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Unequal Competition as an Impediment to Personal Development: A Review of the Relative Age Effect in Sport

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Children born shortly before the cutoff date for age grouping in youth sport programs suffer from being promoted to higher age groups earlier than their later-born peers. Skewed birthdate distributions among participants in youth sport and professional sport leagues have been interpreted as the result of this disadvantage. A growing body of research shows that this *Relative Age Effect* in sport is a worldwide phenomenon and that it exists in many, but not all, competitive sports. Both physical and psychological mechanisms that may be responsible for the effect are identified. Negative consequences on personal development and possible remedies to the problem are discussed. Finally, desirable and necessary directions for future research are formulated. © 2001 Academic Press

Most public school systems specify cutoff dates for entrance into kindergarten or first grade. Although a primary purpose of this procedure is to avoid large age differences, children born shortly after the cutoff date are still up to a full year older than late-born children in their respective age group. This difference of age between individuals in the same age group is referred to as *relative age*, and its consequence is known as the *Relative Age Effect* (RAE). A maximum relative age difference of almost 1 year, which is typical of the public school system in most countries, is associated with significant differences in children's cognitive development (Bisanz, Morrison, & Dunn, 1995; Morrison, Smith, & Dow-Ehrensberger, 1995). It is

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therefore hardly surprising that a large body of research indicates that relatively younger children have more academic problems than their older classmates (Bell & Daniels, 1990; DeMeis & Stearns, 1992; Dickinson & Larsen, 1963; Gilly, 1965; Grondin, Proulx, & Zhou, 1993; Hauck & Finch, 1993). Early entrants are more likely to be classified as learning disabled (Diamond, 1983; Maddux, 1980), and they achieve significantly less than their older classmates (Davis, Trimble, & Vincent, 1980). On the other hand, Maddux, Stacy, and Scott (1981) observed that, in a group of children who were classified as gifted, 61% were advantaged by a late entry to Grade 1 and thus by a relative age advantage.

In almost all sporting activities, a cutoff criterion similar to that of the public school system applies. Children are grouped by chronological age for the purpose of providing developmentally appropriate instruction, fair competition, and equal opportunity. About 15 years ago, Grondin, Deshaies, and Nault (1984) and Barnsley, Thompson, and Barnsley (1985) first discussed a possible relationship between relative age and participation in sport that mirrors the relationship between relative age and scholastic achievement. They argued that the higher age of children born early in the competition year gives them a competitive advantage over their younger peers. To support this argument, Grondin et al. (1984) demonstrated a highly skewed distribution of birthdates among ice hockey players in competitive youth hockey leagues and in the main professional ice hockey league in North America, the National Hockey League (NHL): those born in the first months of the year were overrepresented, whereas there was a lack of players born in the last months of the year. Grondin et al. (1984; cf. Barnsley et al., 1985) suggested that this skewed distribution was the result of the cutoff date, January 1st determining age grouping in minor hockey.

Although there are obvious parallels, there seems to be an important difference between the RAE in school and that in sports. This difference might be the result of compulsory school attendance as compared to voluntary participation in sport. Although age-related differences in cognitive ability and performance at school entry do exist (May & Welch, 1986; Sweetland & De Simone, 1987), they seem to level out in subsequent years (Hauck & Finch, 1993; Kinard & Reinherz, 1986; Langer, Kalk, & Searls, 1984). This might be the result of harder work by younger pupils for competing with their older peers and of the special care that is often taken for weaker children in schools. Russell and Startup (1986) even showed that the difficulties younger pupils experience in mastering their academic work can eventually lead to superior performance at graduate level where success is determined by high motivation and persistent efforts rather than by a relative age advantage. In sport, however, the existence of a RAE is a less well-recognized phenomenon and, until now, no strategies have been implemented to combat the negative consequences of a low relative age. Contrary to older children, the younger ones are likely to drop out rather than to continue voluntary participation (Barnsley & Thompson, 1988; Musch, 1998).

In the following, the growing body of research investigating the RAE in sport is reviewed. First, all empirical findings concerning RAEs in different forms of sport are summarized; possible alternative explanations for the observed effects are discussed next. Mechanisms responsible for the effect, both psychological and physical in nature, are pointed out. The negative consequences of the RAE and remedies to the problem are discussed. Finally, desirable and necessary directions for future research are formulated.

DOES THE RAE EXIST?

The RAE has been investigated in a number of different sports (Thompson & Barnsley, 1996). This was usually done by looking for a divergence between the expected and observed number of players born per month or per quarter, the expected value being based on the one observed in the general population from which the players' sample was drawn. The vast majority of RAE research has been concerned with male athletes.

