CAMBRIDGE ASSESSMENT

Birthdate Effects: A Review of the Literature from 1990-on

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Foreword

For years, evidence of a birthdate effect has stared out of qualifications data; summer-born children appear to be strongly disadvantaged. Whilst those responsible for working on these data have, through mounting concern, periodically tried to bring public attention to this very serious issue, it has been neglected by agencies central to education and training policy. Following a flurry of press interest during 2007 and 2008, it has – justifiably – become a key part of the recommendations which may flow from the Rose Enquiry of the primary curriculum.

The literature review presented here is very specific in focus: it is intended to advance our understanding of the extent and causes of the birthdate effect in the English education system. A number of hypotheses have been advanced for its cause – clarity in understanding this fully is a vital part of determining possible remedies. Although this review focuses on understanding the birthdate effect in England, it uses international comparisons as one means of throwing light on key factors.

A review of this kind offers far more than a simple rehearsal of the findings of a series of relevant studies. It allows us to understand the accumulation of evidence in respect of the birthdate effect and to discount certain explanations of why it occurs. Crucially, it allows us to gain a view across the whole of the education system – and this reveals two critical things. Firstly, that the birthdate effect persists throughout education and training. Secondly, that a strong selection effect may be in operation at all stages – that is, summer-borns are not progressing onto certain routes and into certain levels of education. This effect is not obvious from individual studies limited to specific phases of education. It explains why the summer-borns who get through to the highest level of education are doing well: it's vital to recognise that disproportionately fewer summer-borns actually get to this level *at all*.

Although we believe that the existing research is illuminating in respect of the extent of the birthdate effect and of its causes, we do not advance recommendations in respect of remedies. We believe that work on remedies is not yet sufficiently advanced; substantial, urgent work is required on the means of devising adequate approaches. From this review, and from the work of comprehensive reviews of the quality of primary and early years education, it is likely that adequate remedy will lie in not only development of a strategy regarding *when* formal schooling should start, but also – at least – in respect of: specific balance in respect of curriculum elements devoted to cognitive, emotional and social development; the training requirements of teaching and support staff; curriculum frameworks; inspection foci; pupil grouping strategy; management of differentiation; and the articulation between early years units and compulsory schooling.

'What's going on?' in respect of the birthdate effect has now been subject to extensive scrutiny; the weight of evidence suggests that it is indeed a serious issue. We hope that this review is a key contribution to understanding. However, possible *remedies* need equally expansive examination – leaping into inadequately-researched responses could exacerbate rather than remedy this problem within our system.

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Executive Summary

- There is robust evidence from around the world that, on average, the youngest children in their year group at school perform at a lower level than their older classmates (the 'birthdate effect'). This is a general effect found across large groups of pupils. Specific Summer-born pupils may be progressing well, but the strength of the effect for the group as a whole is an issue of very significant concern.

- In the UK, where the school year starts on September 1st, the disadvantage is greatest for children born during the summer months (June, July, August).

- The effect of being the youngest in the year group holds in other countries where the school year begins at other times in the calendar year. This evidence rules out medical / seasonality hypotheses regarding pre-natal exposure to viral infections during the winter months for Summer-born children.

- The birthdate effect is most pronounced during infant and primary school but the magnitude of the effect gradually and continually decreases through Key Stage (KS) 3, 4, and A level. This pattern is particularly evident in research by the Institute of Fiscal Studies. The disadvantage for August-born children over September-born children in expected attainment dropped from an average of 25% at KS 1 to 12% at KS 2, to 9% at KS 3, to 6% at KS 4 and to 1% at A level. Despite this decrease, the effect remains significant at GCSE, A level and in respect of entry into higher education. Likewise, analysis of the results from all of the GCSE examinations taken by over half a million candidates born in England, Wales and Northern Ireland in the same academic year showed a consistent depression in grades achieved for students born from September through to August. In addition, the same pattern of depression was detected in the number of subjects undertaken. Despite decrease in magnitude, the birthdate effect persists until the end of higher education.

- Data from 13 LEAs providing GCSE results (undertaken in 1990 to 1994) revealed that birthdate effects were still very evident when all subjects were considered. Summer-borns were the lowest attainers in 10 LEAs and Autumn-born children were the highest attainers in 9 of the Authorities. *(See page 13 for amendment).*

- Analysis shows that approximately 6% fewer August-born children reached the expected level of attainment in the 3 core subjects at GCSE (English, mathematics and science) relative to September-born children (August born girls 55%; boys 44%; September born girls 61% boys 50%). One report concludes: *'If all the pupils in this cohort who were born in the spring or summer terms were to perform at the level of the Autumn-born pupils, it would mean that 213 pupils out of a total of 308 improving their GCSE results by an average of 1.5 grades'*. The magnitude of the effect has important implications for pupils' successes and for schools' overall results.

- The birthdate effect is evident in the relative proportions of students who undertake higher education. The percentage of GCSE students going on to take at least one A level drops from 35% in September-born students to 30.0% for August-born students. Likewise, September-born students are 20% more likely to go to university than their August-born peers. The Higher

Education Funding Council has concluded that '…if all English children had the same chance of going to university as those born in September then there would typically be around 12,000 extra young entrants per cohort, increasing young participation by 2 percentage points…'.

- A disproportionately high percentage of relatively young children in the school year also are referred for special educational needs and many of these appear to be misdiagnosed. The birthdate effect may operate in teachers' identification of children in need of special education. Teachers may not be making sufficient allowances for the level of attainment against specific curriculum outcomes of the younger members of their classes.

- The birthdate effect is also seen, worldwide, in other areas of endeavour such as sporting achievement.

- There are competing theories regarding birthdate effects. One is the 'length of schooling' hypothesis - when school admissions are staggered over the year then the youngest have the least schooling. Another is the 'relative age' hypothesis - even with the same length of schooling, the youngest in a year group will be, on average, less mature – cognitively, socially and emotionally – than their older classmates, leading to unequal competition in all 3 domains that could impact negatively on the younger group. Although it is sometimes difficult to disentangle these two hypotheses, evidence tends to support the latter. Using a common start date does not solve the problem of this type of disadvantage.

- Teacher expectancy effects may contribute to birthdate effects – teachers may not take children's relative levels of maturity into account when making assessments of their ability and may therefore label younger children as less able than their older peers.

- Evidence from developmental psychology suggests that children between the ages of 4 and 5 may not be ready, developmentally, for formal education. Birthdate effects appear to be greatly reduced in countries where formal education begins at a later age. There needs to be a careful consideration of what is best for all children in the early years of schooling, based on solid evidence from psychological research.

Cambridge Assessment 2009

Introduction

In their seminal paper, published in 1990, Bell and Daniels re-opened the debate regarding the so-called 'birthdate effects' on educational attainment. The paper reviewed the literature published over the previous 30 years reporting strong and consistent evidence that, where the school start date is September 1st (as in the UK), Summer-born children, typically the youngest in their academic year, generally perform at a lower level to that of Autumn-born children during their primary school years. Bell and Daniels went on to show that the effect appears to persist until at least the end of secondary school education.

The birthdate effect had been previously postulated to be the result of length of schooling and/or age-position/relative age within the class (Pidgeon and Dodds, 1961). Bell and Daniels also noted that there was an often mentioned factor that might account for birthdate effects - the 'seasonality' (or biological) effect (Orme, 1962, 1963). The importance of disentangling the roles of these three factors in accounting for birthdate effects was highlighted by Bell and Daniels when they suggested that:

'Although it is difficult to see how schools could be organised so that there are no age differences in teaching groups, there should be research into mitigating this [birthdate] *effect if the educational system is to be fair to all children'* (p. 78).

The year after the publication of Bell and Daniels' paper, British school children undertook the first of a number of regular assessments that became compulsory under the new National Curriculum introduced in England and Wales in 1987 (DES, 1987). Since that time children have had Teacher Assessments (TAs) and have undertaken Standard Assessment Tasks (SATs) at ages 7, 11, 14, and at GCSE and A level. The educational path that children will take is dependent on the outcomes of these assessments, making Bell and Daniels' suggestion all the more pertinent to the current educational system.

Consequently, the first aim of this report is to review the literature, published since 1990, covering birthdate effects at primary, secondary, and university levels of education in Britain and in other countries. The review will also include literature examining birthdate as a factor governing the incidence of people who have achieved eminence in sport and other fields. A second aim of the review is to evaluate the hypotheses regarding the factors that could be responsible for the variations in performance of children relative to their birthdate.

These mainly involve at least one of three possibilities:

i. Summer-born children are not as intellectually able or potentially able as Autumn-born children (the Seasonality/Medical hypothesis)

ii. All children in a school year group have reached the same level of ability or maturity, but the youngest children have less potential because they have less time at school (the Length of Schooling effect - LoS)
iii. The youngest children in an academic year are at a lower level of maturity, but are as potentially able, as their older classmates (the age-at-entry or Relative Age effect - RAE)

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Birthdate and school admission policies

The compulsory age for children to start school in Britain is at the beginning of the school term *after* the child's 5^{th} birthday (source: Department for Children, Schools and Families 2009). However, many Local Education Authorities (LEAs) admit children before that – usually when children are 'rising fives' – i.e. they will become 5 in the term, half year, or year in which they are admitted. Many LEAs adopt an annual admissions policy whereby children start school at the beginning of the academic year (September) in which they become five. Some LEAs have a bi-annually admissions policy (usually September and January), while others have 3 termly entry dates (usually September, January and April). Bi-annual admissions polices are most often adopted to allow the Summer-born children an extra term at school. In a survey of 102 LEAs (85% of the total number) in England and Wales, Sharp (1995) found that 44% had adopted an annual admissions policy, 23% had a bi-annual policy, and 25% admitted children at the beginning of each term. The variations in admission policies mean that the age children will enter infant school can vary from just 4 years (4:0) for an August–born child admitted in September (in a school that uses an annual admission policy) to 5 years and 4 months (5:4) for an April-born child starting school in September (in a school that has adopted termly admission at statutory age). Thus the age range in any one class can span as many as 16 months, with some children being relatively old, and others relatively young, at entry into school. This difference in ages will be referred to hereafter as relative age (RA). (See Musch and Grondin, 2001, for further discussion).

