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# Relative Age Effects: Implications for Leadership Development

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*Abstract: Relative age effects (RAEs) have been widely studied in the contexts of education and sport over the past 25 years. The RAE phenomenon is concerned with identifying age (dis)advantages relative to other children within a pre-defined age group. While intended to promote equality and fairness through the maintenance of general developmental similarities (e.g., cognitive, physiological), age-based grouping policies common to most educational and sport development systems have had the unintended consequence of advantaging "relatively" older children, while disadvantaging those who are "relatively" younger within the same cohort. Differences in developmental outcomes as a result of relative age have been shown to persist throughout adulthood resulting in considerable long-term social, emotional, and economic benefits (or detriments). The purpose of this review paper is to introduce readers to the RAE phenomenon, explore its underlying causes, examine its short- and long-term discriminatory effects, and provide directions for future research in this area, particularly as they pertain to leadership development.*

Keywords: Relative Age Effects (RAE), Sport, Education, Leadership Development

## Introduction

**FOR MANY, THE** phenomenon known as the *relative age effect* (RAE) was likely first introduced in the opening chapter of Malcolm Gladwell's (2008) best-selling novel *Outliers: The Story of Success*. In his book, Gladwell chronicles the lives of exceptional men and women from various walks of life in an attempt to demonstrate that what often separates these remarkable people from the norm is not necessarily their brilliance or innate ability, but is rather a matter of circumstance. In one example, Gladwell shares that much of Microsoft co-founder Bill Gates' success as a computer programmer, business entrepreneur, and philanthropist could be attributed to his unique access to a computer as an eighth grade student. While seemingly serendipitous, this opportunity was clearly afforded to Gates as a result of his privileged upbringing.

But what if Gates' success could be explained by another factor – one that is less a function of time and place or dollars and cents, and more the result of a systemic feature of developmental systems in virtually all corners of the world? Consistent with Newton's third law of motion, what if for every successful individual like Bill Gates, there was an equally promising computer programmer who got overlooked for similar opportunities as a result of this same systemic feature and is now struggling to make ends meet? Business journals and trade publications are replete with biographical sketches of the world's top business leaders that attempt to describe the various factors that have led to their inevitable success. However,

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what is often absent from these profiles is a consideration for the one enduring characteristic that is beyond their personal control: their date of birth. In some instances, no amount of effort, skill, or intellect can overcome this one fact of life: when you are born matters!

## What is the Relative Age Effect?

For more than a century, researchers have been captivated by the relationship between individuals' birth-dates and various developmental outcomes. Several of these early researchers suggested that persons of eminence tended to be born during the spring months, with slight discrepancies based on the specific population being examined (e.g., Kassel, 1929; Pintner & Forlano, 1934; Huntington, 1938). While the basis for much of this early work was to help understand the gestational patterns of the human species, it laid the groundwork for more recent research linking birth-dates to performance in a variety of developmental contexts, including education and sport (Thompson, Barnsley, & Dyck, 1999).

Whereas the season-of-birth literature examines the birth-dates of children with regard to their placement in the calendar year, the relative age phenomenon is concerned with identifying age (dis)advantages relative to other children within a pre-defined age group. This (dis)advantageous effect is likely to be present "…when, for logistical reasons, children are grouped by age for school attendance or other activities where performance is strongly correlated with development" (Thompson et al., 1999, p. 82). Although intended to promote equality and fairness through the maintenance of general developmental similarities (e.g., cognitive, physiological), age-based grouping policies common to most educational and sport development systems have had the unintended consequence of advantaging "relatively" older children, while disadvantaging those who are "relatively" younger within the same cohort.

