questioning. Members of the birth cohort who were adopted into other families (n = 47) were excluded from the analyses.

Educational attainment

The outcome measures in the present study were based on assessments of cohort members' attainment of New Zealand high school and tertiary educational qualifications. The measures were chosen to reflect an ascending and progressive order of qualifications from those who attained no educational qualifications to those who attained a university degree.

In the New Zealand education system students attend high school for up to 5 years (Year 9-Year 13). The minimum school leaving age is 16. Most students turn 16 in Year 11; however, the majority of students remain in high school at least until the end of Year 12. The high school qualifications framework that applied for this cohort included the following qualifications. At the end of Year 11 students were eligible (but not required) to take School Certificate examinations. Most students sat examinations in 4-6 subjects. Student performance in each subject was graded from A to E, with a C representing a "pass" grade in the subject. In Year 12 (6^{th} form) students could complete an approved course of study (usually 5 or 6 courses in various subjects) leading to a qualification known as Sixth Form

Certificate. Similarly, in Year 13 (7th form) students could complete a qualification known as Higher School Certificate: this qualification was awarded to students who completed 5 years of high school education from Year 9 and who completed at least three subjects above Year 12 (6th form) level. Finally, in Year 13 students intending to progress on to university could sit University Bursary examinations. Those who attained a sufficient grade percentage in these examinations were eligible for entry into university, and those who attained at a higher level again were awarded a bursary to support their university study.

It should be noted that this system of secondary qualifications was changed in 2002 and so no longer provides an accurate description of the current high school qualifications framework in New Zealand.

The University system of qualifications is similar to overseas systems of qualifications, and requires the equivalent of three years full-time study to achieve a Bachelor's degree, a further one to two years for Honors or a Masters degree, and the equivalent of three years for a Doctoral degree.

At ages 18, 21 and 25 cohort members were questioned about their history of enrolment in educational institutions and their attainment of educational qualifications. Using this information the following hierarchy of measures of educational attainment was developed for the current investigation.

No high school qualifications – Sample members who had never attained any of the above high school qualifications by age 21, either while they were at high school or subsequently as adult students, were classified as having no high school qualifications: 18.1% of the sample had failed to attain any high school qualifications.

School Certificate passes – At ages 18 and 21, participants were questioned as to the number of School Certificate examinations they had undertaken and the grades received for each

subject. A measure of success in School Certificate examinations was based on a count of the number of pass (A, B or C) grades attained in these examinations.

Sixth Form Certificate – At ages 18 and 21, participants were questioned as to whether they had achieved Sixth Form Certificate and the subjects undertaken: 68.9% of the sample reported having attained Sixth Form Certificate.

Higher School Certificate- At ages 18 and 21, sample members were questioned about the attainment of Higher School Certificate: 42.3% of the sample had attained this qualification.

University Bursary – At ages 18 and 21 participants were questioned as to whether they had undertaken University Bursary examinations and the outcome of these examinations: 28.1% of the sample had passed the requirements for receiving a University Bursary.

Attended University – At ages 21 and 25, sample members were questioned as to whether they had ever enrolled at University, either full-time or part-time: 39.9% of the sample reported ever attending University by age 25.

University degree or equivalent – At age 25, sample members were questioned as to whether they had ever attained a Bachelor's level or higher degree from a university or equivalent tertiary institution: 26.1% of the sample reported having attained a degree.

Overall achievement score – Finally, a further outcome measure was devised to reflect the overall progression of each cohort member through the hierarchy of educational qualifications. As progression through secondary and tertiary qualifications has the properties of a Guttman-like scale (typically one must attain a particular qualification in order to move on to the next level), each level in the progression was assigned an ordinal value (from 0 = no high school qualifications to 6 = gained university degree), and each individual received a score based on his or her highest level of qualification. This score served as a measure of overall achievement in these analyses.

Confounding factors

The regression models employed a series of observed covariate factors that were abstracted from the study data base and were selected on the basis that: a) they were theoretically relevant predictors of later educational and achievement outcomes; and b) they were known on the basis of prior analysis to be significantly associated either with birth order or with later educational and achievement outcomes in the cohort. For the purposes of data display, scores on some these variables were dichotomized and percentages are displayed in Table 3. However, all covariates were analyzed in their original metrics. These measures are described below.