Three birthdate (or 'season of birth') classifications are most often used in the literature and correspond closely to the 3-term system used by many UK schools. The classifications are:

Autumn-born: children whose birthdays fall in September to December
Spring-born: children whose birthdays fall in January to April
Summer-born: children whose birthdays fall in May to August

In addition to the differences in age-on-entry, there are often inequalities between and within schools in the length of time children spend in infant school. For example, in schools that operate an annually admissions policy (in which children become 5 in the academic year they are admitted), all children, regardless of chronological age, will have spent the same length of time in school before their first formal assessment. Their RA position in their class will be as follows:

Season of Birth	Enter school	Length of schooling at KS1 assessment (LoS)	Position in Year (RA)
a) Spring	Sept term	9 terms	Middle age group
b) Summer	Sept term	9 terms	Youngest age group
c) Autumn	Sept term	9 terms	Oldest age group

In contrast, length of schooling can vary, within the same school, from 6 to 9 terms (Sharp, Hutchison and Whetton, 1994). For example, if a school operates termly admissions and children join the Reception class at the beginning of the term in which they will be 5 then the length of time they spend in school before KS1 assessment is as follows:

Season of Birth	Enter school	Length of schooling at KS1 assessment (LoS)	Position in Year (RA)
a) Spring	Jan term	8 terms	Middle age group
b) Summer	Apr term	7 terms	Youngest age group
c) Autumn	Sept term	9 terms	Oldest age group

It can be seen that there is a relationship between LoS and RA. That is, April to August born (Summer-borns) will have the shortest LoS until they have first national assessments *and* be the youngest in their academic year. In contrast, September to December born (Autumn-borns) will have the longest LoS until KS1 assessment *and* be the oldest in their academic year. While differences in LoS and RA across schools make national comparisons more difficult, they can help to differentiate these two factors and their possible role in birthdate effects on academic performance.

In countries other than Britain, different admissions policies mean that it is not necessarily Summer-born children who are the youngest in the year group. For example, school entry policies in Sweden and Malta mean that Autumn-borns are the youngest in their academic year. Furthermore, children born from May to August would be classified as Summer-born in Britain but would be classified as Autumn-born in Australia. Examination of results across these different countries allows a more comprehensive appraisal of birthdate effects in attainment, and should help to disentangle the LoS factor from the RA factor in explaining the phenomenon. The findings from studies examining birthdate effects carried out in countries other than Britain are therefore reported throughout this review.

Evidence of birthdate effects at infant and primary school

Bell and Daniels (1990) reviewed the literature showing birthdate effects on academic performance prior to the 1990s, and there is evidence that the effect is still visible some 20 years later. One researcher who has contributed considerably to this field is Caroline Sharp. In one study, Sharp (1995) gathered data from 14 LEAs who provided information regarding birthdate and attainment at the KS1 (age 6 to 7 years) assessments undertaken in 1991. Across the Authorities, different admissions policies had been adopted (annually, bi-annually or termly). All 14 LEAs reported the same age-related trend, showing that the youngest in the year group performed at a lower level to that of the oldest children. This pattern was the same for the 3 core subjects (English, Mathematics and Science). Most of the children in the survey had also been assessed in Technology where the same age-related pattern was also evident. The results from 7 of these LEAs were analysed further to examine birthdate effects on *levels* of attainment at KS1 (most children are expected to achieve Level 2 and some will achieve Level 3). In order to standardise the results, Autumn-borns were given a score of 100% and the scores for the other 2 age-groups were then index-linked with the Autumn-born group in the same LEA. The results for more than 23,000 children in the 7 LEAs showed the same age-related pattern, with attainment highest for Autumn-borns and lowest for Summer-borns. However, the differences in attainment were not uniform across LEAs and varied from less than 10% to 22 % of the standard scores. For example, in one LEA, 69% of Autumn-borns, compared with 53% of Summer-borns, achieved Level 2 or more. In a follow-up study, Sharp and Hutchison (1997) carried out similar analyses on the data for the KS1 assessments for 1995 from 50 LEAs in England and Wales. The findings mirrored those of the earlier study in showing that Autumn-borns did best and Summer-borns did least well.

While the birthdate effect is strong in early infant school, the magnitude of the effect does not appear to remain as great throughout primary school. When results of assessments of children in 59 London schools were compared at age 6, 8, 10 and 12, the usual disadvantage for Summer-borns was evident at all age bands (Hutchison and Sharp, 1999). However, there was a substantial reduction in the magnitude of the seasonal group differences between age 6 and 8, little change between age 8 and 10, and another substantial reduction in the magnitude of the differences between ages 10 and 12. Thus the disadvantage to Summer-borns was greatest when the children were in infant school but became weaker as the children got older.

This finding was strongly supported by comprehensive analyses carried out by the Institute of Fiscal Studies (IFS) using data drawn from the English National Pupil Database (Crawford, Dearden and Meghir, 2007). For example, the researchers reported that in one of their cohorts, at KS 1, only 53% (47%) of August-born girls (boys) reached the expected level of attainment in the 3 core subjects[1] relative to 80% (70%) of September-born girls. By KS 2, the

[1] Reading, writing, and maths

August-born disadvantage had narrowed but was still significant. In one cohort, only 63% (59%) of August-born girls (boys) reached the expected level of attainment in the 3 core subjects[2] relative to 76% (72%) of September-born girls. This study also reported cross-sectional findings for cohorts of children at KS 3, 4 and A level and the results are given in later sections of this review that focus on these stages of education.

If birthdate effects are the result of LoS or RA, then they should be evident, although different, in countries where the school intake policies are not the same as those in Britain. In Malta, for example, there is an annual intake policy, whereby children are admitted to school in the September of the year of their 5th birthday. This means that children beginning their first year of school range from 4:9 to 5:9. This system means that the oldest children in any one academic year are born in January and the youngest are born in December. When 3 infant years were each split into 4 age-bands – oldest = January to March; older middle = April to June; younger middle = July to September; youngest = October to December – the usual birthdate effect was found. The youngest in every year were out-performed by the oldest in their peer group in English, Maltese and Mathematics (Borg and Falzon, 1995). Significantly, in this case, the youngest (and the most disadvantaged) group were not Summer-born but Autumn-born.

A reduction over time in the size of birthdate effects was also noted by Borg and Falzon (1995). They looked for any trends in the magnitude of differences between the oldest and the youngest groups over 3 academic years. In English and Mathematics there was clearly a decrease in differences between performance at Grade III (mean age 7) and Grade V (mean age 9). These findings are in line with those of Hutchison and Sharp (1999) who suggested that the early arising birthdate effect may be maintained in the infant school by factors such as ongoing teacher and peer expectations and self-image. These factors may change as the child progresses through the school system. Nevertheless, there may be other explanations for the timing of the apparent 'catching-up' for younger children at around age 7 and age 10. Two of these – the developmental course of executive function abilities and of emotional intelligence – are discussed in another publication.

So there continues to be robust evidence, from Britain and abroad, that in infant school the youngest in the school year perform at a lower level than the oldest in their year group. For how long is the disadvantage for relatively younger pupils maintained and does it lessen as children progress through the educational system?

[2] English, maths, and science

Evidence of birthdate effects at secondary school – KS3, GCSE O-level and A level

KS3 (age 11 to 15)

Once children reach secondary education, the first formal assessments (KS3) are made after three years, at 13 to 14 years of age. There is consistent evidence to suggest that the birthdate effect persists until at least this stage (Bell and Daniels, 1990). For example, in the IFS study, Crawford, Dearden and Meghir (2007) reported that, in one cohort at KS 3, only 65% (60%) of August-born girls (boys) reached the expected level of attainment in the 3 core subjects[3] relative to 73% (69%) of September-born girls. Likewise, in one British High school, analyses carried out on the results of the 3 core subjects taken at KS3 showed that the best average scores were obtained by the Autumn-born students while the lowest scores were obtained by the Summer-born children in Mathematics and Science subjects (Giles, 1993). Significantly, Giles noted that, for both subjects, there was nearly half a National Curriculum level difference in favour of those born in the autumn relative to those born in the summer (Mathematics 5.27 vs 4.73; Science 4.44 vs 4.00) and suggested that *'…sometimes the 'slow learner' is just simply a lot younger than his or her peers and that they may need a different type of encouragement to improve their status'* (p. 135).

The birthdate effects are not only evident in written examinations but have also been seen in the physical performance section of GCSE physical education (PE) examinations. The data for approximately 11,500 students revealed a highly significant ($p<0.001$) downwards trend in achievement from September-born to August-born boys and girls. The effect was seen in the Performance section of the PE examination and was even stronger in the two written papers (Bell, Massey and Dexter, 1997). Although boys did better than girls overall in the Performance section, and this order was reversed in the written section, the birthdate effects were evident in the results for both genders.

The two theories proposed by Bell and Daniels (1990) to explain the age-effect in academic achievement were also put forward in the case of the PE results: i) the 'pessimistic' model - that younger students in their year group start at a disadvantage (cognitively and physically) and do not make up lost ground; ii) the 'optimistic' model - the age effect weakens as students get older; or as Bell, Massey and Dexter (1997) suggest *'younger pupils may not have attained the same performance levels as their older classmates but they have the potential to match them in the future'* (p. 164). However, it was recognised that there are huge individual differences within age-bands, making it very difficult to see how the age-disadvantage could be overcome in either the academic field or the playing field.

In support of Bell and Daniel's (1990) 'optimistic' model, it has been suggested that a weakening of the relative age effect might be the result of

[3] English, maths and science

the ‘fresh start’ offered by a change of school, when children progress from primary to secondary school. The change of circumstances may enable Summer-borns to catch-up with their older peers (Hutchison and Sharp,1999). Indeed, when results of assessments of children in 59 London schools were compared at age 6, 8, 10 and 12, there was a substantial reduction in the magnitude of the seasonal group differences between ages 10 and 12. Thus the disadvantage to Summer-borns became weaker once the children started secondary education. However, a number of cognitive and emotional advances are made at around this age that could also go some way to explaining the lessening in the attainment gap.

The weakening of birthdate effects in the secondary years was provided by Borg (1996) in a study carried out in Malta. As reported above (Borg and Falzon,1995), the oldest children in an academic year in Maltese schools are not those born in the autumn but are those born at the beginning of the calendar year. Borg looked at the academic performance of 816 pupils in the junior lyceum grammar school sector of the island’s educational system who were all born in the same calendar year. The pupils were in Years 1 to 3 and were aged 11, 12 and 13 years old. The gender ratio was 50:50. The sample was split into 4 age-bands: oldest = January to March; older middle = April to June; younger middle = July to September; and youngest = October to December. The oldest pupils significantly out-performed the youngest pupils in Year 1 for English and Religion. Borg noted that it was interesting that a birthdate effect was still evident in this population, given that all the pupils in the study were successful in the 11+ examination in order to attend the schools included in the study and therefore they were a relatively homogeneous group in terms of academic ability. However, as the age of the sample got higher the birthdate effect became weaker and was evident for only English in Year 2, and for only Maltese in Year 3. Borg concluded that *‘…the findings would suggest that although during the first three years of secondary schooling age position is still an important determinant of attainment its effects appear to diminish as pupils proceed in their scholastic career. That is, the effect of readiness and maturation may be less important in the secondary years.’* (p.17). Thus, although apparently growing weaker, birthdate effects are robust and persistent across an international population of students until they reach at least 14 years of age.