To illustrate, assume that a particular school district uses a defined selection year (e.g., January 1 to December 31) to divide and group its students. This simple and seemingly innocent selection process renders chronological age differences of up to 12 months (less a day) for students within a single grade-level. While this age difference (< 1 year) may not seem like much, for students entering kindergarten at five years of age, this means that some students are nearly 20% older than others within the same class. As a consequence of using defined cut-off dates for grouping children at early ages, the RAE has been shown to produce both statistically significant and practically meaningful differences in the mean achievement levels of otherwise similar individuals (Allen & Barnsley, 1993). In general, those born early (e.g., within the first three months) in the selection year have distinct advantages over their relatively younger peers born later in the same selection year (e.g., within the last three months; Cobley, Baker, Wattie, & McKenna, 2009b).

## Relative Age Effects in Education

Differences in developmental outcomes as a result of relative age were first identified in the education system (Armstrong, 1966; Freyman, 1965). Subsequent research has consistently demonstrated higher achievement scores (0.3 to 0.8 standard deviations) for the relatively oldest students in elementary school across a broad range of subjects and countries (e.g., Bedard & Dhuey, 2006). These results seem to persist, albeit at a lesser magnitude (0.1 to 0.2 standard deviations), throughout the end of secondary school (e.g., Smith, 2009). What's

more, students with relative age advantages are more likely to be placed in "gifted" educational streams (e.g., Cobley et al, 2009b), and be selected for student leadership positions (e.g., student council representative; Dhuey & Lipscomb, 2008).

In stark contrast, students with relative age disadvantages experience a greater likelihood (as much as 15%) of being retained for an additional year in the same grade (e.g., Elder & Lubotsky, 2009), referred for a psychological evaluation (e.g., Drabman, Tarnowski, & Kelly, 1987), being designated for remedial instruction (e.g., Wallingford & Prout, 2000) and/or diagnosed with a learning disability (e.g., Martin, Foels, Clanton, & Moon, 2004). Additionally, relatively younger students report having significantly lower attendance rates (e.g., Cobley et al, 2009b), and are less likely to pursue post-secondary studies and gain acceptance into top ranked colleges and universities (e.g., Bedard & Dhuey, 2006) as a result of being tracked into less academically-oriented (i.e., vocational) studies than their relatively older peers.

While an exhaustive review of the RAE literature in educational settings is beyond the scope of this paper, it is clear "…that children who experience the negative effects of a young relative age on school entry will experience both short- and long-term disadvantages at a higher rate than their age-grouped older classmates" (Thompson, et al., 1999, p. 83).

## Relative Age Effects in Sport

One of the earliest RAE studies specific to sport looked at ice hockey in Canada, and determined that relatively older children are over-represented on elite teams, a trend that emerges early in youth hockey and continues through to the sport's highest level (Barnsley, Thompson, & Barnsley, 1985). Hockey organizes players into age groupings according to the calendar year, and researchers have found that those born early in the year seem to be at a distinct advantage when it comes to high achievement in the sport (Musch & Grondin, 2001). This early hockey study was confirmed in other sports, across different countries (Cobley, Baker, Wattie, & McKenna, 2009a).

While hockey tends to advantage children born in January, February and March, soccer players in Brazil and Germany are at an advantage if they are born in August, September, and October, due to a "cut-off" date of August 1st in those countries (Musch & Grondin, 2001). The way in which age distributions change depending on the cut off date argues against a seasonality explanation of the RAE. Powerful evidence in support of the somewhat arbitrary yet important nature of cut-off dates comes from Helsen, Starkes, and Van Winckel (2000) and Musch and Hay (1999) who investigated how changes in the date affected subsequent player distributions. For example, the Belgian Soccer Federation changed its cut-off date from August 1st to January 1st in 1997. Prior to 1997, players born in August through October were over-represented in youth elite leagues, whereas post 1997 there was a distinct shift to players born in January through March playing at the elite level.