Main Investigations

Table 1 offers a summary of the results found for investigations of the RAE in different sports. In order to simplify the presentation, data in Table 1 consist of a contrast regarding the distribution of players' births between the first and second halves of the competition year. In some cases these data are approximate percentages based on figures reported in the reviewed articles. The table also includes some comments, notably about players' position, which refers to the specialized role of a player on a playing surface.

Two sports, soccer and ice hockey, received most attention. In soccer, the phenomenon is worldwide. Verhulst (1992) reported significant RAEs in the first and second professional soccer divisions of Belgium, the Netherlands, and France. Dudink (1994) showed that the effect is also present in the four highest professional soccer leagues in England. Musch and Hay (1999) report RAEs for Brazil, Australia, Japan, and Germany (cf. Bäumler, 1996). Several other studies report RAEs in soccer for players under 20 (Barnsley, Thompson, & Legault, 1992; Baxter-Jones, 1995; Brewer, Balsom, & Davis, 1995; Brewer, Balsom, Davis, & Ekblom, 1992; Helsen, Starkes, & van Winckel, 1998).

The time course of the RAE in soccer was also under investigation. On the one hand, Musch (1998) observed that the RAE in the Tennessee Youth Soccer Program increased with increasing age of the soccer players (7–18 years), and Helsen *et al.* (1998) reported that RAE among regular youth players did not emerge before age 12. On the other hand, Bäumler (1996), in his investigation of the highest professional soccer league in Germany (Bundesliga), found that the RAE gradually decreased with increasing age.

TABLE 1
A Summary of Articles on the Relative Age Effect (RAE) in Sports

Sport	Author(s)	Characteristics[a]	Player born in the first versus second half of the competition year (in %)/Comments
Baseball	Grondin & Koren, 2000	Pro Major League Baseball (MLB), USA	No RAE for players born before 1940s
			55/45 in recent decades; slight variations with position and handedness
		Japan Pro	63/37
	Stanaway & Hines, 1995	Pro (MLB)	56/44
	Thompson et al., 1991	Pro (MLB)	55/45
	Thompson et al., 1992	4–18	If there is any effect, it is weak and depends on age and competition levels
Basketball	Daniel & Janssen, 1987	Pro National Basketball Association (NBA), USA	No RAE for season 1984–1985
Cricket	Edwards, 1994	County cricketers in United Kingdom	From 61/39 to 50/50, depends on player's position
Football (American)	Daniel & Janssen, 1987	Pro: Canada	49/51
		Pro: USA	52/48
	Glamser & Marciani, 1992	American Universities	66/34 (but small sample)
	Stanaway & Hines, 1995	Football Hall of Fame (USA)	57/43
Gymnastics	Baxter-Jones, 1995	Elite junior (UK)	48/52
Handball	Ryan, 1989	11–20 (Canada)	From 61/39 to no RAE, depends on gender and age category
Ice hockey	Barnsley & Thompson, 1988	8–20	From 74/26 to no RAE, depends on age category and competition level
	Barnsley et al., 1985	16–20 (Elite)	72/28
		Pro National Hockey League (NHL)	62/38 For the 1982–1983 season
	Boucher & Halliwell, 1991	Nova Scotia Elite	63/37
	Boucher & Mutimer, 1994	8–20	65/35
	Daniel & Janssen, 1987	Pro (NHL)	No RAE for the 1961–1962 season, and seasons between 1972 and 1975
			64/36 for 1985–1986 (Canadian players)
	Grondin et al., 1984	8–20	Up to 73/27 in higher competition levels
		Pro (NHL)	60/40 For the 1981–1982 season
	Grondin & Trudeau, 1991	Pro (NHL)	For the 1988–1989 season
			From 68/32 to 50/50, according to players' position
			60/40 for canadian players; 53/47 for US players; 61/39 for others
			64/36 in Ontario; 55/45 in smaller provinces of Canada

	Krouse, 1995	Pro (NHL)	60/40, No difference between normal players and all star players/award winners
Soccer	Barnsley et al., 1992	World Cup 90	55/45
		World Tournament Under 17	79/21
		World Tournament Under 20	79/21
	Bäumler, 1996	Pro (Germany)	68/32 Among youngest professionals (18–20)
			49/51 Among oldest professionals (33–35)
	Baxter-Jones, 1995	Elite junior (UK)	81/19
	Brewer et al., 1992	Sweden, Under 17	78/22 (but small sample)
	Brewer et al., 1995	Elite junior (UK)	87/13 (but small sample)
	Dudink, 1994	Pro (UK)	62/38
	Helsen et al., 1998	Pro (Belgium)	57/43
		National Youth	70/30
		Top Youth	62/38
		Regular Youth	62/38
	Musch, 1998	Tennessee Youth, USA	Increasing with higher age levels
		7–8	51/49
		17–18	68/32
	Musch & Hay, 1999	Pro —Australia	58/42 (1988/89, January 1st)
			60/40 (1995/96, August 1st)
		—Brazil	57/43
		—Germany	56/44
		—Japan	66/34
	Verhulst, 1992	Pro —Belgium	55/45
		—France	58/42
		—Netherlands	60/40
Swimming	Baxter-Jones, 1995	Elite junior (UK)	73/27
	Ryan, 1989	8–20 (Canada)	From 61/39 to no RAE, depends on gender and age category
Tennis	Baxter-Jones, 1995	Elite junior (UK)	70/30
	Dudink, 1994	12–16 (Netherlands)	30 of 60 Players born in the first 3 months
Volleyball	Grondin et al., 1984	Elite 14–15 (Canada)	64/36 For male; 53/47 for female
		Elite 16–19 (Canada)	weaker effect
	Ryan, 1989	11–20 (Canada)	From 58/42 to no RAE, depends on gender and age category