Family size – At the point of the survey child's birth, parents were questioned as to the number of live births of children into the family prior to the birth of the survey child, and the ages of these children. In addition, at each year from age one to 16 years detailed information was obtained via parental interview on current family structure, including the number and ages of all children in the family. For the purposes of the present analysis a measure of family size was based on the maximum number of children ever resident in the household at any time during the participant's childhood up to age 16 years.

Measures of socio-demographic background

Maternal age – this was assessed at the time of the survey child's birth.

Maternal education – maternal education level was assessed at the time of the survey child's birth using a three point scale which reflected the highest level of educational achievement attained. This scale was: 1 = mother lacked formal educational qualifications (had not graduated from high school); 2 = mother had secondary level educational qualifications (had

graduated from high school); 3 = mother had tertiary level qualifications (had obtained a university degree or tertiary technical qualification).

Single parenthood – single parenthood was assessed at the time of the survey child's birth by asking mothers whether they currently lived with the father of the child. Those cohort members who were born into single-parent families were classified as having single parenthood for the purposes of these analyses.

Family socioeconomic status – this was assessed at the time of the survey child's birth using the Elley-Irving (Elley & Irving, 1976) scale of socio-economic status for New Zealand. This scale classifies SES into 6 levels on the basis of paternal occupation, ranging from 1 = professional occupations to 6 = unskilled occupations.

Perinatal factors

Duration of breast-feeding – the duration of breast-feeding in months was estimated on the basis of the mother's report of her breast-feeding history obtained when the child was aged four months and one year.

Birth weight – the child's birthweight in grams as recorded in medical records of the child's birth.

Child cognitive ability

IQ – Child cognitive ability was assessed at ages 8 and 9 using the Revised Wechsler Intelligence Scale for Children (WISC-R: Wechsler, 1974). Total scores were computed on the basis of results on four verbal and four performance subscales. The split half reliabilities of these scores were .93 at age 8 and .95 at age 9. For the purposes of these analyses the observed WISC-R total IQ scores at age 8 and 9 were combined by averaging over the two administrations.

Scholastic ability - At age 13 cohort members were administered the Test of Scholastic Abilities (TOSCA: Reid et al., 1981). This test is designed to assess the extent to which the child exhibits the skills and competencies necessary for academic work in high school. The test was scored as recommended in the test manual to give a total scholastic ability score. The reliability of this score assessed by coefficient alpha was .95.

Statistical analyses

The bivariate associations between birth order and educational outcomes (Table 1) were tested for statistical significance using the Mantel-Haenszel chi squared test of linearity for dichotomous outcomes and one way analysis of variance for continuous outcomes. The associations were adjusted for family size (Table 2) by fitting a series of nested regression models. For continuous outcomes a linear regression model was fitted of the form:

$$Yi = B0^{k} + B1^{k}Xi + Ui$$

where Yi was the score on a given educational outcome for participant i, Xi was the participant's birth order and Ui was the model disturbance. In this model the intercept parameters $B0^{k}$ and slope parameters for birth order $B1^{k}$ were permitted to vary with family size k (k=1, 2, 3, 4+). The parameters $B0^{k}$ thus represent the main effects of family size and the parameters $B1^{k}$ represent the effect of birth order within levels of family size. For dichotomous outcomes a logistic regression model was fitted of the form:

$$\text{Logit}(Yi) = B0^{k} + B1^{k}Xi$$

where Logit (Yi) was the log odds for outcome Y, Xi was birth order and the parameters $B0^{k}$ and $B1^{k}$ had a similar interpretation to the linear regression model.

It should be noted that there is an underidentification in the above models that arises from the fact that, for a family size of one, birth order and family size are confounded. That is, for a family size of one it is not possible to estimate separate intercept ($B0^{1}$) and slope

($B1^1$) parameters. In the present analysis this problem was overcome by fixing the slope parameter $B1^1$ to zero. With this restriction a test of the equivalence of the birth order effect across different levels of family size was given by testing the null hypothesis H0: $B1^2 = B1^3 = B1^4$ using the fitted model parameters for each outcome. For continuous outcomes this hypothesis was tested by applying an F-test and for dichotomous outcomes by a log likelihood ratio chi squared test. Failure to reject the null hypothesis leads to a reduced model with a single slope parameter B1 reflecting the effect of birth order pooled over all levels of family size.