Specific to the sport context, maturation rates appear to be an important influence on the emergence of RAEs (Cobley et al., 2009a), as 11 months difference can provide a substantial advantage in terms of height, weight and co-ordination during adolescence (Malina, 1994). These advantages often translate into better performance on the playing field or the ice rink. In sports like gymnastics, where height and weight may be detrimental to performance outcomes, reverse findings have been found (e.g., Baxter-Jones, Helms, Maffulli, Baines-Preece, & Preece, 1995). Even in sporting activities that are less dependent on physical attributes

(i.e., size and strength), such as shooting sports (Delorme & Raspaud, 2009a) and stock car auto racing (Abel & Kruger, 2007), evidence of the RAE persists.

Of equal or greater concern to the developmental implications of the RAE are the long-term social, emotional, and economic benefits (or detriments) that educational- and sport-based (dis)advantages can have on children. Relative age (dis)advantages are predictive of more (or less) active social lives (Billari & Pellizzari, 2008), higher (or lower) levels of self-esteem (Thompson, Barnsley, & Battle, 2004), as well as lower (or higher) incidences of suicide (Thompson et al., 1999) and teenage pregnancy (Black, Devereux, & Salvanes, 2008). Moreover, RAEs have also been linked to (un)favourable labour market outcomes, including a higher probability of being (un)employed (Grenet, 2009) and increased (or decreased) wages (Plug, 2001).

## How are Relative Age Effects Caused?

The RAE is likely to be present in any developmental system where: (1) selection of individuals is made on the basis of ability; (2) individuals, once selected, are placed into different streams (e.g., gifted or competitive), and (3) different streams provide discriminate opportunities for instruction, contact time, and competition. The resultant outcome of these discriminate opportunities can often lead to a positive self-concept, intrinsic and/or extrinsic motivation to continue in the activity, and an accumulated advantage that manifests itself in the form of increased leadership and/or career opportunities (see Figure 1).