[a] Numbers indicate age (in years).

Whereas the proportion of players born in the first half of the competition year was as high as 68% among young professionals ages 18–22 years, it monotonically decreased thereafter and finally reached an even proportion (49%) among the 33- to 35-year-olds. Bäumler (1996) interpreted this finding as evidence for a gradual wearing-off of the physical advantage of the players born in the first half of the competition year and a corresponding shift toward players with better technical attributes who only initially suffered from a relative age disadvantage.[1]

The RAE in North American ice hockey is also firmly established. The phenomenon was shown by several authors to exist not only in the NHL, but also in different geographical regions across Canada in competitive minor hockey (Barnsley et al., 1985; Barnsley & Thompson, 1988; Boucher & Halliwell, 1991; Boucher & Mutimer, 1994; Grondin et al., 1984; Grondin & Trudeau, 1991; Krouse, 1995). Daniel and Janssen (1987) provided evidence that the effect is a fairly recent phenomenon, however. Although the skew in the birthdate distribution is strong nowadays, it was not present in the NHL in the 1970s and 1960s.

Most other sports, including baseball (Grondin & Koren, 2000; Thompson, Barnsley, & Stebelsky, 1991, 1992; cf. Stanaway & Hines, 1995), cricket (Edwards, 1994), and tennis (Baxter-Jones, 1995; Dudink, 1994), show an RAE. In cases like swimming (Baxter-Jones, 1995; Ryan, 1989), volleyball (Grondin et al., 1984; Ryan, 1989), and handball (Ryan, 1989), the effect depends on age and categories. For basketball (Daniel & Janssen, 1987), gymnastics (Baxter-Jones, 1995), and American football (Daniel & Janssen, 1987; Stanaway & Hines, 1995), no significant RAE is reported. However, relative age is a factor in college football participation. Glamser and Marciani (1992) found that players born early within their cohort and behind their age group in school were overrepresented in the football teams of two U.S. state universities.

Alternative Explanations for RAEs

In spite of the pervasive evidence for RAEs in many sports, any claim of cutoff dates in youth sport as the only or major causal factor underlying skewed birthdate distributions must be defended against possible alternative explanations. Most of the published evidence addresses this point by comparing the birthdate distributions found in sports with that of the general population, thereby avoiding possible artifacts due to a skewed distribution already present in a nonsport population.

A number of competing explanations for seasonal variations in birth rates

[1] An alternative hypothesis for this finding is that the RAE was less important in Germany 25 years ago, when these older players were involved in youth soccer programs. However, we have unpublished data that the RAE in the highest professional soccer league in Germany was already as strong in 1965, 1975, and 1985 as it is today.

of sports professionals in terms of climatical, environmental, sociocultural, and biological influences exist, however. As Wendt (1974, 1978) pointed out, significant phases in a child's development, such as first sitting up, walking, etc., occur at a fairly constant time after birth. Therefore, rather than the time of birth, certain seasonal (circannual) circumstances during a later sensitive phase may be significant. Because anything that is triggered during such a postnatal stage is automatically related to the date of birth, lag artifacts may be the result that falsely appear to be caused by a cut-off date in youth sport. For example, if warm weather during important phases of motor learning and first outdoor activities promotes critical sport-related skills, children born in certain months of the year profit from the fact that their critical sensitive phases are during summer rather than winter months.