Evidence that relative age effects weaken as students progress through the school system was provided on an international level in a comprehensive report by the Department of Economics, at the University of California (Bedard and Dhuey, 2006). The authors used data from the 1995 and 1999 Trends in International Mathematics and Science Study (TIMSS)[4] to compare performance across up to 38 OECD countries. Using data from 19 countries

[4] TIMSS is an assessment in the series of IEA studies to measure trends in students' mathematics and science achievement. TIMSS 1999 was conducted by the TIMSS and PIRLS International Study Centre at Boston College and included 38 countries. The 1999 assessment measured the mathematics and science achievement of eighth-grade students (ages 13 and 14 years). Of the 38 participating countries, 26 also participated in the 1995 TIMSS assessment, which enabled these countries to measure trends in their children's mathematics and science achievement and in schools and home contexts for learning.

and taking account of school starting age and school cut-off dates, Bedard and Dhuey (2006) found substantial evidence that initial relative age effects last until at least age 14, but that they reduce in magnitude from age 9 onwards. They noted specifically that *'….the oldest students score 4 – 12 percentiles higher than the youngest students at the fourth grade level* (children aged 9*) and 2 – 9 percentiles higher at the eight grade level* (children aged 13*) across a wide range of countries'* (p. 22). However, although the findings from this study were robust, they were not entirely universal. The data from two countries - Denmark and Finland - revealed no relative age effects. The significance of this finding will be considered in the Discussion.

Summer-born students can be seen to have a poorer academic profile beyond the first three years of secondary education. Information regarding students up to 15 years old who took part in the APU Science survey[5] for 1983 and 1984 was collated by Bell and Daniels (1990). Within the project, seven subcategories of science activity (e.g. making and interpreting observations, applying concepts of biology, chemistry, and physics) are assessed. Pupils' relative ages were calculated, from the oldest - born on 1st September to the youngest – born on 31st August. To reduce variability, only pupils from state-maintained schools were included in the analyses. Data were available for each subcategory from approximately 2,000 to 3,000 pupils in Years 1, 3 and 5 of secondary school. The birthdate effect was seen in every subcategory for all 3 age-bands. Furthermore, the age effect extended to other factors examined in the analysis. Relative to their older peers, Summer-born pupils were more likely to be in low-ability teaching groups, while Autumn-born pupils, compared to younger pupils, were more likely to be in high-ability groups. In addition, looking at the examination intentions of the 15-year-olds, there was a trend for Summer-born pupils to be more likely to be entered for CSE examinations rather than O-level GCSE examinations (when these two levels of assessment were offered in the UK) compared to pupils born in the autumn (pupils taking CSE-level subjects only: Autumn-borns = 41%, Summer-borns = 44%; pupils intending to take 6 or more O-level GCSEs: Autumn-borns = 34%, Summer-borns = 29%). The same pattern was evident when data for the individual science subjects and mathematics were examined (e.g. Mathematics - entered for CSE-level: Autumn-borns = 51%, Summer-borns = 57%; entered for O-level: Autumn-borns = 26%, Summer-borns = 21%).

Interestingly, Hutchison and Sharp (1999) argued that, although still present in the early years of secondary school, the disadvantage for Summer-borns '*was no longer educationally significant'* (using an effect size lower than 0.25) by the time the children had reached 12 years old. Nevertheless, any evidence that one population of students is at a disadvantage relative to other populations of students gives cause for concern and should be considered as educationally relevant.

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[5] The Assessment of Performance Unit's Science project was established to plan, conduct and report a series of sample surveys of the science performance of pupils, including science, in Years 6, 8 and 11. It ran from 1978 to 1988.

CSE/GCSE (age 16)

Despite the findings from the first 3 years of secondary education that birthdate effects appear to weaken as students get older, there is robust evidence to show that relatively young children are still disadvantaged academically when they reach their 5th year of secondary education. At this stage (in some cases 1 year earlier) students sit their GCSE level examinations. Data from 13 LEAs providing GCSE results (undertaken in 1990 to 1994) revealed that birthdate effects were still very evident when all subjects were considered (Sharp, 1995). Summer-borns were the lowest attainers in 10 LEAs and Autumn-born children were the highest attainers in 9 of the Authorities. If gender was included in comparisons then Summer-born boys had the greatest disadvantage and autumn girls had the greatest advantage. *Significantly, it was noted that the difference between these 2 groups was about 1 grade at GCSE in approximately each of 9 subjects taken.* Further scrutiny of the original source (January 2016) indicates that the difference (italicised above) was reported by an individual LEA officer as "… about one grade in each nine or so subjects entered." (Sharp, 1995, p.261). The difference was not reported as a result of the author's analyses. Benton (2014) found that, for each typical GCSE subject, the average difference between autumn-born pupils and summer-born pupils is one seventh of a grade. (Note: "typical" means taking the median difference across all subjects).

From a much larger database, Alton and Massey (1998) analysed the results from all of the GCSE examinations taken by over half a million candidates in England, Wales and Northern Ireland in 1991. All of the students were born in the same academic year. Numerical scores were assigned to grades[6] and the GCSE results showed a consistent decline in grades achieved for students born from September through to August. In addition, the same pattern of decline was detected in the number of subjects undertaken. Similarly, the IFS researchers (Crawford, Dearden and Meghir, 2007) found that approximately 6% fewer August-born children reached the expected level of attainment in the 3 core subjects (English, mathematics and science) relative to September-born children (August-born girls 55%; boys 44%; September-born girls 61% boys 50%).

In other research looking at performance on the 3 core subjects only, Cambridge University Local Examinations Syndicate (UCLES – now Cambridge Assessment) examined the results of GCSE examinations taken in June 1993 for over 20,000 Science papers, 55,000 Mathematics papers and 1,400 English papers from students all born in the same 12 month period. Using the same numeric transformation of grades, a research team (Massey, Elliott and Ross, 1996) found robust birthdate effects, as Autumn-born students out-performed the other two groups and Summer-born students were the poorest performers. This was the case for all 3 subjects and included the

[6] GCSE examinations are awarded grades from A to G, or U for 'ungraded'. In order to compare students' results, researchers typically transform these alphabetic grades to numeric ones, by giving A to G and U grades 7 to 0 points.

English oral sub-test. There were the often-reported gender differences (with girls out-performing boys) and the birthdate effects were stronger in girls than in boys, although the gender effects were not as large as birthdate effects in Mathematics and Science. Furthermore, there was an effect of birthdate (although non-significant) in the uptake pattern on at least one paper. Pupils born in the autumn were the most likely to sit the Science Extension paper and those born in the summer were the least likely to choose this test.

However, Massey, Elliott and Ross (1996) took a closer look at the results of the Mathematics examination and found an apparently ambiguous pattern in regard to birthdate effects. Students could sit 1 of 3 tiers of paper – the Foundation (Grades available E, F, G), Intermediate (Grades available C, D, E, F), or Higher tier (Grades available A*, A, B, C, D). These are designed to provide appropriately targeted assessment. The paper at each tier requires a combination of short answers, extended answers and coursework. Over all 3 tiers together, the usual pattern of birthdate effects were obvious and significant. However, looking at the results for each tier individually, there were no birthdate effects evident in the Foundation or the Higher test papers, although the Intermediate examination (but not the Intermediate Coursework assessment) did show the effect *but in the opposite direction*. It was suggested that these results could be explained by taking account of selection processes. The lack of an effect in the Higher tier could be explained by the fact that fewer Summer-borns took this tier (31% of Summer-born versus 35% of Autumn-born students) and those who did might be expected to attain the higher grades. A similar explanation was given for the results in the Intermediate and Foundation tiers – the Summer-born children would include a disproportionately high number of relatively able students (with the opposite applying to Autumn-borns).

It could also be argued that the findings of the overall results from the Massey, Elliott and Ross (1996) study are consistent with the ‘self-selection hypothesis’ (Bell and Daniels, 1990). Birthdate effects might be more evident when subject choice is compulsory and students have to undertake certain subjects whether they expect to do well or not. Whereas, when subjects are chosen by the students, depending on their aptitude and preference for them, birthdate effects might be less evident in these subjects. Children who elect to take subjects of choice do so because they expect to do well in them. At GCSE level, the three core subjects are compulsory (English, Mathematics and Science) and additional subjects are chosen by the students. One study that teased apart performance on compulsory versus elected subjects was reported by Moon (2003). In a small study at the Comprehensive school in which he was the Vice Principal, Moon analysed the results of the 1999/2000 GCSE examinations for 308 students. He found that, taking all the subjects together, there was no evidence of a birthdate effect on the average scores across the 3 seasonal age-bands. However, when subjects of choice or aptitude were excluded from the analysis and only the scores for the 3 core subjects were examined, there *was* a strong birthdate effect. Indeed, the Autumn-born students achieved an average of 1.5 grades more than their Summer-born peers on the total points scored on the 3 subjects. The findings lead Moon to emphasise the educational significance of the difference in scores by noting that *'If all the pupils in this cohort who were born in the spring or summer terms were to perform at the level of the Autumn-born pupils, it would mean that 213 pupils out of a total of 308 improving their GCSE results by an average of 1.5 grades'* (p.32). The magnitude of the effect has important implications for pupils' successes and for schools' overall results.

Two interesting findings came from the Giles (1993) study when he analysed the GCSE results at his school and found that there was a trend towards a birthdate effect in favour of Autumn-born students taking Mathematics, although the results for Science and English were more random. Giles noted that Mathematics was assessed by an end-of-year examination, while the assessments for the other 2 subjects were on coursework only. A birthdate effect for examinations as opposed to coursework was also reported by Massey, Elliott and Ross (1996) in the Intermediate level mathematics paper. These findings raise the question of whether birthdate effects are more prevalent in examination results than they are in coursework. The findings could also be argued to support the 'self-selection' hypothesis, as coursework may be undertaken on a more voluntary basis, whereas the Mathematics examination is compulsory.

Giles (1993) identified a weakening of the birthdate effect between age 15 and 16 in the results of the GCSE Mathematics examination. He split the results into those taken by Year 10 students and those taken by Year 11 students. Across the two years together there was a strong trend for Autumn-born students to dominate the top grades and Summer-born students to dominate the bottom grades. The effect was particularly striking in Year 10, with the top grade-band consisting of approximately 37% Autumn-born versus 29% Summer-born, while the bottom grade-band comprised only 17% Autumn-born versus 52% Summer-born students. Year 11 results followed the same pattern but were not so striking (top grade-band 34% Autumn-born versus 24% Summer-born, bottom grade-band 16% Autumn-born versus 42% Summer-born)[7]. Some theories that might explain the lessening of the birthdate effect are discussed in a later section of this review.

A Level (age 18)

There is consistent evidence that the birthdate effect becomes less pronounced as children progress through the school system. Nevertheless, it appears that the Summer-born students are still educationally disadvantaged, relative to their Autumn-born peers, at age 18 and even beyond. For example, Crawford, Dearden and Meghir (2007) reported that while 43% of September-born girls (33% of boys) reached the expected level of attainment at 'KS 5' – A level, only 41% of August-born girls (32% of boys) did so.