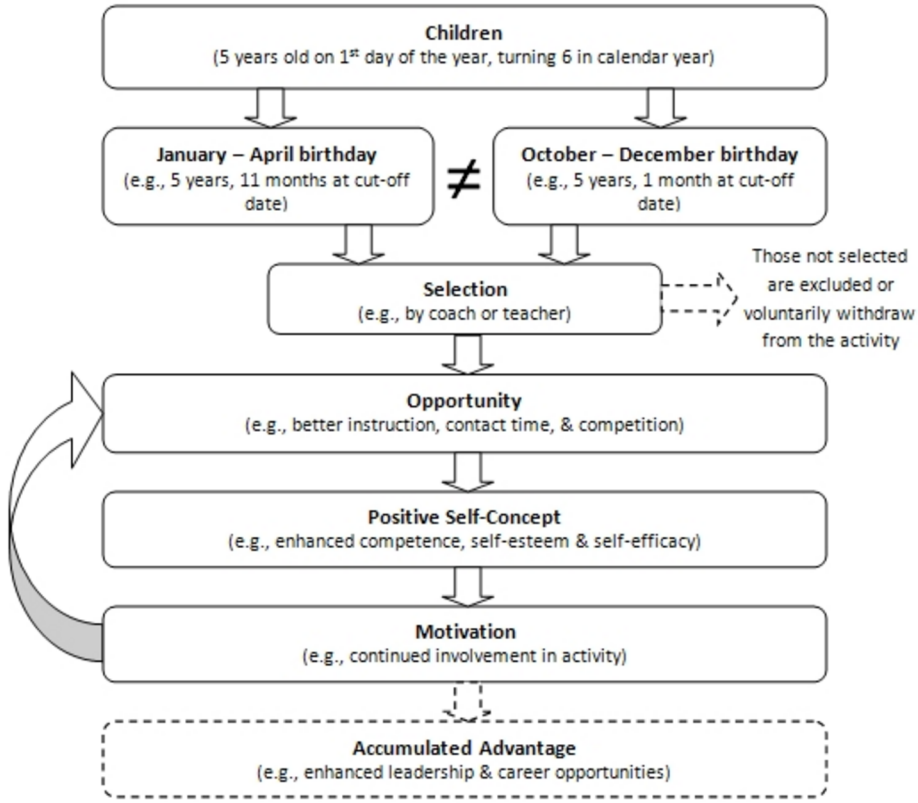


Figure 1: A Model of the Relative Age Effect

Based on this description, the RAE is not that dissimilar from what is found in a meritocracy, where responsibilities and appointments are granted to individuals based on their demonstrated abilities (i.e., merit). Coined by Michael Young (1958), a meritocracy is characterized by a society that rewards those who are perceived to be talented and competent as a result of their demonstrated actions or through competition. Evaluation and training systems like formal education have been widely criticized for being closely aligned with the values of meritocracy (Young, 2001). While proponents of meritocracy suggest that it reduces the likelihood of rewards and legitimacy being based on arbitrary criteria (e.g., sex, race, wealth), opponents contend that meritocracy is a myth and that there are a number of non-merit explanations for why some people are able to get ahead, while others are left behind (McNamee & Miller, 2004). The RAE is but one of the many factors that may serve to suppress, neutralize, or even negate the effects of merit in industrialized countries by unconsciously discriminating against children who are late to mature (Allen & Barnsley, 1993).

What distinguishes the RAE from a true meritocracy is that ability is difficult, if not impossible, to distinguish from maturity during childhood, which is when initial selection (i.e., streaming) decisions take place. According to Allen and Barnsley (1993), abilities are innate and cannot be directly observed (e.g., reaction time, coordination). Thus, teachers, coaches,

and others entrusted with making selection decisions commonly rely upon observed skill as a proxy for the underlying abilities. However, skill is as much the product of maturity (Musch & Grondin, 2001), as it is ability. Thus, basing selection decisions on observed skill can often result in systematic selection errors due to the influence of maturity. As demonstrated throughout the literature, these selection errors can have long-term social and economic consequences. On this point, Allen and Barnsley (1993) noted that "…systems that stream may fail to provide training to some able individuals, as they may also fail by providing higher-level training to some individuals not able to make adequate use of it" (p. 657). The persistence of these selection errors may further lead to a misallocation of resources, inadequate amounts of human capital being developed, and misleading information being communicated to the labour market regarding the system's ability to produce talent.

Once selected into the advantaged stream, relatively older children are furnished with greater opportunities for training from more highly qualified instructors. When combined with increased contact time and improved competitive conditions, this privileged minority is able to further distance itself from the performance norms of the relatively younger children within the same age cohort. Having profited from an initial relative age advantage, these children are more likely to be perceived, erroneously, as the most talented in their age cohort. When the perceptions and behaviours of others (e.g., parents, instructors, and peers) co-vary with initial perceptions of their own abilities, these children may further benefit from what is known as the *Pygmalion effect* (Rejeski, Darracott, & Hutslar, 1979).

Coined by Rosenthal and Jacobson (1968), the Pygmalion effect has been suggested to stabilize and amplify relative age advantages by inadvertently influencing children's subsequent motivation and performances in what can be termed a "self-fulfilling prophecy" (Merton, 1948)[1]. When relatively older children are selected into advanced streams and receive positive feedback regarding their performances, they are more likely to have high self-perception and are, thus, motivated to continue participating in the activity. On the contrary, relatively younger children are frequently excluded from the activity from the outset as a result of their non-selection, and the few that are selected are prone to receiving less favourable feedback and demonstrate lower levels of self-perception. This ultimately influences their decision to withdraw from the activity altogether (Cobley et al., 2009b).