Several findings suggest that seasonal influences do not offer a satisfactory account of the observed RAEs, however. For example, December and January—being at opposite ends of the competition year in hockey—are juxtaposed and very similar climatically. Nevertheless, significant RAEs were found in hockey (Barnsley et al., 1985; Barnsley & Thompson, 1988; Boucher & Halliwell, 1991; Boucher & Mutimer, 1994; Grondin et al., 1984; Grondin & Trudeau, 1991; Krouse, 1995). This suggests that the cutoff date rather than some seasonal influence causes the RAE. Moreover, soccer shows an RAE that is very similar to that found in hockey, even though the two sports use different cutoff dates (Barnsley, Thompson, & Legault, 1992; Dudink, 1994; Verhulst, 1992).[2]

Musch and Hay (1999) conducted a cross-cultural comparison of the RAE in soccer to assess explanations in terms of climatical and sociocultural factors that might coincide with the cutoff date in soccer. They first examined the RAE in the highest soccer leagues of Germany and Brazil, two countries with a highly developed soccer system both employing a cut-off date of August 1st in their junior soccer squads. Since the periodicity of birthdates in the Southern Hemisphere is exactly the reverse of that of the northern one, paralleling the reversed seasons and climates (Cowgill, 1966), a 6-month shift in the pattern of birthdates of soccer players in Brazil would have indicated an influence of season or climate. However, the distribution of professional players' birthdates was the same in both countries. The persistence of a shifted peak shortly after the Japanese cutoff date of April 1st also supported the notion of a universal RAE associated with the respective cutoff date irrespective of other sociocultural effects.

Musch and Hay (1999) conducted another test of the cutoff date hypothesis by directly observing the consequences of a change in the cutoff date in the Australian youth soccer system, where the traditional cutoff date of January 1st was replaced by a new cutoff date of August 1st following a proposal

[2] An anonymous reviewer suggested these points, which speak against seasonal explanations for RAEs in sport.

of the world soccer association FIFA in 1988. A corresponding shift in the birthdate distribution of professional players 10 years after the change provided strong evidence that the cutoff date is indeed the causal factor underlying the RAE.

A MECHANICS OF THE RELATIVE AGE EFFECT

In what follows, a review of possible factors and mechanisms that may contribute to the RAE is given.

Competition as a Necessary Condition

Suppose there are 15 places on a sport team, and that in a given school or community, there are 15 young persons of a given age group interested in occupying these places. In such a case, there is no reason to expect a RAE. Everyone will have a place on the team. However, suppose that there are 150 persons from this age group interested in playing with this team. In such a case, there will be strong competition to obtain a place, and RAEs are much more likely to occur. The general principle that can be derived from the situation is that the larger the pool of potential players for a given sport in a given category, the stronger the resulting RAE should be.

This is exactly what was reported in Grondin et al. (1984). Minor hockey in Canada was organized in such a way that higher competitive levels in a city were related to the number of inhabitants in those cities (Grondin, 1982). In general, the results reported in Grondin et al. (1984) showed that the RAE was stronger in higher level, i.e., in cities where more ice hockey players were available to form teams. Consistent with this finding was the fact that, among NHL players, the RAE was most pronounced for those born in Ontario, the most populous province of Canada (Grondin & Trudeau, 1991). In line with this reasoning, Grondin et al. (1984) reported a weak RAE for volleyball, a sport less popular than ice hockey in Canada. For volleyball teams in schools, there was no RAE. We can suppose that most players interested in volleyball had a chance to be part of the teams. Nevertheless, the study also revealed that, when regional elite teams are formed from this pool of players in schools, there was a RAE for male players in the 14- to 15-years-old category. A similar finding was reported by Helsen et al. (1998) for youth soccer players in Belgium. Whereas there was a strong RAE already at age 6 among elite youth players being transferred to top teams, there was no RAE among average youth players before age 12. Although none of these findings provide direct evidence that the level of competition directly determines the magnitude of the RAE, they are at least compatible with the notion that competition for obtaining places on a team is fertile ground for RAEs to occur. This competition will come from the number of players available for the places, and this number will depend on the popularity of a given sport in a given country. In this view, given the worldwide popularity of soccer, it is interesting to note that empirical reports from all over the world show a strong RAE in this sport (Barnsley et al., 1992; Bäumler, 1996; Baxter-Jones, 1995; Brewer et al., 1992, 1995; Dudink, 1994; Musch, 1998; Musch & Hay, 1999; Verhulst, 1992).

Physical Development

Physical capabilities undoubtedly are significant determinants of success in sport (Malina, 1994). In the case of ice hockey, for example, somatic strength is of great importance both for carrying the heavy weight of the equipment (Grondin & Trudeau, 1991) and for body checking (Barnsley & Thompson, 1988). Physical development (and also motor skill, a major determinant of team placement in junior ice hockey; Daniel & Janssen, 1987) is strongly correlated with chronological age (Brauer, 1982). Several studies therefore attributed the RAE solely to the physical advantages of the relatively older players (Baxter-Jones & Helms, 1994; Baxter-Jones, Helms, Baines-Preece, & Preece, 1994; Brewer et al., 1992; Verhulst, 1992). Explanations based on physical maturity seem particularly convincing given that an up to 1- or 2-year age difference can indeed make a big difference in the stature and weight of young children in youth sport programs (Baxter-Jones et al., 1994; Malina, 1994). Between height and weight on the one hand and performance in disciplines such as the 50-yards' dash, throwing, pull-ups, and sit-ups on the other hand, significant correlations were reported even within an age range of only 1 year (Espenschade, 1963). It is important to note that central tendency measures of physical growth are also accompanied by variability. For weight and height, individual variability is at its maximum between 13 and 15 years old for boys, and slightly earlier for girls (Bouchard, Hollmann, & Herkenrath, 1968; Dimerjian, Janicek, & Dubuc, 1972; Tuddenham & Snyder, 1954; Twiesselmann, 1969). It seems therefore plausible to assume that a relative age disadvantage, coupled with a late maturation, can make it virtually impossible for a young player to compete (see Fig. 1).