Significantly, A level data from 2 London metropolitan authorities for 1992 and 1993 showed that there were fewer Summer-born students entered for A level

[7] All of these numerical percentages have been extrapolated from the bar charts published in the Giles (1993) study.

courses, relative to Autumn-born (e.g. in one authority 12% of Summer-born and 17% Autumn-born carried on to A level). This may have been as a result of the relatively poor performance of Summer-borns at GCSE level. A further point of note was that there were fewer Summer-borns, relative to Autumn-borns, achieving higher A level grades in the 1993 examinations, and the difference was significant in one of the authorities (Sharp, 1995).

On a much larger scale, Alton and Massey (1998) followed the progress of approximately one third of the candidates who had undertaken GCSE examinations two years earlier and had taken at least one subject at A level in 1993. Data were available from approximately 170,000 candidates who had all been born in the same academic year. The grades attained were converted to a numerical score by allocating 10 points for an A grade, 8 points for a B grade...to 0 points for a U grade. The researchers found that the birthdate effect was much less obvious in the A level results. Although the directionality of the scores was the same, there was a much more even distribution of scores (Autumn-born = 4.63; Spring-born = 4.63; Summer-born = 4.61). There was also a small but steady decline in the number of subjects undertaken from the September-born students (mean score = 2.90) to the August-born students (mean score = 2.87). Therefore, while older students do better than their younger classmates at GCSE level, this advantage is not as strong at A level. Indeed, as reported earlier in this review, this weakening in the magnitude of the birthdate effect shows a decline throughout formal schooling. One study showed that the disadvantage for August-born pupils decreased from approximately 25% for girls and 26% for boys at KS 1 to 13% (girls) and 12% (boys) at KS 2; 8% (girls) and 8% (boys) at KS 3; 6% (girls) and 6% (boys) at KS 4; and 2% (girls) and 1% (boys) at 'KS 5' – A level (Crawford, Dearden and Meghir, 2007).

The apparent weakening of the birthdate effect at age 18 could be the result of a self-selection bias. Students' choices of subjects at A level are determined by their results at GCSE level. If a student does not do well in a subject at GCSE level, he/she is unlikely to undertake that subject at A level, meaning that the students who take subjects at A level hope to achieve relatively good grades. In support of this view, Alton and Massey (1998) noted that there was a steady decline, from September-born to August-born, in the percentage of GCSE students going on to take at least one A level (September-born = 35.2%; August-born = 30.0%). It could be argued that, as a result of the self-selection process, those who do proceed to A level are a more academically homogeneous population than those who undertake GCSE level examinations. If there continues to be a greater number of subjects undertaken and higher grades achieved by Autumn-born students, then it may be the case that these relatively older students will be disproportionately represented at universities.

University level

As suggested above, there is evidence that fewer Summer-born children progress through the higher education system. Strong support for this is provided in research carried out by the Higher Education Funding Council for England (HEFCE). In research which examined the numbers of pupils who entered university in England from 1994 to 2000, it was noted that when the seasonal pattern of births has been allowed for, there was a strong seasonality effect in the numbers of candidates entering university at age 18 that was not redressed by entry at age 19 (HEFCE, 2005). The researchers found that those born in September, are over 20 per cent more likely to enter higher education at age 18 than those born in August. It was argued that *'If all English children had the same chance of going to university as those born in September then there would typically be around 12,000 extra young entrants per cohort, increasing young participation by 2 percentage points'* (p. 135).

Despite these noteworthy findings, there appears to be a paucity of research into the effects of birthdate in uptake and achievement at university level but one comprehensive study that reported on results at this level was conducted by Russell and Startup (1986). The researchers used data, provided by the Universities' Statistical Record, for almost 300,000 British students who had completed a 3-year degree course between 1972 and 1982. Only those whose entry requirements were based on their A level results, and whose degree class was either a first, upper second, lower second, or a third were included in the analysis. Results showed that the number of people graduating varies as a function of their month of birth and the pattern is constant over the different years examined in the study. Allowing for differences in population figures for monthly birth rates, Russell and Startup found that students who are relatively old on entry to university still seem to have an educational advantage, as a disproportionately high number of them graduate. In addition, the change in the proportion of students achieving particular grades as their birthdate changes remains invariant over the years. Thus the birthdate effect was apparent at University level.

Nevertheless, by the time they graduate, the relationship has altered. Looking at the quality of their degrees, the greatest percentage of students achieving the two highest class degrees were more commonly the *youngest* in their year (July = 43.6% and August born = 43.1%) and the lowest percentage of students who obtained higher class degrees were commonly the *oldest* in their year (September = 41.8% and November = 41.5%). It was argued that this reversal of fortunes could be the result of a selection bias, as there could be an under-representation of Summer-born students (and an over-representation of Autumn-born students) having obtained good enough A level results selected for university places. The Summer-born students who do get to university may be more able than their Autumn-born contemporaries. Nevertheless, Russell and Startup rejected this theory because it was argued that if it applies at university level it should apply earlier in the educational process. However, this weakening of the birthdate effect as children progress educationally has been illustrated in a number of studies published subsequently (Giles, 1993; Massey, Elliott and Ross,1996; Borg,1996; Hutchison and Sharp, 1999). In addition, Alton and Massey (1998) found support for the 'selection bias' argument when they found that the birthdate effect weakened between O-level and A level. It appears that if younger students are highly motivated to succeed, then this may pay off by the time they reach the later stages of formal education.

To summarise the findings regarding birthdate effects in educational attainment, there is strong and consistent evidence that the youngest children in their year group generally perform at a lower level to their relatively older peers at all levels of formal education. The effects last until at least university level. In the UK, the youngest are born in the summer months, but the effect holds in other countries where they may be those born in the first months of the calendar year if these are the first months of the academic year. However, the effects are not uniform across all subjects or even across methods of assessment. They appear to be more robust in the three core National Curriculum subjects than in those taken by choice and in assessments made by examination rather than in coursework.

In addition, the magnitude of the effects does not remain stable throughout the school years. It appears to grow smaller in a step-wise manner, with reduction in magnitude seen at approximately ages 7, 10 or 11, and 15. Furthermore, there appears to be a reversal of fortune by the end of higher education where, although a greater number of relatively older students graduate (allowing for monthly birth rates in the general population), there is a trend for the younger students to obtain the higher class degrees. Reductions in the birthdate effect over time have been argued to be the result of 'self-selection' whereby less able students who do not do well in certain subjects do not go on to take them at a higher level. Thus relatively younger students are under-represented at the higher stages of formal education. Those who are motivated to go on to university level may be of higher ability than their older peers and thus they then become the highest achievers.

Evidence for birthdate effects in children with special educational needs

Given the robust and consistent nature of birthdate effects, it might be expected that relatively young children would be seen to require greater educational assistance, at least in the earlier years of schooling. Indeed, in the UK, there is a large body of research showing that a disproportionate number of Summer-born children, relative to their Autumn-born peers, are referred for special educational needs. For example, Peagram (1992, quoted in Wilson, 2000) reported on a population of children attending Moderate Learning Difficulties (MLD) schools whose main educational problems were based on emotional and behavioural difficulties. Peagram found that this population consisted of almost twice as many Summer-born pupils (30.5%) as Autumn-born children (16.4%). The ages of the children are not given for Peagram's study but other research has found that the effect is only present in children of primary school age and not at secondary school level (Sharp, 1995). In contrast, Wilson (2000) found a clear birthdate effect in 178 pupils aged 11 to 18 years attending a British comprehensive school. There were 17% of Spring-borns and 17% of summer born children, compared to only 10% of Autumn-born children, diagnosed as having special educational needs (SEN).

Significantly, Bibby, Lamb, Leydon and Wood (1996) found that there was no academic disadvantage for Summer-born children, relative to those born at other times of the year, despite the fact that Summer-borns were disproportionately represented at MLD schools in Britain. On the contrary, multivariate analysis revealed that Summer-born children performed *better* than other groups on tests of intelligence, mathematics, reading comprehension and communication skills. The researchers concluded that the birthdate effect may operate in teachers' identification of children in need of special education. This conclusion was supported by Sharp (1995), who noted that, when the needs of young children were assessed by teachers on screening for reception classes, using the Quick Check section of the Bury Infant Check, teachers initially identified a larger proportion of boys and Summer-borns as requiring extra support. However, when a further section of the Bury Infant Check was carried out on those identified, with teacher assessment removed, then the gender and birthdate variations disappeared. This highlights a possible bias on the part of teachers against the younger children in their year group. These findings should not be misinterpreted. The birthdate effect is evident throughout education in respect of *attainment data and progression rates*. What this study suggests is that an underlying depression in *ability* is not the cause.

Similar conclusions were drawn by Gledhill, Ford and Goodman (2002). Gledhill and colleagues were able to access data on over 8,000 children[8], aged 5 to 15 in a population-based survey. They obtained teacher reports on the incidence of children having SEN because of learning difficulties. When assessed on objective measures of IQ, reading and spelling ability, comprehension, and communication skills, there were no significant differences within the general population between the autumn, spring or Summer-born children. However, the percentage of children designated as having SEN was notably higher among Summer-born (23.3%) than among those whose birthdays occurred in the spring (17.2%) or the autumn (15.2%) ($p<0.0001$). The authors noted that *'Despite this equivalence on objective measures, Summer-born children were significantly more likely than their older peers to be described by their teachers as having officially recognised learning difficulties.'* (p.46). Gledhill and colleagues put forward two factors that might contribute to the findings. Firstly, on average, teachers may not be making sufficient allowances for the level of attainment of the younger members of their classes. Secondly, the younger children may find the curriculum too challenging and this may lead to disruptive behaviour in the classroom. They cautioned that if a proportion of Summer-born children have been misdiagnosed as having SEN these children could be at increased risk of future academic failure, lower self-esteem, or emotional and behavioural difficulties. The report concluded that, as approximately one-third of children have a birthday in the summer term, there may be important implications for the academic attainment and emotional well-being of a very large number of school children.

[8] The data had been collected as part of the Mental Health of Children and Adolescents in Great Britain survey of 1999, which covered approximately 90% of British children (Meltzer et al., 2000).

The apparent over-diagnoses of special educational needs among Summer-borns relative to Autumn-born children is also evident in countries other than Britain. For example, research in the US reporting data on approximately 8,000 children showed that fewer than expected Autumn-borns were diagnosed as having behavioural and emotional difficulties, in contrast to a greater than expected number of spring and Summer-born children (Polizzi, Martin and Dombrowski, 2007). Polizzi and colleagues suggested that the findings could have a biological (pre-natal) explanation. They note that there is accumulating evidence of a greater frequency of pathologies of the central nervous system among people born between January and June relative to those born in other months. The findings are strongest in schizophrenia but are evident in other mental illnesses. However, it was suggested that the higher than expected diagnoses among spring and Summer-born children could be the result of relative age position in the classroom.