The overarching conclusion from the vast number of RAE studies that have been conducted within the education and sport settings is that "…children with a relative age advantage are more likely to succeed, while children with a relative age disadvantage are more likely to encounter problems in the particular activity for which they have been 'age grouped'" (Thompson et al., 1999, p. 83). Despite their obvious parallels, greater effect sizes are typically found in sport than in educational contexts (Musch & Grondin, 2001). At least two explanations have been provided for these differences. Firstly, the concept of streaming is not always relevant in contemporary educational systems. Many boards of education have moved away from the streaming of children into classes on the basis of their early academic performance. Without streaming, the RAE is greatly reduced (Allen & Barnsley, 1993). Secondly, these differences may also be the consequence of compulsory school attendance. In sport, children have the flexibility of withdrawing from activities at their discretion, but are obligated to

[1] In spite of the technical shortcomings of Rosenthal and Jacobson's (1968) work, we agree with Thorndike (1968) who stated that "the general reasonableness of the 'self-fulfilling prophecy' is not at issue" (p. 708).

remain in school until they have reached the legislatively determined drop-out age (Musch & Grondin, 2001).

## How are Relative Age Effects Moderated?

The extent to which the RAE impacts academic and athletic successes is moderated by a number of variables including: the intensity of competition, sex, socio-economic status, and playing position (Baker et al., 2010). In general, the larger the pool from which children can be drawn from, the stronger the RAE should be (Musch & Grondin, 2001). This actuality is due to competition being a necessary condition for RAEs to exist. In instances where there is no competition for selection into advanced streams (or there is no streaming), there can be no relative age advantages because everyone who wants to participate is given an equal opportunity to do so. However, as competition for these limited placements increases, unconscious discrimination may take place in the selection of candidates based on relative age differences.

Given that competition is necessary for RAEs to take hold, where children are brought up can also have an impact on their likelihood of experiencing a relative age (dis)advantage. This is particularly true in the context of sport, where athletes are selected to elite teams on a regional basis. The more popular the sport and the more it is culturally valued (e.g., ice hockey in Canada, soccer in England), the more likely youth will be "professionalized"– where participants are identified and streamlined very early based on their perceived talents. The greater the number of participants a sport attracts, and hence the more competition for spots on elite developmental rosters, the increasing likelihood that early height, weight or motor co-ordination advantages will play a role (Cobley et al., 2009b).

With respect to sex, Musch and Grondin (2001) hypothesized that stronger RAEs would be present in male than female youth sports. This argument was based on the nature of competition being generally more intense among male sport participants. Supporting this argument, Baxter-Jones (1995) found smaller and non-significant RAEs in female soccer players. However, there have been many studies published since this time that have refuted this contention. For instance, Delorme and Raspaud (2009b) found significant RAEs in both male and female youth basketball, with the effect being more pronounced in the female population. In their meta-analysis of studies spanning from 1984 through 2007, of which females represented only 2% of participants, Cobley et al. (2009a) found that sex had little impact on the odds of being exposed to the RAE. Conflicting results have also been noted in the education setting. Smith (2009) found that gender differences in the RAE were quite small in elementary school, but were shown to become larger in secondary school, with female students exhibiting greater variability in test scores.

While the jury is still out regarding the overall effect of sex on RAEs, explanations for differences between the sexes in sport are thought to be the result of the earlier maturation of females and the greater variation in the maturity status of males during the selection period (Baxter-Jones, 1995). In addition, Vincent and Glamser (2006) suggested that females face greater pressures to conform to socially constructed gender roles. As a consequence, early maturing females may become less motivated to engage in competitive sport activities as society might not value it to the same extent as it does for males. Similarly, Shakib (2003) noted that female athletes are constantly negotiating a tension between popularity (i.e., peer status) and athleticism. This tension can often lead early maturing females to withdraw from

competitive sports earlier than their relatively younger female counterparts, thereby reducing the overall RAE in female populations.

In educational contexts, the pressure to conform to social norms is also prevalent (Allen, 2008). This was highlighted by the work of Bishop (2003) and his colleagues at Cornell University. These authors demonstrated that "when it comes to academic engagement, peer culture sets a norm – an optimal level or range of academic effort – that if adhered to prevents many students from achieving all they could academically" (Bishop & Bishop, 2007, p. 7). This means that students may be likely to "try hard but not too hard" and "get grades *just* good enough to get into college" in order to avoid having sanctions imposed upon them for violating these norms, which may include banishment from the leading crowd (Bishop & Bishop, 2007). As a consequence, persistence of RAEs at the secondary and post-secondary levels may be as much about adherence to (or defiance of) the predominant social norms as it is about sex.