The associations between birth order and covariates (Table 3) were tested for linearity using Mantel-Haenszel chi squared for dichotomous measures and one way analysis of variance for continuous measures. The associations between birth order and educational outcomes were adjusted for family size and other covariates (Table 4) by extending the nested regression models above to include the measures of family socio-demographic background, perinatal factors and child cognitive ability. Finally, the estimated rates (dichotomous outcomes) or means (continuous outcomes) for each educational outcome adjusted for family size and other covariates were calculated (Table 5) using the methods described by Lee (1981).

Sample size and sample bias

The present analyses are based upon the samples having complete data on birth order and educational outcomes. As noted above, the analyses also exclude the small number of children (3.7% of the cohort) who entered adoptive families at birth. Sample sizes ranged from 1015 for high school outcomes to 968 for measures of university attendance/degree attainment. These samples represented between 79% to 83% of the original cohort of 1218 children who entered biological families at birth. In addition, there was further sample

attrition as a result of missing data on some of the covariates. In particular, data were missing for approximately 20% of the sample on the measures of child cognitive ability (WISC-R IQ, TOSCA) as a result of historical budgetary constraints that limited the cognitive testing of children to those who were resident in the local Canterbury region.

The following approaches were used to address possible selection bias resulting from sample attrition and missing data. First, missing data estimation methods were used to impute ability scores for those children with missing values on the cognitive ability measures. Missing value estimation was conducted using the impute procedure of Stata 8.0 (StataCorp, 2003) under the assumption that the data were missing at random. Second, to address issues of selection bias the data weighting methods described by Carlin, Wolfe, Coffey and Patton (1999) were applied. These methods involved a two-stage process. In the first stage, the obtained samples with complete data in each analysis were compared with the remaining sample members on a series of socio-demographic measures collected at birth. This analysis suggested that there were small but statistically significant ($p<.01$) tendencies for the obtained samples to under-represent individuals from socially disadvantaged backgrounds characterized by low parental education, low socio-economic status and single parenthood. The sample was then stratified on the basis of these characteristics to estimate the probability of inclusion in the sample for each analysis. In the second stage the data were reanalyzed with the data for each individual weighted by the inverse of the probability of sample inclusion. These analyses produced essentially the same pattern of results to those reported here, suggesting that the conclusions of this study were unlikely to have been influenced by selection bias.

Results

Associations between birth -order and academic achievement (by 25 years)

Table 1 shows cohort members classified into four groups on the basis of birth order. For each group the Table shows outcomes on a series of measures of school achievement. These include:

1. Measures of secondary (high) school achievement including School Certificate, 6th form Certificate, Higher School Certificate, and University Bursary. These outcomes were assessed up to age 21.
2. Measures of university participation including university attendance and degree attainment.
3. The overall levels of achievement on a rank scale from 0 (no qualifications) to 6 (university degree; see Method).

For each comparison the Table reports tests of linear association using the Mantel-Haenszel chi-squared test for dichotomous outcomes and one-way analysis of variance for linear trend for count measures. The Table shows that in all cases, declining birth order was associated with increasing achievement at high school and university. These trends are reflected in the overall achievement score which shows that first born children had mean achievement scores that were approximately .45 standard deviations higher than fourth or later born children.

INSERT TABLE 1 HERE

Adjustments for family size

As explained in the Introduction and Methods, an important factor that may confound the association between birth order and academic achievement is family size. This is so because the size of an individual's family sets the upper limit on their birth order. To take account of these linkages between birth order and family size, nested models were fitted to estimate the association between birth order and academic achievement for each family size strata k (k= 1,2,3,4). These models made it possible to estimate the association between birth order and educational outcomes taking into account family size. The results of the nested models are summarized in Table 2 which shows estimates of the pooled regression coefficients B and their standard errors, between birth order and each outcome, taking into account family size. The Table also reports the results of statistical tests for the equality of the regression coefficients across strata of the family size measure. The Table shows:

1. In all cases the associations between birth order and academic outcomes remained after stratification for family size. This result shows that the association between birth-order and educational outcomes did not reflect the disguised effects of family size on educational achievement.
2. In all cases, the tests of parameter equality do not show significant between-strata differences in the effects of birth order on outcomes. This test result justifies pooling data across family size strata to estimate the overall effects of birth order on outcomes.