Similarly, Drabman and colleagues (Drabman, Tarnowski and Kelly, 1987; Tarnowski, Anderson, Drabman and Kelly, 1990) found that relatively younger American children were disproportionately referred for mental health services. Of 222 children referred for learning disability services, 77 (34.7%) were born July to September, 37 (16.7%) were born October to December, 54 (24.3%) were born January to March, and 54 (24.3%) were born April to June. The children were in classes from kindergarten to 8th grade and the findings showed that the birthdate effect appeared to be a general one that was not age or grade specific. The researchers also found that the pattern of referral rates could not be explained by differences in IQ, reading, mathematics and written language achievement. Some support for the possible over-diagnosis of the Summer-born children was provided by analysis of the final provision rates. Of the 77 July to September born children referred, only 20.78% went on to receive learning disability services. This contrasts with the findings that learning disability services were provided for 35.14% of the referrals of the October to December borns; 38.88% of the referrals of the January to March borns; and 40.74% of the referrals of the April to June born children. However, these rates did not differ statistically across the seasonal groups.

In summary, although the apparent educational disadvantage that might be experienced by relatively young children gives rise to concerns regarding current educational policies, the existence of birthdate effects in children identified with SEN is of particular concern. Evidence shows that, not only is there a greater than expected proportion of Summer-born children referred for SEN but also many of these children appear to have been misdiagnosed. The fact that there were higher proportions of Summer-born children attending MLD schools or of those referred for mental health services could not be explained by differences in IQ, or performance on other academic measures. These anomalies have been noted in large-scale studies in the US (Drabman, et al., 1987; Tarnowski, et al.,1990) and replicated in the UK (Sharp, 1995; Gledhill et al., 2002). These findings provide robust support for the view that teachers may be misidentifying Summer-born children as having special educational requirements, when in fact these children may simply be less mature in terms of cognitive and emotional development than their older classmates. This problem is discussed further in the ‘Teacher Expectancy Effects’ section below.

Evidence for birthdate effects on incidence of Absenteeism

A further consequence of being the youngest in the year group was reported by Carroll (1992, quoted in Wilson, 2000). These children were reported to have relatively poorer school attendance records than those born at other times of the year.

Evidence for birthdate effects on incidence of suicide

A particularly disturbing finding regarding birthdate effects is that suicide rates may be higher among young people who were the youngest in their school year. Thompson, Barnsley and Dyck, (1999) examined records of all of the people under the age of 20 who committed suicide in the US from 1979 to 1992. They found that there was a disproportionate number of people born in the second half of the ‘school eligibility year’, indicating that there was a higher probability rate of suicide among students who were relatively younger than their classmates. It was argued that poor academic performance may lead to lower confidence and lower self-esteem – both considered precursors to suicidal thoughts. The researchers concluded that research aimed at neutralising the negative effects of relative age should have important personal and social consequences.

It can be seen that the educational disadvantages bestowed on children who are youngest in their academic year group can be persistent and pervasive. This body of evidence highlights the need for further investigation into school entry policies.

Evidence for birthdate effects in sport, future eminence etc

The birthdate effect is also seen in many other areas of endeavour. Many studies were published in the 1990s showing birthdate effects in many sporting arenas and these are evident worldwide (See Musch and Grondin, 2001 for a review). Dudnik (1994) found a significant relationship between date of birth and people playing in National tennis and soccer leagues in the Netherlands and in England. In the Dutch youth tennis league, where the sports year coincides with the calendar year, half of the 60 players were born in the first 3 months of the year. This pattern was the same for swimmers, whose sports year also coincides with the calendar year (Baxter-Jones and Helms, 1994). In contrast, the Dutch soccer season starts on 1st August, so players born in the autumn months would be the oldest in their player year group. The data from 36 clubs, involving 621 players, showed that there were relatively more players born in the autumn and winter months and fewer in the spring and summer months (August to October born = approximately 200, November to January = 175, February to April = 150, May to July = 100)[9]. The same pattern of numbers of players was seen in the English soccer

[9] These approximate numbers were extrapolated from a bar-chart in the article.

league which begins in September[10]. Examination of the numbers playing in the four major leagues by month of birth in the 1991/2 season showed that almost twice as many players were born in September to November (N = 1020) as were born in June to August (N = 516). Dudnik also reported the results of a study by Barnsley and Thompson (1988) who found that there was a birthdate effect related to the Canadian hockey season. Players who had a relative age advantage, i.e. born in January to June, were more likely to be on minor and major hockey teams than those born from July to December. Grondin, et al. (1984, quoted in Musch and Grondin, 2001) found the same advantage for older players in American ice hockey at amateur and professional levels.

Dudnik suggested that young children are usually placed in sports teams within age-bands (e.g. under 13s; under 14s etc.) and that this stratification may present the same advantages for older children (and disadvantages for the younger children) within each group as is evident in the academic system. Thus the age-effect may pervade many other aspects of life. Indeed, Huntington (1938, quoted in Russell and Startup, 1986) reported that there was a disproportionate number of people who had achieved some form of fame or distinction born in winter months, peaking in February. Furthermore, in one study among American-borns reported by Huntington, the most eminent people showed the most exaggerated peak – in February. Further reviews of the literature in the sports arena are provided by Bell, Massey and Dexter (1997) and Musch and Grondin (2001).

Musch and Grondin (2001) discussed the possibility that birthdate effects might be explained by reasons other than an age-position effect. These included, climatical, environmental, sociocultural or biological factors. However, many of these factors appear to have been discounted by the findings of Musch and Hay (1999). These researchers looked for birthdate effects in soccer squads in Germany and Brazil, where the junior soccer squad year begins in August, but the climatic conditions at this time of the year are the reversed for the two countries. They found that the distribution of birthdates for the professional players in each country were the same. Furthermore, there was an advantage for players born at the beginning of the playing year for Japanese soccer players, where the sports year begins in April. Musch and Hay (1999) followed these studies by looking at what happened when the start of the Australian soccer season was changed from January to August, following a proposal by the World Soccer Association in 1988. They noted a corresponding shift in the birthdate distribution of professional players 10 years after the change. This and other birthdate effects relating to sports season cut-off dates provide strong evidence that, in many sports and around the world, participants have an advantage if they are the oldest in the relevant sports' year. Nevertheless, Musch and Grondin (2001) concluded that *'the growing number of empirical findings and theoretical considerations suggest that a mixture of physical, cognitive, emotional and motivational causes work together to produce the effect'* (p. 159). These factors include:

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[10] The English soccer season started in September at the time of Dudnik's (1994) study.

1. Competition: competition is a necessary condition for the existence of birthdate effects. The greater the competition for places on sports teams is (e.g. in large cities relative to less populated rural areas, or popular sports versus low-participant sports), the greater the relative age effect (Grondin et al, 1984; Helsen, 1998; both quoted in Musch and Grondin, 2001).
2. Physical strength: physical strength and speed are strongly correlated with chronological age. Weight and height can vary greatly over the 1 to 2 year age gap that exists in youth sports programmes. Indeed, with one chronological year, there is evidence that, in the UK, Autumn-born children are heavier at birth than Summer-born children (Murray, O'Reilly, et al, 2000). Some support for the effect of physical development in birthdate effects was provided by Grondin and Trudeau (1991, quoted in Musch and Grondin, 2001) when they noted that, while 55% of ice hockey forwards were born in the first half of the selection year, this proportion jumped to more than two-thirds for goal-keepers in the same sport. It was argued that goal-keepers have to be the strongest members of the team. On the other hand, in gymnastics in which physical maturation is a disadvantage, no birthdate effects were found among young elite participants (Baxter-Jones, 1995, quoted in Musch and Grondin, 2001). See McGrath, Keeping, Saha, Chant, Lieberman, and O'Callahan (2005) for a comprehensive review of the literature on birth weight relative to season of birth.
3. Psychological factors: children not only differ in physical maturity as a function of age but also in psychological maturity. *'Perceived competence is a powerful determinant of sport participation.'* (p.157). Children become more accurate in their perceived competence with age, with children of 8 and 9 years being less accurate than those of 10 to 13 years. Children of low perceived competence show less motivation and report less enjoyment from their sport than children high in perceived competence. If relatively younger children perceive that they are expected to perform at a lower level to that of older classmates (as evidenced by the 'teacher expectancy effect'), this may result in low self-esteem and therefore relatively poorer motivation and performance.
4. Experience: the older participants may have more experience than their younger team-mates, resulting in better performance. But this would not account for the fact that younger participants are under-represented on many sports teams.

To summarise the evidence regarding birthdate effects in the sporting arena, it is clear that individuals born in the early months of a given sports season are typically under-represented in the relevant teams and leagues of that sport. This has been seen to apply to sports as varied as swimming, Canadian hockey, American ice hockey, and soccer in countries as far afield as England, Brazil, Japan and Germany. Many of these sports start their seasons at different times of the year from one another, but their date of birth consistently disadvantages the youngest in the relevant season. The evidence from around the world strongly suggests that climatic conditions are not a contributing factor to the under-representation of younger individuals. Thus the sporting arena provides a forum in which birthdate effects can be examined.

Hypotheses regarding the existence and persistence of birthdate effects

As noted in the Introduction, the main hypotheses regarding the educational disadvantages of Summer-born children in the UK (or the youngest children in an academic year) appear to be as follows:

I. Summer-born children are not as intellectually able or potentially able as Autumn-born children (the Seasonality/Medical hypothesis)
II. All children in a school year group have reached the same level of ability or maturity, but the youngest children have less potential because they have less time at school (the LoS effect)
III. The youngest children in an academic year are at a lower level of maturity, but are as potentially able, as their older classmates (the Relative Age Effect - RAE)

I. The Seasonal/Medical hypotheses

Some authors in the 1960s (e.g. Orme, 1962, 1963) argued that the lower academic performance of Summer-borns may be the result of lower intelligence levels due to prenatal exposure to viral infections during the winter months. However, more recently reported studies argue against this hypothesis. If there is a relatively greater medical risk to children born during the summer months, then Summer-borns might be expected to perform at a relatively lower level to Autumn-borns, regardless of the timing of the academic year. However, this does not appear to be the case. For example, Sweden has adopted a school entry policy whereby children born in the *autumn* are the youngest in their year group. In a study of 24,000 Swedish 11-year-olds, it was the Autumn-borns who had the lowest scores on standardised tests (Burgand, 1967, reported in Sharp, Hutchison and Whetton, 1994).

Similarly, in Malta, there is an annual intake policy whereby children born in January are the oldest in the school year and the youngest are born in December. Research by Borg and Falzon (1995) carried out in 3 year groups showed that Summer-born children were not the poorest performers. The youngest in every year were out-performed by the oldest in their peer group in English, Maltese and Mathematics yet they were not Summer-born but Autumn-born. These findings weaken the argument that younger children in Britain perform relatively poorly because of prenatal exposure to infection in winter months.