The observation that the magnitude of the RAE varies according to players' position in ice hockey provides additional evidence for the importance of physical development. Grondin and Trudeau (1991) found the RAE to be strongest among players in the position characterized by the highest physical demands, namely, goalkeepers, who have to carry the heaviest equipment of all players in ice hockey. In the NHL, 55% of forwards were born in the first half of the selection year, but more than two-thirds of goal keepers were born during the same period (Grondin & Trudeau, 1991).

It is also interesting to have a look at gymnastics, one of the few sports where advanced maturation is a disadvantage (Baxter-Jones, 1995). Late maturation has repeatedly been observed among successful gymnasts (Malina, 1994; Baxter-Jones, Helms, Maffull, Baines-Preece, & Preece, 1995). Remarkably and in accordance with the notion that physical development is

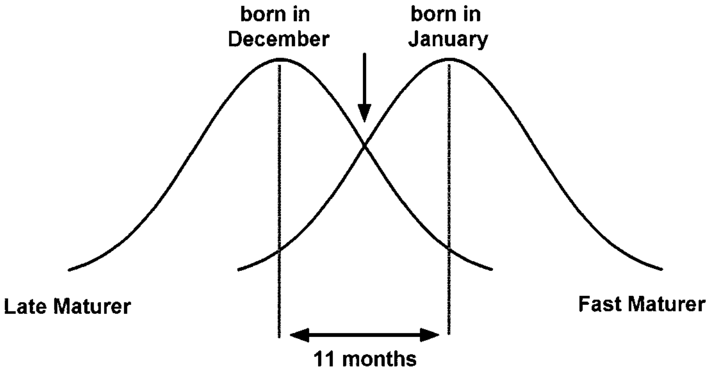

FIG. 1. Illustration of the physical maturity advantage of children born in January over those born in December of the same year. Although the child born in January has an 11-month age advantage over the child born in December, both children are grouped in the same age class in an age-based system with a January 1st cutoff date. Each distribution represents a potential disparity, assumed to be normally distributed, in physical maturity (*x*-axis) among children of the same chronological age. The figure shows that an early maturer (5.5 months in advance over the mean) born in December and a late maturer (5.5 months behind the mean) born in January may have the same physical age (the crossing point on the distribution, see vertical arrow). The figure also illustrates, however, the potential advantage of a January-born fast maturer and the disadvantage of a late maturer born in December. The additional relative age disadvantage of December-born children may make it impossible for late maturers to compete. This advantage/disadvantage can be magnified at puberty where deviations from the mean are even more important.

an important factor only in sports where advanced maturation levels promote performance, Baxter-Jones (1995) found no RAE among elite young British gymnasts.

In spite of the obvious importance of physical development, surprisingly little work has been conducted to substantiate the relationship between physical development and RAEs by measuring the somatic and strength properties of young players. Brewer et al. (1992) showed that members of a Swedish Under-17 elite soccer team had above average levels of physical growth in terms of body weight and height as compared to normative data for the total population. Garganta, Maia, Silva, and Natal (1993) showed significant differences in height and mass between national youth team players and regional youth soccer players in Portugal. Advanced physiological maturity was observed for many children participating in the Little League World Series by Hale (1956), who used pubic hair ratings, and by Krogman (1959), who estimated skeletal age. Data comparing the physical properties of dropouts and players disadvantaged by their relative age to the body indices of players profiting from a relative age advantage are completely lacking, however. The only direct evidence for a relationship between relative age and sport performance was reported by Bell, Massey, and Dexter (1997). They found birthdate effects in ratings of sport performance for both male and female pupils taking physical education examinations in different sports at age 16.