INSERT TABLE 2 HERE

Adjustment for other covariates

Table 3 shows the association between birth order and a series of possible covariate factors that span family socio-demographic background (maternal age; maternal education; single-

parent family; family socio-economic status); perinatal factors (breast-feeding; birth weight); and measures of childhood ability (IQ, scholastic ability test scores). For ease of data display, some measures have been dichotomized and the association between each variable and birth order is tested for significance using either a) the Mantel-Haenszel chi-squared test of linearity for dichotomous variables, or b) a one-way analysis of variance for continuous measures. Examination of the Table shows:

1. There were clear and highly significant tendencies for increasing birth order to be associated with increasing age of mother at the birth of the research participant ($p<.0001$) and with lower maternal educational achievement ($p<.001$). In addition, first born children were more likely to enter a single parent family at birth ($p<.0001$). However, any association between birth order and family socio-economic status was weak and statistically non-significant.
2. Later born children were significantly less likely to have been breast-fed as infants ($p<.05$), but on average weighed more at birth ($p<.0001$).
3. Later born children had significantly lower scholastic ability (TOSCA) scores at age 13 ($p<.005$). Fourth or later born children also had lower IQ scores at ages 8-9. However, this association was non-significant.

INSERT TABLE 3 HERE

Covariate adjustment

To take account of the covariate factors in Table 3, the nested regression models used to generate Table 2 were expanded to include the variables in Table 3 as covariates. The results of this analysis are shown in Table 4. The Table shows estimates of the pooled regression coefficients B and their standard errors, between birth order and each outcome, taking into

account family size, and adjusted for the covariates in Table 3. The Table also reports the covariates that were found to be statistically significant in the fitted model for each educational outcome. The Table shows:

1. In all cases, the association between birth order and educational outcomes remained statistically significant after adjustment for both family size and the range of covariates in Table 3. This result shows that the associations between birth-order and educational outcomes did not reflect the effects of confounding factors.
2. In a number of cases, and in particular for the dichotomous outcomes, adjustment for confounding factors *increased* somewhat the parameter estimates for the effect of birth order on achievement in comparison to adjustment for family size alone. For example, in comparison with Table 2 the parameter estimate for the relationship between birth order and failure to obtain high school qualifications increased from .20 before adjustment to .39 after adjustment for other covariates. To examine this issue, further analyses were conducted in which covariates were removed individually from the regression equations to examine the impact on the resulting parameter estimates for birth order. These analyses suggested that the apparent inflation in the parameter estimates could be attributed almost entirely to a single covariate, maternal age. The reason for this was due to the fact that increasing birth order was associated with increasing maternal age. However, increasing maternal age was also associated with increased educational achievement. The net effect of this was that within levels of maternal age, the association of birth order with educational outcomes was stronger than would be observed in the absence of adjustment for maternal age.

INSERT TABLE 4 HERE

While the regression results in Table 4 suggest that birth order was significantly related to educational achievement after adjustment for confounding, the regression parameters do not give a clear indication of the strength of the adjusted associations between birth order and educational achievement. To address this issue the parameters of the fitted regression models were used to generate estimates of the adjusted percentages or means for each outcome controlling for family size and other covariates. Table 5 shows these adjusted estimates for each outcome cross-classified by birth order. The adjusted estimates were computed by the methods described by Lee (1981) and can be interpreted as the hypothetical means or percentages for each educational outcome for a given level of birth order averaged over all covariates in the model.