In some instances, peer culture and social norms have also been used to explain reversals in expected RAEs. Billari and Pellizzari (2008) examined a group of Italian university students and reported that the youngest students performed better, particularly in the more technical subjects. In an attempt to reconcile their results, Billari and Pellizzari acknowledged "…that the youngest students in a given birth cohort are also those with the least active social lives: they are less likely to do sports, go to discos and have love relationships" (p. 4). Presumably, having less active social lives allows relatively younger students more time to dedicate to their studies (Billari & Pellizzari). Thus, either age, or social skill status can lead to a reversal of the traditional RAE pattern.

Socio-economic status (SES) has also been shown to moderate the RAE, at least in educational settings. When comparing effect sizes of RAEs across the income distribution, Smith (2009) uncovered that age effects were more persistent for secondary school students from the lowest income quartile. Similar results were found by Elder and Lubotsky (2009) in their study on kindergarten entrance age, and by Grenet (2009) in his study on labour market outcomes. These studies are consistent with a larger body of research that shows significant differences in the educational achievements of students from various socioeconomic and racial backgrounds (e.g., Duncan & Brooks-Gunn, 1997; Fryer & Levitt, 2004). According to Elder and Lubotsky, "to the extent that high-SES families provide their children with higher levels of investment, children's prekindergarten experience will have a larger effect on test scores among rich children than among poor children" (pp.659-660). These age advantages tend to persist for students with higher SES due to the fact that wealthy parents are able to provide supplemental resources such as extra books, remedial classes, tutors, and so forth throughout their child's education (Smith, 2009). Parents of low SES are also less likely to delay their children's entrance into school, a strategy employed by some parents to offset RAEs in education, due to the cost-prohibitive nature of pre-kindergarten child care (Dhuey & Lipscomb, 2008). Although we are not aware of any research specifically examining the moderating effect of SES on RAEs in sport, there is sufficient reason to believe that differences may also be prevalent in this context, as SES is generally highly correlated with participation in sport and physical activity, regardless of age (e.g., Grzywacz & Marks, 2001; Humbert et al., 2006; Stalsberg & Pedersen, 2010;).

Finally, specific to the sporting context, the position that an athlete plays has also been shown to moderate the RAE. The magnitude of the RAE has been reported to vary according to position in the sports of ice hockey (e.g., Grondin & Trudeau, 1991), cricket (e.g., Edwards,

1994), baseball (e.g., Grondin & Koren, 2000), soccer (e.g., Ashworth & Heyndels, 2007), and German handball (e.g., Schorer, Cobley, Büsch, Bräutigam, & Baker, 2009). In many instances, explanations for such differences have been attributed to the "handedness" of the individual athlete (e.g., Schorer et al., 2009). Since right-handed people are more prominent in the general population (Raymond, Pontier, Dufour, & Møller, 1996), positions that favour right-handed athletes attract higher competition and thus invoke higher effect sizes (Schorer et al., 2009).

## Opportunities for Relative Age Effects Research in Leadership

The benefits that come with being an older member of one's age cohort tend to endure, resulting in an "accumulated advantage" (Murray, 2003). According to Bedard and Dhuey (2006), "…if early relative maturity effects propagate themselves through the human capital accumulation process into later life, long after small differences in age are important in and of themselves, they may have important implications for adult outcomes and productivity" (p. 1437). In light of the findings from educational and sport contexts, the RAE may have considerable implications for academics and practitioners in the domain of leadership development.