Explanations based exclusively on physical development predict a strong RAE very early and already at the elementary school level. This is because the relative age difference as compared to total age, and thus the physical advantage of relatively older players, is biggest at the youngest ages and gradually decreases subsequently. Therefore, the prediction of a very early effect of relative age can be used to test whether physical development is indeed the only or main factor underlying the skewed distribution of birthdates that can be observed among sports professionals. In addition, if physical maturity is the only reason for the RAE, a reduction rather than intensification of the skewness of the distribution should be observable in subsequent years because the relative age difference as compared to total age gradually decreases rather than increases. Both of these predictions are at odds with empirical findings. There was no RAE among the youngest players in the studies of Barnsley and Thompson (1988) and Musch (1998), and the magnitude of the RAE increased rather than decreased with increasing age in these studies. This pattern of results suggests that RAEs cannot be explained by physical variables alone.

Psychological Factors

Although chronological age differences are certainly related to discrepancies in physiological maturity, size, and strength, careful consideration should also be given to psychological variables. As a function of their age, children differ not only in their physical maturity but also in their psychological maturity.

Perceived competence is a powerful determinant of sport participation. According to Harter’s (1978) theory of competence motivation, those high in perceived physical, academic, or social competence are more likely to participate in their respective activities. Smith’s (1986) cognitive–affective model of stress also suggests that in a situation that is characterized by an imbalance between situational demands (e.g., the need to demonstrate ability in a competitive context) and resources (e.g., lack of physical ability), children may perceive sport participation as too stressful and consequently withdraw from the activity. Correlations between perceptions of competence and actual competence, as measured by teacher’s ratings of sport performance, revealed that children become more accurate in their perceived competence with age, with children of 8 to 9 years being less accurate than children of 10 to 13 years. Since children high in perceived competence show a more intrinsic motivational orientation and report enjoying their participation more than children low in perceived competence (Feltz & Petlichkoff, 1983; Roberts, Kleiber, & Duda, 1981; Vallerand, Deci, & Ryan, 1988), relatively older children advantaged by their higher relative age are more likely to continue their participation once all children are able to accurately assess their competence. From this cognitive development perspective, an increased skew in the distribution of birthdates is to be expected with increasing age. Explanations based on physical development, on the other hand, would predict a strong effect already at elementary school level when the relative age difference as compared to total age is largest.

In spite of the growing body of research on the RAE, recent reviews of sociological and psychological factors influencing dropout rates in youth sport do not even mention the RAE (Gould & Petlichkoff, 1988; Skard & Vaglum, 1989; Weiss & Chaumeton, 1992). This is surprising because several psychological theories are capable of explaining RAEs. For example, a Pygmalion effect (Rosenthal & Jacobson, 1968; Rosenthal, 1974) may be functioning (Barnsley et al., 1985; Thompson et al., 1991). Traditionally researched within the context of classroom achievement, the Pygmalion effect predicts that expectancies of student ability trigger a series of verbal and nonverbal interactions which inadvertently control the student's subsequent achievement behavior in what can be termed a self-fulfilling prophecy. Children profiting most from an initial relative age advantage are likely to be erroneously perceived as the most talented in their age group. The Pygmalion effect may amplify and stabilize this relative age advantage if the behaviors of parents, coaches, and peers covary with the inital perception of children's abilities (Rejeski, Darracott, & Hutslar, 1979; Landers & Fine, 1996). Parents and coaches should therefore understand fully the potential influence of the RAE.

In view of the devastating effects of low self-esteem that might be acquired by relatively younger children, future research should investigate more closely the affective, cognitive, and motivational effects of a relative age disadvantage. The importance of such an investigation is highlighted by the current disturbing finding that a relative age disadvantage at school is even associated with a higher incidence of youth suicide (Thompson, Barnsley, & Dyck, 1999). With respect to the RAE in sport, current theories of achievement motivation should prove to be helpful in revealing the exact mechanisms that finally lead to the withdrawal of relatively younger players (cf. Gould & Petlichkoff, 1988; Weiss & Chaumeton, 1992).

Experience

In addition to the physical and psychological factors involved in age differences, there is another simple, but critical, factor contributing to the RAE. To illustrate this point, let's take an example. Among 10-year-old children, an 11-month difference in age represents, of course, considerable advantages in terms of height, weight, strength, and cognitive development. However, beyond these mere facts, this age difference represents almost 10% of total life experience. Maybe more importantly, this difference represents an extra year of experience in a given sport itself, which means much more training.

This training effect is likely to enhance chances of participating more actively in games during the season. The training time difference among children may also be magnified by the fact that relatively older players are more likely to be chosen for select teams and high ability groups. Such selection is not only associated with receiving better coaching and facing better opponents; being involved in higher competition levels is in itself more prestigious and therefore likely to increase motivation.

Thus, if, in a coach's mind, two children are considered to have the same age because they are born in the same year, the child born in January has a huge advantage over the other, first, in chances to be part of the team if too many children compete for limited places on a team, and second, in active participation in the games. The relatively younger child, on the other hand, is likely to be frustrated by his or her limited ability to compete and may finally drop out of organized sport.

To summarize, there are multiple factors contributing to the RAE. 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.