The Table shows that after adjustment for confounding, there were clear tendencies for increasing birth order to be associated with poorer high school achievement, lower rates of university participation and degree attainment. Further, the adjusted associations were generally very similar to the unadjusted associations given in Table 1. This is reflected in the adjusted means for the overall achievement measure, which shows that fourth or later born children had mean scores after adjustment that were approximately .4 standard deviations lower than first born children, compared to an unadjusted mean difference of .45 standard deviations.

INSERT TABLE 5 HERE

Discussion

In recent decades there has been a great deal of research examining the relationship between birth order and later life outcomes, and in particular the relationship between birth order and

educational and achievement outcomes. This research has thus far demonstrated a relationship between birth order and educational and achievement-related outcomes, and has generally concluded that later born children are less likely to gain educational qualifications, prestigious jobs, and high salaries. The evidence on which these conclusions have been based however has suffered from a number of limitations, including: a) the use of cross-sectional designs (Herrera et al., 2003; Paulhus et al., 1999; Sputa & Paulson, 1995); b) relying on retrospective recall to estimate the influence of family and other risk factors in determining educational outcomes (Marjoribanks, 1997; Travis & Kohli, 1995); c) failure to adjust results for family size (Andeweg & Van Den Berg, 2003; Herrera et al., 2003; Marjoribanks, 1997; Newman et al., 1995; Newman & Taylor, 1994; Travis & Kohli, 1995); d) failure to control for the psychosocial context in which the individual develops, and that may be confounded with birth order (Black et al., 2005; Herrera et al., 2003; Marjoribanks, 1997; Paulhus et al., 1999); and e) employing small or selected samples, or studying specialized populations (Andeweg & Van Den Berg, 2003; Marjoribanks, 1997; Newman et al., 1995; Newman & Taylor, 1994). In this study we have attempted to address many of these issues by using data gathered over the course of a 25 year longitudinal study to examine the extent to which birth order was associated with later educational and achievement outcomes. These analyses led to the following general conclusions.

First, there were pervasive associations between birth order and a range of educational outcomes spanning high school and university achievement. For all outcomes there were clear and linear trends for declining birth order to be associated with increasing educational achievement. These trends were reflected in an overall achievement measure that showed that first born children had mean scores that were .45 standard deviations higher than fourth or later born children.

As noted previously, family size is a major factor that may confound the association between birth order and achievement. In this study we have used nested regression models to estimate the association between birth order and achievement taking into account family size. These analyses clearly showed that increasing birth order was associated with declining achievement independently of the effects of family size.

Further examination suggested that later birth position was associated with both advantages and disadvantages in terms of family background and personal history. Advantages included increased maternal age, a lower likelihood of being born into a single-parent family, and a higher birthweight. Disadvantages included a lower level of maternal education, a lower likelihood of having been breast fed, and lower scholastic ability. It appears then, that there are a number of family and childhood-related factors that may contribute to the birth order effect (by being advantageous for early born children), whereas others may compensate for the birth order effect (by being advantageous for later born children). It could be suggested, therefore, that any apparent association between birth order and later outcomes reflects the psychosocial context in which the child develops, rather than the direct effects of birth order on longer-term development. This hypothesis was not supported however; after adjustment for the confounding effects of family size and the influence of a range of covariates, the effects of birth order on the attainment of educational qualifications and progress through secondary and tertiary education remained statistically significant, and in some cases were strengthened in magnitude. This suggests that, overall, family and childhood-related factors may have a small influence in terms of the effects of birth order on later outcomes, but in a way that compensates for the relative advantage conferred upon earlier born children.

The findings of this study can be viewed in the context of research on the relationship between birth order and educational and achievement outcomes. In the present cohort, earlier

born individuals were more likely to follow a path that led to gaining educational qualifications at the secondary and tertiary level. These findings are consistent with the literature on the relationship between birth order and educational and career achievement, which has generally found that earlier born individuals tend to outperform later born individuals in academic settings and in some employment outcomes (Andeweg & Van Den Berg, 2003; Black et al., 2005; Cherian, 1990; Herrera et al., 2003; Marjoribanks, 1997, , 2001; Newman et al., 1995; Newman & Taylor, 1994; Paulhus et al., 1999; Sputa & Paulson, 1995; Travis & Kohli, 1995).