II. Length of Schooling hypothesis

Some findings from studies carried out in the 1970s and 1980s suggest that birthdate effects might be the result of length of time at school. Fogelman and colleagues (1978, 1983) (quoted in Sharp, Hutchison and Whetton, 1994) reported data from the National Child Development Study taken from over 10,000 children all born within one week in March 1958. Some of these children had started school early (aged 4:5 to 4:11) and some had started late (aged 5:0 to 5:6). The early starters (who had longer schooling) performed better than the late starters on 3 measures of academic ability when they were 11 years old, suggesting that longer schooling was beneficial to performance.

However, more recent studies have produced less straightforward findings. If length of schooling before key assessments is a contributing factor to birthdate effects, then schools with an annual admissions policy (in which pupils all experience the same number of terms in school) might be expected to show fewer effects of birthdate in attainment among their pupils than schools in which intake was staggered over 3 terms. Among the 14 LEAs examined by Sharp (1995) covering over 20,000 children, the length of schooling varied from 7 terms for Summer-borns to 8 terms for the other age-groups in some schools, to 9 terms for all age-groups in other schools. However, Sharp (1995) did not find conclusive evidence that length of schooling alone could explain birthdate effects in KS1 performance. Although many LEAs reported that children who spent longest in infant school did best at KS1, Sharp noted that length of schooling is strongly related to age at entry. Many Autumn-borns have both the longest time at school before the KS1 assessments *and* are the oldest in their academic year. Sharp concluded that *'there does not appear to be a clear relationship between the relative attainments of children born at different times of the year and the length of time they spent in school'* (p. 257).

Many studies have not been able to distinguish easily the effects of LoS from the age-at-entry effect in British school-children. However, Sharp, Hutchison and Whetton (1994) collected data regarding age of entry and length of schooling for around 4,000 children who had undertaken KS1 assessments. The researchers were able to differentiate the possible effects of the two factors on birthdate effects in performance on the 3 core subjects. The cohort was split into 4 groups depending on age of entry to school: Group 1 were 4:0 – 4:3 and had 9 terms of schooling; Group 2 were 4:4 – 4:7 and had 8 or 9 terms; Group 3 were 4:8 – 4:11 and had 7, 8 or 9 terms; and Group 4 were 5:0 – 5:3 and had 6, 7 or 8 terms. Looking at the LoS factor, the researchers found that, for children who were in the same age band at entry, those who had been at school longest generally performed best. However, further analysis revealed an interaction between LoS and entry age. Group 1 (the youngest starters) did slightly less well on average than the 2 intermediate groups on all 3 subjects. Therefore, children who started school at a very young age did less well than older starters, even when they had longer schooling, but once this age threshold was passed, LoS seemed to relate positively to achievement at KS1. In addition, Group 4 (the oldest starters) also did slightly less well on average than the 2 intermediate groups on all 3 subjects. The authors suggested that the lower attainment of this group may be attributable to the fact that they had, on average, only 7 terms at school prior to assessment. Therefore Sharp, Hutchison and Whetton (1994) suggested that LoS does seem to be a factor in birthdate effects but only for children who are relatively older (over 4:5) at entry. This suggestion is in line with the findings of Fogelman and colleagues (1978, 1983) who reported that, in a cohort of children all of the same chronological age, those who had started early (and therefore had been at school longer) showed better academic ability relative to those who had entered school later. All of the children had started school after they had reached four and a half years of age. The findings of the later part of the study by Sharp, Hutchison and Whetton (1994), looking at RAEs, are reported in the section below.

In a further analysis of the data from the 1995 KS1 results, Sharp and Hutchison (1997) also found that LoS was related to performance but not in a straightforward way. There was a slight advantage for Autumn-borns who had spent the full 9 terms at school prior to assessment, relative to Autumn-borns with shorter schooling, but there was no such advantage within Summer-borns. Those with 6 terms did least well but those with the full 9 terms did not do much better. The researchers do not report the age of the children in the cohort but if the Summer-born children were below 4:5 on entry to school, then the findings would be in line with those reported in Sharp, Hutchison and Whetton (1994)

Further support for the findings that Summer-born children do not benefit academically from greater LoS was provided in a study carried out by Daniels, Shorrocks-Taylor and Redfern (2000). They used a multilevel model to examine the performance of *Summer-born children* who had either 7 or 9 terms of schooling prior to assessment. The data were taken from the 1991 (100 schools) and 1992 (90 schools) KS1 results for reading, writing, number and science. The model showed that only the effect of social background had significant explanatory power and that having allowed for this factor, any advantage of 2 extra terms of schooling on the scores disappeared. Therefore it was concluded that there was no evidence that an increase in schooling of one or two terms made any difference to the achievement at KS1 assessments.

The conclusion from these studies is that, although the effects of LoS are not clearly differentiated from those of relative age at entry into school, the evidence seems to suggest that LoS appears to be beneficial to the academic performance of children at KS1 level, but only for those who are older than 4:5 when they start school. Typically, Summer-born children in the UK are younger than this at entry and this may account for the findings that children born in the summer months are not advantaged by starting school early.

III. *Relative age hypothesis*

The findings from the studies reported in the previous section suggest that LoS may have less explanatory power than RAE for birthdate effects. The RA hypothesis holds that younger children are not as mature or ready for formal education as their older classmates are but that they nevertheless have the same level of potential to achieve. However, this potential may not be recognised or acknowledged by teachers.

In the later part of the study by Sharp, Hutchison and Whetton (1994), Summer-born children from 194 classes were divided into those who were the youngest in their class when they undertook their KS1 assessments and those who had younger classmates (those who were too young to be included in the

SATs). Analysis of performance showed that, in Science, those who were *not* the youngest in their class significantly out-performed those who were the youngest. However, the results for English and Mathematics did not reach significance. The former result does provide some support for the RAE hypothesis as a factor in birthdate effects, but it was not clear why the effect was not visible in the other 2 subjects.

However, stronger evidence of RA in explaining birthdate effects has been seen in other studies. If LoS is the same for a class of children whose ages span one chronological year, then it should be easier to detect RAEs. In Borg and Falzon's (1995) study reported above, the oldest in every year out-performed the youngest in their class in English, Maltese and Mathematics, despite the fact that all of the children had the same length of schooling.

If being the youngest in the class is detrimental to performance, then Summer-borns who enter school in a mixed-age class would perform more poorly than those who entered a class in which all the children were a similar age. This theory was examined by Pote (1996) who looked at the age structure of Reception classes. One LEA provided information on 142 children, born between May and August 1985 and who had spent the same length of time in Reception/infant school. These children were grouped according to the type of Reception class they had joined. Group A had joined an existing Reception class, Group B had joined a vertically-grouped class (Reception and Year 1 combined) and Group C had formed a separate class on starting school, comprising children closely grouped in age. When performances on SATs and TAs at age 7 were analysed, Pote found that children who had first joined a vertically-grouped class (with mixed age groups) did relatively less well in both forms of assessment than children who had first joined a class in which there was less heterogeneity in the age of the children. Fewer children in Group B attained Levels 3 and 4 and more attained Level 1 and Working Towards Level 1 than expected. The pattern was reversed in the other 2 groups. Thus being taught in a class of mixed ages was detrimental to the youngest children. However, many of the significant findings were restricted to the scores of the girls in the sample.

Pote suggested that the findings could be explained in two ways. Either the girls take longer to adjust to school life (maybe because they try to adjust on a social level more than boys do) or boys have greater difficulty adjusting but receive greater attention from the teachers than girls do, to help them. The latter suggestion was put forward by Croll and Moses (1991) who also provide a comprehensive review of literature of gender differences in infant school. Gender differences aside, Pote noted that vertical grouping had been recommended for Summer-born children as a way of ensuring continuity between Reception and Year 1 classes, but that the evidence from a number of studies had suggested that this was not necessarily a sound policy. She pointed out that teaching in a mixed-age class, relative to a more homogeneous class, requires greater planning and organisation. Pote also expressed concerns that the curriculum may not be demanding enough for older children while not providing the appropriate level of support for younger children.

Being among the oldest in the class was also shown to be an advantage for children in schools in the USA. Here some parents have recognised the relative disadvantage suffered by Summer-born children and many postpone the starting date of their children with summer birthdates by one year to allow them to start school at or near age 6. This means that children who would otherwise be the youngest in their year are then the oldest. The practice has become known as 'redshirting'. The National Center for Education Statistics (NCES, 1998, quoted in Katz, 2000) reports that academic redshirting is seen in about 10% of the population of young children, with postponement more likely among boys than girls, and Summer-borns than spring- or Autumn-borns. Although the evidence of the long-term effects of redshirting is somewhat mixed, the short- to medium -term effects are beneficial in a number of ways. The academic achievement of the held-back children is soon level with that of their grade-level peers, and they are less likely to receive negative feedback from teachers on their performance or conduct. There are also lower identification rates of special educational needs among this group. For further evidence from the USA on the merits of starting school when relatively older, see Sharp, Hutchison and Whetton (1994).

Teacher expectancy effects

Given that their RA might, at least in some measure, account for the relatively poor performance of children who are the youngest in their school year, many researchers have suggested that the 'teacher expectancy effect' might exacerbate any disadvantage relatively young children might have. Teachers may not always take these children's relative levels of maturity into account when making assessments of their ability. A number of studies have suggested that this might be the case in Britain (Sharp, Hutchison and Whetton, 1994) and in the USA. (May et al.,1995, Shepard and Smith, 1988). For example, Sharp, Hutchison and Whetton, (1994) argue that *'teachers may subconsciously 'label' Summer-borns as immature because they have poorer coordination, shorter attention spans and exhibit less ability to cooperate with other children than their older peers.'* (p.110). Furthermore, children who are perceived by their teachers as more intelligent, irrespective of their actual ability, tend to perform better (Brophy, 1981, 1983; Good, 1982, quoted in Sharp, Hutchison and Whetton, 1994).

There is more recent evidence that teachers do not allow for the cognitive and emotional developmental stage that young children have attained and they may under-estimate their ability and their potential. Mortimore et al, (1988) examined teacher expectancy in 2,000 junior school pupils. Teachers' ratings of ability at screening were shown to significantly favour Autumn-born children. Furthermore, the ability of Summer-born children on a verbal reasoning test was underrated, while that of the Autumn-born children was overrated. The authors noted that *'These results give cause for concern. It seems that, within a year group, teachers find it difficult to take full account of the impact of age in judging children's abilities* (p. 125). The negative bias that teachers may show towards younger children in their class has also been shown to extend as far as assessment for special educational needs (Sharp,1995).

Furthermore, Bell and Daniels (1990) emphasised the importance of the 'teacher expectancy effect' and its possible contribution to the relative under-achievement of Summer-born children *throughout* their compulsory schooling. The authors quote a study carried out in the US by Raudenbush (1984) in which teachers were provided with information on pupils from 1st to 7th Grade. The information was designed to raise the teachers' expectations of pupils actually selected at random. Analysis suggested that there were positive expectance effects, but only for children with whom the teachers were not familiar.