POSSIBLE REMEDIES TO THE PROBLEM

A sport system committed to the fullest possible development of all children would have to attempt to maintain the motivation of every child. It is very likely that many promising talents have been overlooked in the past because they suffered from a relative age disadvantage in their early childhood. This may well have resulted in a lowering of the overall quality of professional sport teams. Furthermore, from a public health perspective, physical activity in children and adolescents is seen as important for disease prevention and health promotion (Anderssen, 1993). Instead of equalizing the opportunities to develop health-promoting lifestyles, for many children the youth sport system works against the learning of health habits that often carry over into adulthood. A relative age disadvantage can thus have important personal and social consequences. It is therefore a question of great interest whether any remedies can be offered to the RAE problem.

Classification Systems Based on Biological Age

Since the RAE was shown to be quite a robust phenomenon in many sports, there is a need to reconsider the theoretical question of age grouping. One alternative to chronological age as the basis of the classification system is biological age: anthropometric measurements such as height, weight, or a height–weight ratio, or physiological measurements such as dental age or sexual maturity revealed by secondary traits like pubic hair may be used as criteria to determine age grouping. Skeletal age is another promising indicator of physiological maturity since it provides a continuous indication of growth until maturity (Krogman, 1959; cf. Baxter-Jones, 1995).

However, it is unlikely that it would be possible to find all material and human resources required by classification criteria other than chronological age in order to accommodate all sport participants. Moreover, even a classification of children based on bone age would produce an unfair context for sport competition. For instance, Bouchard and Roy (1969) reported that ice hockey players participating in the Québec Tournament (with a chronological age of 11–12 years) had a skeletal age varying from 7 to 14 years. That is to say that the adoption of skeletal age would result, in some cases, in classifying a 12-year-old child with 7-year-old children. Given the differences in psychological maturity at these ages (cognitive and socio-affective) and the differences in practice hours of various motor skills, such a classification would expose some children to non-sense conditions of development. On the other hand, in some sports like boxing or wrestling, competitive classes based on weight categories turned out to be a sensible solution.

Classification Systems Based on Chronological Age

In many sports, classification systems based on biological age are difficult to organize. Alternative solutions based on chronological age do exist, however, and multiple criteria for classifying children for competition may be used.

Variation of cutoff date within the competition year. In individual sports, cut-off dates can be determined anew for each competition. For example, swimming does not have a fixed cut-off date. As Ryan (1989) showed, this can prevent RAEs on the condition that the accumulation of key competitions in certain months of the year is avoided. However, the age-grouping system in swimming is not applicable in team sports.

Rotation of RA advantage within curriculum for one given sport. Rotating cutoff dates offer a possible solution to RAEs in team sports. For example, Grondin et al. (1984) proposed a 15-month or 21-month category system to break the structure based on multiples of 12 (cf. Boucher & Halliwell, 1991). This would have the advantage of constantly cycling the cutoff date throughout the year, thereby eliminating a systematic bias against children born late in a fixed competition year.

Brewer et al. (1995) argued that 1-year or 2-year periods typical for most team sports are too great an age band from which to select squads. A shorter 9-month period as suggested by Boucher and Halliwell (1991) would reduce the age difference between the youngest and oldest children. However, a smaller age band—as well as a rotating cutoff date—might prove to be difficult to run on a practical basis due to organizational problems and the lower number of players available in each age group if a shorter competition year applies.

Distributing RAE among youth potential activities. Different sports often use the same cutoff dates for age grouping, and very often these cutoff dates do not only apply in sport, but in school as well (Musch, 1998). Grondin and Koren (2000) reported that in professional baseball, the RAE is much more important in Japan than in the United States. One potential explanation for this difference is that in Japan, many activities, sports-related or academic, are based on a similar cutoff date (April 1st), which is not the case in the United States, where the cutoff date (August 1st) for children's league in baseball does not necessarily apply to other activities.

Varying the cutoff dates for different sports would make it possible for all children to get involved in activities in which the cutoff date is favorable to them. A possible problem of such a procedure would be, however, that many educators may find it preferable for children to stay with the same friends as much as possible. Nevertheless, as regards the strict RAE, such a distribution of cutoff dates among different sports would be an appropriate way of addressing the problem, without provoking too much disturbance within a given sport organization.

Age quotas. Another simple, clever, and easy-to-apply solution based on chronological age was proposed by Barnsley and Thompson (1988). These authors suggested that quotas of children born throughout the activity year should be required on high-caliber competitive teams (cf. Barnsley et al., 1992).