The findings may also be viewed in the context of questions about the ways in which within-family dynamics can affect later life outcomes. While it is unclear at this point exactly what mechanism causes birth order to be related to later outcomes, the evidence to date would suggest that some aspect of family dynamics set in motion by having children born at different points in time (as is the case in most families) has an effect on those children's outcomes. One plausible explanation is a family resources explanation (Hertwig et al., 2002; Marjoribanks, 2001; Travis & Kohli, 1995), which suggests that the resources aimed at the future success and welfare of children are limited in any family, and that each successive child draws upon an ever-dwindling pool of family resources. Another plausible explanation is the family niche explanation (Feinberg et al., 2003; Schachter & Stone, 1985; Sulloway, 1996; Super & Harkness, 1986; Wachs, 1996), in which successive children in families tend to develop somewhat different personalities and interests in order to maximize outcomes in an uncertain future environment. These explanations are not mutually exclusive; for example, the family resources model could explain the mechanism by which the niche explanation operates, with resource comparison serving as a trigger for niche development in children. It should be noted, however, that the current findings are consistent with either explanation.

While the present study has a number of advantages that accrue as a result of studying the effects of birth order in the context of a long-term study of human development, the findings are not without possible limitations. Possible threats to the validity of the findings and conclusions drawn above include:

Control of covariates. It is possible that issues regarding covariate control may have influenced the results of this study. It may be plausible to suggest that the results of the study were "under-controlled" by the omission of related confounding variables (for example, common genetic factors), and that the effect of birth order on later outcomes could be due to a failure to identify and examine the correct set of covariates. While this possibility cannot be ruled out, it should be noted that the current study has employed a wide range of covariates, including those shown to be important in a wide variety of developmental outcomes in previous research regarding this cohort.

Cohort effects. This particular study examined the effects of birth order in a group of individuals born at the same time and who lived in the same location for a large portion of their lives. It could be suggested that these findings are applicable to this particular cohort, but may have limited applicability to other populations, particularly in light of changes in social trends over the last two decades. While there is evidence of cohort effects in social trends in a variety of studies, it is unclear how cohort effects may influence the validity of the present conclusions.

Sample bias. A further threat to the validity of the conclusions may come from non-random sample losses. However, as mentioned in Methods, corrections for potential sample selection biases suggested that the influence of non-random sample biases on the results were likely to be small.

Possible limitations notwithstanding, the results of the present study suggest that birth order is indeed related to a number of educational outcomes, particularly in terms of the attainment of educational qualifications. Even after controlling for the effects of confounding factors, earlier-born children were found to be more likely to obtain educational qualifications at both the secondary and tertiary level and were likely to have progressed further in their educational careers. The results suggest that intra-family dynamics play an important role in life outcomes, tending to shape different paths for different individuals.

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Table 1. Associations between birth order and measures of educational achievement up to age 25.

	Birth Order				
Measure	First born	Second born	Third born	Fourth or later born	p [1]
High School Achievement (by 21)	(N = 396)	(N = 383)	(N = 175)	(N = 61)	
% With no high school qualifications	15.2	19.1	20.6	24.6	<.05
Mean (SD) passes in School Certificate	3.5 (2.3)	3.2 (2.3)	3.2 (2.3)	2.7 (2.2)	<.05
% Gained 6th Form Certificate	71.7	68.9	66.3	57.4	<.05
% Gained Higher School Certificate	46.2	40.7	40.6	31.2	<.05
% Gained University Bursary	32.1	25.6	26.9	21.3	<.05
University Participation (by 25)	(N = 385)	(N = 361)	(N = 163)	(N = 59)	
% Attended university	45.5	37.1	37.4	27.1	<.005
% Gained university degree	29.1	25.5	23.9	17.0	<.05
Overall Achievement (by 25)	(N = 385)	(N = 361)	(N = 163)	(N = 59)	
Mean (SD) overall achievement score	4.5 (2.2)	4.1 (2.2)	4.1 (2.3)	3.5 (2.2)	<.001

[1] p-value from test of linearity of association derived using Mantel-Haenszel chi squared test for dichotomous outcomes, one way analysis of variance for continuous outcomes.