Teachers may also adopt a different teaching style with the children they think may not be ready for the curriculum. Appropriate teaching styles vary according to the age and personalities of children (Pote, 1996). An informal teaching style has been linked with poorer performance in reading and mathematics for children of all levels of ability except low achieving boys (Bennett, 1976).

If primary school teachers in the UK show this bias in assessment, then the disadvantage caused to younger children might be expected to disappear when children move on to secondary school thus enabling Summer-borns to catch-up with their older peers (Hutchison and Sharp, 1999). The studies summarised above do indeed suggest that the birthdate effect is less evident at secondary education level and is even less pronounced by the time the student reaches university.

In summary, the three main hypotheses regarding birthdate effects are based on medical considerations, length-of schooling, or relative age-at-entry to school. Evidence from around the world does not provide support for the view that birthdate effects are the result of prenatal exposure to infections. For the remaining two hypotheses, it is not always easy to differentiate the contributions of LoS from RAE, but some studies have been able to disentangle these variables. It appears that there may be an interaction between these two factors, such that LoS appears to be beneficial to the academic performance of children at KS1 level, but only for those who are older than 4:5 when they start school. The bulk of evidence points to a relatively strong contributing role of age-position in accounting for the poorer performance of relatively young children compared to that of their older peers. It has been suggested that children who start school very soon after their fourth birthday may have relatively more difficulty adjusting to school routines. In the 1980s schools may not have been staffed – in terms of numbers of teachers and experience of teachers - to meet the needs of this age group and the curricula may not have been appropriate. In addition, there is robust evidence to suggest that the 'teacher expectancy effect' may have a contributory role in the relatively poorer performance of the youngest children in the classroom and may be exacerbated by a more informal teaching style that might be adopted towards the relatively younger children in the first-year classroom.

Discussion

There is robust evidence that the youngest children in their year group generally perform at a lower level to their relatively older peers at all levels of formal education. In the UK, the youngest are born in the summer months, but the effect holds in other countries where they may be those born in the first months of the calendar year if the academic year begins in January. There are other negative effects of being the youngest in the year group. Not only is there a greater than expected proportion of relatively young children referred for SEN but also many of these children appear to have been misdiagnosed. Further evidence of birthdate effects comes from the sports arena. Individuals born in the early months of a given sports season are typically under-represented in the relevant teams and leagues of that sport. In addition, a number of studies provide robust evidence that the magnitude of birthdate effects reduces over time. However, the change is not a linear one. There appear to be steps in the reduction of magnitude at approximately ages 7, 10 or 11, and 15.

The three main hypotheses regarding birthdate effects are based on medical considerations, length-of schooling, or relative age-at-entry to school. The bulk of evidence points to a strong contributing role of relative age-at-entry (i.e. age-position in class) in accounting for the poorer performance of relatively young children compared to that of their older peers. Among other studies, the international study carried out by Bedard and Dhuey (2006) provided support for the relative age hypothesis. The study covered up to 38 countries and the academic year varied from country to country (e.g. January 1st, April 1st, May, 1st or September 1st). The findings showed that age-position in class, rather than the actual season in which a child was born, was responsible for the differences in performance on the TIMSS.

These findings give rise to the question: Is the effect the result of being *young* or being the *youngest*? Evidence suggests that the answer is probably ‘both’. In the UK, first-year classes of formal education comprise children whose ages range from just over 4 years to over 5 years. Thus Summer-born children are both young (probably just over 4 years old) and the youngest in their class when they start school. These children may be disadvantaged by being young because they would probably not have reached a level of competence required to tackle a curriculum that may have been developed with 5-year-olds in mind.

Furthermore, children who have just reached the age of 4 can also be expected to experience difficulties, over and above those of low competence levels, when beginning formal education. In order to cope with the demands of a school day children will arguably require levels of physical, social and emotional maturity normally expected of 5-year-olds. Within the physical domain one area in which 4-year-old children may be noticeably less mature than their 5-year-old peers is that of fine motor control. This may result in poorer writing ability. Within the social and emotional domains 4-year-olds might be expected to be poorly equipped to deal with many of the adjustments they have to make when they begin school. These include:

- Facing separation from their parents every morning
- Spending longer time away from parents than they might be used to
- Leaving familiar (and probably comforting) surroundings and possessions
- Spending time with other adults and children
- Getting to know strangers (in a short time and a concentrated way)
- Finding their place in a new hierarchy
- Having an unfamiliar structure to their day
- Adapting to new routines
- Assimilating and adhering to new rules
- Taking instruction from unfamiliar adults
- Taking on new responsibilities
- Getting used to not having their own way

Thus children around the age of 4 may not be ready for the environment they encounter in the Reception class, which will include having to deal not only with a curriculum that may not be tailored to their needs but also with a number of social and emotional adjustments. These factors may cause stress and anxiety. The older children in the class are more likely to have reached the required level of competence in all of these skills and therefore may not suffer the same levels of stress as those experienced by their younger peers. The evidence suggests that birthdate effects may be the result of lower levels of maturity in the physical, cognitive, social and emotional domains in the Summer-born children, relative to those who are more than a year older at the start of school. These factors may act independently, or more likely interdependently, in contributing to the type and level of birthdate effects seen in the literature.

A second question that arises is: Why are the effects of birthdate so long lasting? One way to answer this question is to suggest that younger children are affected in a negative way by their experiences in the early school years and this negativity continues to affect their academic performance throughout their schooling. There may also be some circularity taking place: young children have negative experiences that lead to relatively poorer achievements that lead to negative experiences later. This negativity could arise in any or all of the domains listed above.

Teachers' interpretations of children's successes and failures in ways that reflect favourably or unfavourably on their ability also affect children's judgments of their intellectual efficacy. A very relevant point was made by Giles (1993) who suggested that *'…sometimes the 'slow learner' is just simply a lot younger than his or her peers and they may need a different type of encouragement to improve their status'* (p. 135). Thus the fact that teachers may not expect as high a level of performance from younger pupils as they do from the older members of the class may have a contributory role in the relatively poorer performance of the youngest children by affecting their levels of developing and on-going self-esteem and self-efficacy.

A third question that arises is, if being relatively young at entry to school bestows an educational disadvantage, could this effect be ameliorated by holding back children until they are the oldest, rather than the youngest, in class? That is, is there evidence that starting formal education later helps to reduce birthdate effects? In some countries children are not introduced to formal curriculum-based education until they are 6 or 7. However, comparing evidence of RAE from educational systems across different countries has proved problematic, given the differences in a number of variables including the start date of the academic year, policies of delaying the start of formal education for younger children, and the presence or absence of ability grouping in early years. Nevertheless, Bedard and Dhuey (2006) were able to make comparisons across the educational systems of up to 19 OECD countries on performances on the TIMSS. Taking these variables into account, Bedard and Dhuey still found robust relative age effects for maths and science in the majority of the countries examined. However, there were two notable exceptions - no significant RAE were found at 8th grade (children aged 13) for children in Finland and Denmark. Unfortunately, no data are available for Finland or Denmark at 4th grade so it is not possible to draw any firm conclusions about the absence of a RAE in these 2 countries. It would be interesting to know whether any RAE would have been evident at 4th grade and have dissipated by 8th grade, or whether it did not exist in these countries at either timepoint.

Nevertheless, Bedard and Dhuey put forward one possible explanation for the apparent absence of RAEs at age 13 in Finland and Denmark.They point out that, in Finland, children do not begin compulsory education until age 7 and the primary classes do not focus on a formal curriculum, but on play and personal development. In Denmark, formal education begins at age 6, but children are not differentiated on the basis of ability until the age of 16. This led Bedard and Dhuey to suggest that RAEs might be weaker in countries where children begin a formal curriculum late, relative to children in other countries. It is important to note here that Scandanavian countries typically have very high levels of structured pre-school provision.

If there are advantages in starting a formal curriculum relatively late, then this raises the very important question of what educational provision could best be provided for children in the years immediately prior to the start of formal schooling. The influence of the quality and quantity of pre-school provision for children is comprehensively examined and discussed in reports on research commissioned by the Department for Children, Schools and Families (Sylva, et al., 2004; 2008). In the Effective Provision of Pre-School Education (EPPE) project, a major longitudinal study, the developmental trajectories of approximately 2800 children in England from age 3 to 11 years were examined. In-depth discussion of the many findings of this project are beyond the scope of this review but some relevant findings include:

- There are significant differences between individual pre-school settings and their impact on children, some settings are more effective than others in promoting positive child outcomes.
- High quality pre-schooling is related to better intellectual and social/behavioural development for children.
- Settings that have staff with higher qualifications have higher quality scores and their children made more progress.
- Quality indicators include having a trained teacher as manager and a good proportion of trained teachers on the staff.
- Where settings view educational and social development as complementary and equal in importance, children make better all round progress.

These findings, taken with the findings of Bedard and Dhuey (2006), suggest that the disadvantage for Summer-born children, which is particularly significant in the early years of schooling, might be eased by delaying the undertaking of a formal curriculum, but that care should be taken to make adequate and suitable provision for children's education prior to that point. This is borne out to some extent by the results found by Bedard and Dhuey (2006) for children in Sweden. Sweden is the only other country among those covered in the study that also delays formal education (until the age of 7), but RAEs were noted here. However, in the Swedish education system children are grouped by ability in the primary classes. This suggests that ability grouping might outweigh any advantage bestowed by beginning schooling later. Being placed into high- ability (or low-ability) groups may be positively (or negatively) reinforcing for children until at least the age of 7.

From a developmental psychology perspective, there are at least three theories that could inform the debate on birthdate effects. These are in the emotional, social and the cognitive domains. From the emotional and socially-based perspective, the period between age 4 and age 5 is arguably the time of greatest growth in the development of emotional and social competency (Harris, Olthof, et al,1987; Harter and Buddin, 1987; Harter and Whitesell, 1989; Stein and Trabasco, 1989; Ferguson and Stegge, 1995; Denham 1998). Thus it can be expected that there will be large variations in the levels of competency reached by the youngest, compared to the oldest, in the first-year group. During this period, children are beginning to use emotional terms (Ridgeway and Kuczaj, 1985, quoted in Denham, 1998) and fantasy play, which help them to grow socially. In addition, between age 4 and 5, children acquire more comprehensive social skills through the development of Theory of Mind - the ability to understand the mental states of others. Theory of Mind ability (ToM) has been argued to be a developmental pathway to school readiness and is related to the ability to learn (Astington and Pelletier, 2005). Language also provides a vehicle for thinking about mental states and research has shown that there is a strong interdependence between ToM and children's linguistic abilities (Astington and Pelletier, 2005). As language ability will also be more mature in relatively older children, they will be more likely to be able to think about emotional concepts. Thus parents and teachers need to recognise that there are important developmental and individual differences in young children's emotional competence. Denham, (1998) noted that *'Not only* *must parents, educators and psychologists know what to look for in terms of young children's emotional development, they must know why such development is so crucial, and what aspects of it need fostering.' (*p.13).