Multiple Squads Based on Multiple Standards

The physical development and the technical skills of young players will usually be correlated. However, there nevertheless will be players who are technically at a high standard, but who are currently lacking in terms of their physical development (Brewer et al., 1995). Different squads may be established for such players to give them a better chance for fair competition. Furthermore, if individuals are not able to perform up to set standards, they could be allowed to continue participating at a lower level in spite of their age, giving them the chance to experience competition at their ability and readiness level (Ryan, 1989). Testing for ability standards, of course, would be costly and would take considerable cooperation and coordination among sport organizers, administrators, and coaches. The strict supervision needed to ensure that all organizations treat participants fairly if this type of organizational change were implemented suggests that this would be a long-term solution.

Warning Practitioners

The results of the research reviewed in this article show how much is at stake if the current system is not altered in some way or another. It can also be expected that the long-term result of a RAE will be a lowering in the overall quality of the highest competitive teams if players with good technical attributes are being overlooked at an early age due to a lack of physical development that is simply related to the period of the selection year in which they were born. For all of these reasons, coaches and those responsible for sport must fully understand the possible effects of age differences within the same age group, and efforts to realize possible remedies to the relative age problem should be intensified.

A possible first step would be for decision-makers to look at factors such as technical skills rather than physical strength, and ensuring that coaching is equivalent for all players regardless of their present, age-dependent level of ability. Deemphasizing competition and recognizing that a coach's task with young children is to maintain interest, motivation, and participation seem to be necessary preconditions to avoid creating dropouts. French and Thomas (1987) point out that both cognitive and motor skills are important for children's sport development. Optimal coaching should therefore not exclusively concentrate on motor skills, but also devote time to teaching sport-specific procedural knowledge and cognitive skills such as knowledge of the rules of the game, optimal player positions, and game strategies (Bunker & Thorpe, 1983). In their interactions with relatively younger players, coaches should always concentrate on the player's individual improvement rather than (1) conducting unfair comparisons with his (or her) relatively older peers and (2) focusing on winning.

FUTURE RESEARCH

The birthdate phenomenon was found at least to some degree in almost any form of sport. Undoubtedly, relative age can be an important factor in whether a young player succeeds or not. However, the extent of existence of the RAE has not yet been completely examined nor have the physical, social, and emotional mechanisms that bring it about been clearly identified.

For example, little is known about the role of sex in the RAE. Considering that competition is likely to be a major factor in the development of the RAE and competition is often higher among male sport participants (Baxter-Jones, 1995), stronger RAEs in male youth sports can be predicted. Comparing male and female elite soccer players and swimmers, Baxter-Jones (1995) indeed found smaller and nonsignificant RAEs among females. Baxter-Jones (1995) also pointed to the earlier maturation of girls and the higher variance of the maturity status of boys as possible causes for a stronger RAE among male athletes. It is noteworthy that the RAE at school is also stronger for male than for female pupils (Grondin et al., 1993). Future research should look more closely at RAEs in female youth sport, trying to sort out possible influences of gender on the RAE.

A recommendation that can also be given on the basis of the present results is to search for sports where the RAE is *not* observed in top-caliber adult players. Determining the attributes needed for success in such a sport and examining the philosophy, organization, and structure of this sports' developmental programs would help to identify hitherto unknown limiting factors to the effect. Nonphysical, technical disciplines such as golf or chess, sports where an advanced physical development is a disadvantage, as in, for example, gymnastics, and sports with low participation rates are likely candidates in a search for domains where a RAE cannot be observed. Attention should also be given to nonparticipants to determine if their month of birth is related to their decision not to get involved in organized sports in the first place.

Another question that has to be addressed is the exact point at which an RAE begins to operate (cf. Barnsley & Thompson, 1988; Grondin et al., 1984; Musch, 1998). For now, we know that the RAE occurs very early, before age 10, in ice hockey (Boucher & Mutimer, 1994; Grondin et al., 1984). However, in soccer an increasing skew in the distribution of birthdates was reported in the higher age groups only, with no uneven birth distribution in the youngest age group of the soccer program (Musch, 1998). Exploring the time course of RAEs will help to decide between explanations based on physical as opposed to cognitive, affective or motivational factors. In this context, it seems worthwhile to conduct prospective and longitudinal studies relating drop-out decisions to a children's perceived ability, anxiety, intrinsic motivation, self-concept, and self-esteem (see Alsaker & Olweus, 1993, and Fenzel, 1992, for similar studies pointing out the effect of relative age in school on these variables).

Taken together, a growing body of research reviewed in this article suggests that RAEs are a pervasive phenomenon in competitive sports. The most likely explanation for the effect is the interplay of a variety of factors including physical, cognitive, emotional, and motivational causes. A fair organization of competitive sport is of critical importance in the personal development of children, however. A necessary first step toward ensuring equal treatment and fair competition is to bring the RAE to the attention of all coaches involved in the minor sports system. Only coaches who are fully aware of the struggles of late-born children are prepared to offset the disappointment and setbacks these children encounter.

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