Table 2. Pooled regression coefficients for the effect of birth order on achievement outcomes adjusting for family size, and tests of parameter equivalence across levels of family size.

	Pooled Regression Parameter		Test of Parameter Equivalence	
Measure	B (se)	p	χ^2/F	p
No high school qualifications	.20 (.10)	<.05	3.1 [1]	.21
Number of School Certificate passes	-.21 (.09)	<.05	1.4 [2]	.26
Gained 6th Form Certificate	-.18 (.09)	<.05	1.7 [1]	.44
Gained Higher School Certificate	-.22 (.08)	<.01	0.1 [1]	.94
Gained university bursary	-.24 (.09)	<.01	1.6 [1]	.44
Attended university	-.25 (.09)	<.005	1.4 [1]	.50
Gained university degree	-.26 (.10)	<.01	0.1 [1]	.93
Overall achievement score	-.31 (.09)	<.001	0.3 [3]	.77

[1] LR Chi squared with 2 df; [2] F tests with (2, 997) df; [3] F-test with (2,957) df.

Table 3. Associations between birth order and measures of family sociodemographic background, perinatal factors and child cognitive ability.

	Birth Order				
Measure	First born (N = 396)	Second born (N = 383)	Third born (N = 175)	Fourth or later born (N = 61)	p
Mean (SD) age of mother at birth of child	23.8 (4.4)	25.9 (4.3)	28.0 (4.2)	31.1 (5.1)	<.0001
% Mother lacked formal education qualifications	42.7	52.0	58.3	65.6	<.001
% Child entered single parent family at birth	12.9	1.6	3.4	6.6	<.0001
Mean (SD) family socioeconomic status (birth) [1]	3.7 (1.5)	3.6 (1.4)	3.3 (1.5)	3.7 (1.4)	.08
% Breastfed	77.5	69.4	68.4	62.3	<.05
Mean (SD) birthweight (grammes)	3273 (506)	3391 (549)	3443 (478)	3541 (595)	<.0001
Mean (SD) child IQ (8-9 years)	104.3 (15.1)	102.7 (14.4)	104.0 (13.3)	100.1 (14.5)	>.11
Mean (SD) TOSCA score (13 years)	36.7 (14.4)	33.6 (14.5)	34.9 (15.0)	31.2 (14.4)	<.005

[1] A higher score implies lower SES.

Table 4. Fitted regression coefficients for the effect of birth order on achievement outcomes after adjustment for family size, family sociodemographic background, parental factors and child cognitive ability.

Measure	B (se)	p	Significant Covariates [1]
No high school qualifications	.42 (.16)	<.01	1, 4-6
Number of School Certificate passes	-.18 (.08)	<.05	1-6
Gained 6th Form Certificate	-.29 (.13)	<.05	1, 4-6
Gained Higher School Certificate	-.44 (.17)	<.01	1, 2, 4-6
Gained University Bursary	-.43 (.14)	<.005	1, 4-6
Attended university	-.32 (.12)	<.01	1, 2, 4, 6
Gained university degree	-.34 (.14)	<.05	1-4, 6-8
Overall achievement score	-.31 (.08)	<.001	1, 2, 4-6

[1] Significant covariates: 1 = Maternal age; 2 = Maternal education; 3 = Family type; 4 = Family socioeconomic status; 5 = Child IQ (8-9 years); 6 = Scholastic ability (13 years); 7 = Birthweight; 8 = Family size.

Table 5. Birth order and educational outcomes adjusted for covariate factors.

	Birth Order				
Measure	First born	Second born	Third born	Fourth or later born	p
% With no high school qualifications	14.2	17.9	22.3	27.1	<.01
Mean School Certificate passes	3.5	3.3	3.1	3.0	<.05
% Gained 6th Form Certificate	72.6	68.7	64.5	60.2	<.05
% Gained Higher School Certificate	51.3	44.9	38.6	32.6	<.01
% Gained University Bursary	35.5	29.9	24.7	20.0	<.005
% Attended university	45.4	39.8	34.4	29.3	<.01
% Gained university degree	31.5	26.9	22.7	18.8	<.05
Mean overall achievement score	4.5	4.2	3.9	3.6	<.001