From a cognitive perspective, it is significant that the step-wise manner in which birthdate effects reduce in magnitude at approximately ages 7, 10 to 11, and 15 mirror those of the developmental course of executive function abilities (Zelazo, Mueller, et al., 2000). The term 'executive function' has been used rather broadly in cognitive psychology and neuropsychology, but is consistently agreed to encompass the set of cognitive processes required to initiate and drive future-oriented, goal-directed behaviour (Pennington, 1997). Executive function is therefore a pre-requisite for planned, rather than reflexive, behaviour. This can be anything from the apparently simple action of producing a sentence to solving complex problems. Executive function is generally agreed to comprise processes such as working memory, planning, action monitoring, the inhibition of prepotent, but inappropriate, responses, shifting attention, flexibility of thought, and decision-making. The developmental course of executive function abilities follows a multistage process (Passler, Isaac, and Hynd, 1985). Infants and young children exhibit rudimentary executive skills (e. g. Bruner, 1973; Kopp, 1982; Piaget, 1954) which later develop in three stages. Between the ages of 5 and 7 children are capable of flexible strategic behaviour and simple planning ability. By age 10, children show more complex organised search, impulse control, and set maintenance skills. However, verbal fluency, motor sequencing, and the formulation of more complex plans of action only reach adult-level at about 15 to 16 years of age. It has been suggested that the integration of executive processes may develop in line with the maturation of the ability to hold information on-line in working memory (Case, Kurland, and Goldberg, 1982). Or as Barkley (1996) puts it "*the various executive functions likely emerge at different points in development, interact with each other to progressively reorganise the executive system at each new stage, and show overlapping growth trajectories with the continued development of the earlier emerging executive functions*" (p 320). Thus the on-going maturation of executive function abilities could provide a comprehensive cognitive-based explanation for the lessening of birthdate effects as children progress through the school system.

In summary, this review has highlighted the robustness and persistence of birthdate effects and confirmed that they present potentially serious consequences for relatively young children that put them at a clear and long-term disadvantage in the educational system. Some theories from developmental psychology have been put forward that might help to explain these effects. If the aspiration of 'fairness for all children' in education is to be realised, the contribution of the developmental courses of cognitive and emotional abilities to birthdate effects needs closer investigation.

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Supplement – Developmental Aspects of Cognitive Ability

Definitions and Development of Theory of Mind and Executive Function

1. Theory of Mind

<u>Definition of Theory of Mind</u>

Theory of Mind (ToM) ability is the ability to attribute mental states of others. First-order ToM is a person's ability to understand that another person can have a different mental state from theirs (e.g. John thinks that.....).
Second-order ToM is a person's ability to understand a higher level of thinking in others, involving the comprehension of embedded information (e.g. John thinks that Mary thinks that.....).

<u>Tasks used to assess Theory of Mind</u>

The two main tasks traditionally used in cognitive psychology to assess ToM ability are 'unexpected transfer tasks', or 'false-belief' tasks (Wimmer and Perner, 1983). The false belief task requires an understanding that two people can have *conflicting beliefs* about reality.

The first is the **Sally-Anne test** (Wimmer & Perner, 1983). The experimenter uses two dolls, "Sally" and "Anne". Sally has a basket; Anne has a box. Children are shown that Sally puts a marble in her basket and then leaves the scene. While Sally is away and cannot watch, Anne takes the marble out of Sally's basket and puts it into her box. Sally then returns and the children are asked where they think she will look for her marble. Children are said to "pass" the test if they understand that Sally will most likely look inside her basket before realizing that her marble isn't there.

Another 'false-belief' test is the **Smarties test** (Perner *et al*, 1987). Children are shown a Smarties tube, and asked what they think is inside. They are expected to say "Smarties" or "sweets". The children are shown that the tube actually contains pencils. They are then asked what they think a friend will say when they are brought into the room, shown the tube, and asked what is inside. Children are said to "pass" the test if they understand that the other child will think there are Smarties in the tube, conflicting with their own belief that the tube contains pencils.

An example of deficits in ToM ability comes from clinical psychology. Individuals with autism are impaired on tests of ToM (Baron-Cohen, Leslie & Frith, 1985). Early-arising difficulty in the understanding of another's mental states provides an elegant explanation for many of the facets of autistic behaviour. Baron-Cohen (1994) argues that if one has no comprehension that another person can form a mental representation of an object (for example that seeing leads to knowing), then there would be no requirement to draw the other's attention to that object. Furthermore, there would be no understanding of a need to follow the gaze of another in order to know what they know. It would be unnecessary to carry out acts of deception and impossible to grasp the implications of a surprised expression. There would be difficulty in predicting people's behaviour, which would appear to be randomly generated. Emotions might be understood as having arisen from specific situations but not from particular beliefs. In addition, there would be little ability to recognise the importance of social conventions. These difficulties are reminiscent of those experienced by young children when they start school at age 4.

Development of Theory of Mind

First-order 'unexpected transfer' tasks, or 'false-belief' tasks, are passed by normally-developing children between the age of 4 and 5 years. Second order 'false-belief' tasks are normally passed between the age of 7 and 8 years. Higher level understanding of the mental states in others is attained by age 12 years.

2. Executive function

Definition of executive function

The term 'executive function' has been used rather broadly in cognitive psychology and neuropsychology, but is consistently agreed to encompass the set of cognitive processes required to initiate and drive future-oriented, goal-directed behaviour (Luria, 1966; Pennington, 1994). Executive function is therefore a pre-requisite for planned, rather than reflexive, behaviour. This can be anything from the apparently simple action of reaching for an object, to producing a sentence, to solving complex problems. Executive function is generally agreed to comprise processes such as working memory, planning, action monitoring, the inhibition of prepotent, but inappropriate, responses, shifting attention, flexibility of thought, and decision-making (Duncan, 1986; Shallice, 1988; Welsh and Pennington, 1988).

Tasks used to assess executive functioning

The traditional neuropsychological tasks which have been used to assess executive functioning include the Wisconsin Card Sorting Task (WCST), the Tower of Hanoi (TOH) task, the Tower of London (TOL) task (Shallice, 1982), and Trailmaking Tests (Spreen and Strauss, 1991). These tasks are thought to measure a number of executive processes, being sensitive to impairment in most areas of goal-directed behaviour. In the WCST participants are required to switch from one sorting strategy to another, allowing assessment of the abilities to establish a successful sorting strategy, benefit from feedback, switch attention, think flexibly, and alter ongoing behaviour. The Tower tasks are disc-transfer tasks that require the planning and execution of a series of actions designed to attain a defined end-state and are therefore sensitive to all of the executive processes required for the efficiency of goal-directed behaviour. The aim of the two Tower tasks is to transform a number of discs from a ‘start’ position into a pre-specified ‘goal’ position in as few moves as possible. There are physical differences between the 2 versions of the Tower tasks that require different cognitive strategies in order to solve them. The TOH task comprises 3 pegs *of equal length* placed upright into a base, with the middle peg equidistant from the other two pegs. A pre-determined number of discs (usually between 3 and 5), all the same colour but graded in size, are placed on one of the pegs in the form of a tower. This constitutes the ‘start’ position. The aim of the task is to place all of the discs onto another pre-determined peg, while maintaining the relative position of the discs – the ‘goal’ position. The TOH task requires adherence to the following *four* rules:

i) only one disc may be moved at a time
ii) a disc cannot be moved if there is another disc on top of it
iii) when a disc is moved from one peg it must be placed on another peg rather than held in the hand
iv) a larger disc must not be placed on a smaller disc

Moves are therefore constrained by the size of the discs.

In contrast, the TOL consists of 3 pegs *of graded lengths* arranged in a base. The shortest peg will accommodate 1 disc, the medium peg will accommodate 2 discs, and the longest peg will accommodate 3 discs. The TOL task only utilises a total of 3 discs. The TOL differs from the TOH in a second respect which is that the discs of the TOL are all the *same size* but each is a *different colour*. In the ‘start’ position the 3 discs can be in any configuration on the 3 pegs and the aim is to move them until they match a pre-determined ‘goal’ position. The restrictions of the two versions of the Tower tasks are not the same.

The restrictions in the TOH task involve adherence to a set of rules, while the restrictions in the TOL task are the lengths of the pegs, as they constrain how moves can be made. This is a *physical* constraint rather than one which is a *rule to be held in mind* (‘a large disc must not be placed on top of a smaller one’).

Mental flexibility is also assessed by the Trailmaking Test - Part B (Spreen and Strauss, 1991). In this task participants are required to make a trail between letters and numbers arranged randomly on a page. The letters and numbers have to be joined up in ascending order, but the trail must alternate between letters and numbers (e.g., A, 1, B, 2, C).

<u>Development of executive function</u>

The developmental course of executive function abilities follows a multistage process (Passler, Isaac, and Hynd, 1985). Infants and young children exhibit rudimentary executive skills (e. g. Bruner, 1973; Kopp, 1982; Piaget, 1954) which later develop in three stages (see Welsh, Pennington, and Groisser, 1991). Between the ages of 5 and 7 children are capable of flexible strategic behaviour and simple planning ability. By age 10, children show more complex organised search, impulse control, and set maintenance skills, enabling them, for example, to perform at adult level on the WCST (e.g. Chelune and Baer, 1986). However, verbal fluency, motor sequencing, and the formulation of more complex plans of action required, for example, in the TOH task, only reach adult-level at about 15 to 16 years of age. It has been suggested that the integration of executive processes may develop in line with the maturation of the ability to hold information on-line in working memory (Case, Kurtland, and Goldberg, 1982). Or as Barkley (1996) puts it "the various executive functions likely emerge at different points in development, interact with each other to progressively reorganise the executive system at each new stage, and show overlapping growth trajectories with the continued development of the earlier emerging executive functions" (p 320).

The ability to plan efficiently does not develop in a gradual way. Simple planning is observed by the age of 4, followed by abrupt increases in performance between 5 and 7 years. More complex planning can be achieved by 12 years of age. This is evidenced by the attainment of success in solving the 3-disc tower-to-tower 7-move TOH puzzle at about this age. However, executive skills are still developing into early adolescence. This transition in level of ability may be the result of the acquisition of more advanced, or sophisticated, problem-solving strategies. The developmental course of efficient performance on planning tasks mirrors that on other executive tasks. One theory for the comparatively late development of complex planning skills is that, with development, the ability to hold information on-line in working memory matures, enabling more sophisticated executive strategies to be employed (Case, Kurtland, and Goldberg, 1982).

The spurts in ability (at 5 to 7 years and around age 12) coincide with apparent rapid advances in problem-solving skills. These advances have been variously attributed to increases in logical thought (Piaget, 1954), verbal mediation (Kendler and Kendler, 1962), working memory (Case, 1985), and selective attention (Miller and Weiss, 1981).