The advantage accumulated throughout one's educational and athletic development may prove favourable when it comes to career opportunities. Relative age differences in university preparation and leadership skill accumulation may ultimately translate into greater levels of success in a variety of leadership contexts. This may be particularly true considering that possession of a degree from an elite educational institution has been shown to facilitate ascendency into leadership positions within corporate settings (Useem & Karabel, 1986). In fact, recent work by Flynn and Quinn (2010) confirmed that over 98% of the S&P 500 CEOs in 2004 held a bachelor's degree, with 28.5% of these executives majoring in business and 11.2% graduating from an Ivy League institution. These authors also reported that 61.9% of these CEOs had an advanced degree, with 38.3% having obtained their MBA. An obvious opportunity for researchers interested in the RAE phenomenon is to explore how the RAE impacts acceptance and success rates at the undergraduate and graduate levels within these educational programs.

In a similar vein, economists have identified a substantial adult wage premium attached to high school leadership activity (Kuhn & Weinberger, 2005). Given that relatively older students are more likely to be selected to high school leadership positions (i.e., team captains, student council representatives; Dhuey & Lipscomb, 2008), how pervasive is the RAE in explaining the career success of our sport, education, business, and public sector leaders? If relatively older individuals are being selected as leaders during adolescence, it is likely that these experiences will help them to achieve acceptance into university, and obtain future leadership positions. Thus, not only might researchers be interested in the RAE's impact on leadership selection and ascendency, but also on leaders' performances in these roles.

Assuming that RAEs are found in these populations, the logical extension of this research would be to explore possibilities for mitigating these discriminating effects in the leadership selection and ascension process. Several remedies have been proposed in the education and sport literatures, but implementation of these has proven difficult (Baker et al., 2010; Cobley, 2008). In many cases, these proposed solutions merely result in a shifting of cut-off dates, thereby (dis)advantaging children born at different times of the calendar year (Baker et al.,

2010). As noted by many, simply raising awareness of RAEs may be enough to mitigate their impact (e.g., Cobley et al., 2009a; Dhuey & Lipscomb, 2008). Ultimately, RAEs may result in inefficiencies in the labour market due to the youngest members of a particular cohort being overlooked during their developmental years, and thus never being given the opportunity to demonstrate their leadership potential.

## Methodological Concerns

While a plethora of research has been published on the RAE in education and sport it has often been difficult to compare the findings across different studies. Without a heightened awareness of these concerns, the same issues are likely to be perpetuated in future examinations of the RAE. Some of the issues that contribute to this difficulty are the measures used to reflect the RAE, the identification of cut-off dates, mechanisms underlying RAEs, and strategies used for calculating RAEs.

Birth date effects can be described by a number of different measures each with its own definition and contribution to the literature. Chronological age is defined as an individual's age on a given calendar date. In contrast, relative age is an individual's age relative to a predetermined cut-off date, and thus reflects discrepancies between individuals within an age-grouped cohort (Barnsley et al., 1985). The difficulty in distinguishing between chronological age and relative age is that those individuals who are chronologically older are also the relatively oldest (Smith, 2009). A related issue can be described by season-of-birth (SOB) effects, which is often reported as relative age. Evidence for SOB effects comes from literature suggesting that individuals born during the same time of the year experience the same seasonal conditions that might influence prenatal and perinatal development. The difference between relative age and SOB effects is the cut-off date used to define the RAE, and the underlying mechanism contributing to the effect. SOB effects have been primarily identified as having an influence on cognitive and psychiatric development (e.g., Castrogiovanni, Iapichino, Pacchierotti, & Pieraccini, 1998), with the mechanisms being related to maternal exposure to illness, temperature, and vitamin intake (de Messias, Cordeiro, Sampaio, Bartko, & Kirkpatrick, 2001; Murray, O'Reilly, Betts, Patterson, Smith, & Evans, 2000; McGrath, 1999). RAEs in education and sport have been linked to how socially-based mechanisms associated with age-groups affect development. As previously reported, even small differences in relative age can lead to lower levels of attainment (see Musch & Grondin, 2001, and Smith, 2009).

While the identification of cut-off dates, and ultimately the RAE in sport is relatively straightforward, it is less so in the education system. Within and between countries there are large variations in the starting date of school. If the start date cannot be verified easily, then the identification of RAEs becomes problematic. In one of the most comprehensive studies to date Bedard and Dhuey (2006) examined academic performance across OECD countries of students in grades four and eight. Bedard and Dhuey describe how the cut-off date for schools was determined by using the distribution of births across months in each country. The beginning of the first month of the twelve consecutive months that contained the largest percentage of student births was defined as the cut-off date. A different approach to identifying cut-off dates was taken by Billari and Pellizzari (2008). They classified students as being *regular, older, and younger*, and then focused their analyses on the three different samples. While several strategies have been employed to account for individual differences,

the majority of studies have relied on a variation of relative age to describe differences in their samples.

Several mechanisms have been proposed to account for the underlying cause(s) of the RAE in educational (and other developmental) settings (see Crawford et al., 2007 and Grenet, 2009). While these mechanisms present solid reasons as to why the RAE might exist, the assessment of their importance presents a host of empirical challenges. As highlighted by Grenet (2009) there are a number of concerns: (1) *Effects of date of birth:* When students are enrolled in school there is the interaction of multiple factors including age at start of school, age on test day, and length of time in school. (2) *Sample selection issues:* Within every cohort of students, there is heterogeneity of age due to actual birthdate, and the age at the start of school. Not all students enter at the requisite age, and early or late enrolments are likely linked to date of birth. Those who enter early tend to have birthdates soon after the cut-off date, while those who enrol late typically have birthdates just prior to the cut-off date. Similarly, heterogeneity in age might exist because students were promoted to the next grade early, or were held back in a previous grade. (3) *Age at testing:* The age at testing is related to item 2 above. Whether a student is older or younger on the test day impacts performance, and again is related not only to relative age, but chronological age.

Finally, a large range of estimation strategies have been employed in the literature to address some of these empirical issues. Despite the variation in methods employed, the samples, and test scores measured, the findings are relatively consistent. Whether these effects are due purely to maturational differences, social differences, or a combination of the two, remains to be determined. Overall, it can be concluded that there is evidence to support the finding that RAEs persist from elementary through to university level education, and that there are a myriad of models, attributes and methods to describe them.

## Future Directions and Conclusions

Much has been written about the RAE in education and sport over the past twenty-five years. To date, almost all of this research has been carried out in a cross-sectional nature. What appears to be lacking is a longitudinal and/or retrospective examination of people's engagement in education and/or sport and how these experiences may have shaped their livelihoods. If, indeed, relatively older children are provided with greater leadership opportunities throughout their childhood and adolescence as a consequence of their involvement in education and sport, then how (if at all) do these experiences carry over to provide leadership advantages into adulthood? Which context provides a better training ground for future leaders: education or sport? Perhaps the best leaders had extensive leadership experiences in both of these contexts, thereby suggesting an interactive effect. At present, we can merely speculate about the answers to these questions.

Furthermore, despite all that has been learned to date about the RAE in the education and sport contexts, very little has been done to address it. While numerous solutions have been proposed in the literature, there have been very few documented attempts at reducing and/or eliminating the discriminatory effects. Those that we do know about have had mixed results (e.g., Cobley, McKenna, Marchant, Baker, & Wattie, 2009). Assuming that RAEs do, in fact, carry over into adulthood and manifest themselves in the ascendency and selection of our sport, education, business and public sector leaders, what kinds of interventions would be best suited to eradicate this trend? What role(s) should our current leaders play in fostering

this change? If the quality of a leader can be measured by the performance of his or her successors (Collins, 2001), then we argue that our present day leaders have a critical role to play in bringing about change with respect to the RAE. For, without some type of affirmative action, we risk squandering talent within our next generation of prospective leaders, and suffering the opportunity costs associated with advancing the careers of less-qualified candidates.

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