STROKEARCS

The Newsletter of the Association of Rowing Coaches, South Africa

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Hi All

This is the final StrokeARCs for the year. As most of us are having a break from rowing for a few weeks I have kept the contents off rowing and focused on some of the other endurance sports.

Have an Merry Christmas and a Happy New Year

Jamie

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SWIMMING

THE X FACTOR

Is there any one factor or trait that determines a successful swimming coach? If there is, could we educate a coach to have this particular trait? The business world has long wondered what makes a good executive, a good administrator, or a good salesman. Research into this ingredient of success has led to the use of multimillion dollar testing bureaus. For example, the executives of U.S. Steel are given personality tests, intelligence tests, leadership ability tests and others in every possible measurable area. So far they have had very little success in identifying any single trait that their subjects have in common. For instance, they sometimes find the lowest paid filing clerk to have more basic intelligence than the highest paid executive. They have determined that once a person reaches a level of intelligence somewhere above average, that higher intelligence by itself is not necessarily a determinant. So, we cannot give all coaches intelligence tests and determine that the most intelligent will be the best coach. If this were true, then all we would have to do to select a good coach is hire the man with the highest I.Q. It might be just the opposite. A man with a high I.Q. might be too smart to get involved in coaching.
Let's get back to the business world. I personally feel that intelligence has a lot to do with success in coaching, in business, in almost any field of endeavor. However, the type of intelligence I am speaking of is not the type that can be measured by academic testing, it could better be called a type of "perception." The business school at Indiana University has found their search for a common denominator from which to predict success to be rather fruitless. They have, however, isolated an unidentifiable factor which they have named the "X" factor. They can't sharply define this factor, but they talk about it, and they feel they are closing in on a definition.

I would like to apply this "X" factor to swimming coaches. They know a little about this factor in business, and I would like to mention a few of the dangers encountered by business in attempting to build a perfect administrator. Business has sent its top administrators to training courses very much as you have come to this clinic. They send them to universities and sometimes to the Menninger Foundation in Kansas. The most outstanding business training course is given in Kansas at the Menninger Psychiatric Clinic. Here, three times a year, a course is offered to top executives at a fee of $1,200. Entrance is limited to 20 per group in three groups, and is called "Understanding Man." Business sends its top executives to this clinic, the theory being that with this type of training they will return and do a better job. Just as many of you have come here and hope to return to your swimmers and do a better job with them.

Unfortunately, business has found that many of its executives get back from such a clinic and do worse. Likewise, many of our coaches go home from these clinics and do a worse job of coaching than before. I can see some of your kids now saying, "Oh my God, Coach has been to one of those screwy clinics again. Now we get all of those screwy workouts and those crazy ideas on stroke mechanics." I believe that we must continue to experiment, to continually change our programs and our methods. Therefore I do not recommend that we stop attending clinics such as this, but I would caution you about one thing.

There are examples of men who have trained themselves to be coaches, devoted their entire lives to that end, and failed miserably. Some of these men have been warned before they start that they will fail, just as I now warn some of my graduate students that they too will fail. Why do they fail? Let Us take a partially true case and synthesize an individual. Give him a false name, call him Frank Zilch.

Frank Zilch came to me some years ago and said, "I want to study under you, learn all that you know, take all the scientific courses available, so that I can become the greatest swimming coach in the world." Of course, his approach was wrong; this was not the thing he should have said.

As his graduate advisor, I set out to plan his education. Theoretically, he had everything going for him: he was good looking, he had desire, he had lots of energy, he was intelligent, and with good planning we should be able to make a great coach out of him. But, as it turned out, it was an impossible task, because he lacked the "X" factor, which we will discuss later.

Frank Zilch read all the research on swimming he could find; he read the "Research Quarterly," "Swimming Technique," "The Journal of Applied Physiology" and many, many others. He attended all the coaching clinics he could find, he did research, he lived, he ate, his every thought and every waking minute was applied to swimming. We designed his courses to cover every area of knowledge possible that could contribute toward making him a great swimming coach. He knew more facts about swimming than any person in the world; his brain was crammed with swimming knowledge. In setting up his course of study we tried to give him a full education in the areas necessary to make him a great swimming coach.

He had to be a great physiologist to understand the process of conditioning: what happens to the swimmer's body when he trains. The perfect coach should know that the swimmer's body changes as be trains; he should understand these physiological changes that occur. In preparing the perfect coach for this area of knowledge, he should certainly read Dr. Selye's book on Stress and Adaptation. Frank Zilch studied all of this.

The thought must occur to you, "does all of this really seem necessary?" We all wonder if we should not concentrate on just training the swimmers and let Dr. Selye and others do this type of research. Maybe we should learn by trial and error by either overworking or underworking our swimmers. Most of the U.S. progress in training technique has occurred through trial and error. The Europeans, in particular those from the Iron Curtain countries, are usually surprised and disappointed when they visit training sites in the United States and fail to see the American coaches taking pulse rates and electrocardiograms. They expect American coaches to be more scientific, they expect us to take pulse rates, they expect us to take electrocardiograms, and to measure all physiological changes in our swimmers. During a recent trip to Russia, I gave an hour lecture at the Russian Institute for Physical Education in Minsk. During the question and answer period the questions were entirely on minute details such as; "Did the swimmers take vitamins?" "How many milligrams of Vitamin C did they take?" "Do you measure their electrocardiograms?" They asked no questions on training of swimmers, on repeats, etc.

Later we had a special conference with officials of the Russian sports field. There were about six or eight sitting about the table; they had a nutritionist, an expert on fluid mechanics, a physiologist; the only thing missing was a swimming coach. Again, the questions were on, in my opinion, irrelevant subjects. Their favorite question was on the "IT" wave. Then they asked the sixty-four ruble question. They wanted to know why they were not getting better swimmers in spite of spending millions of rubles. They asked if they were behind the times, they asked what we in the U.S. were doing that they were not. I told them that they were actually far ahead of our country in scientific methods, but they did not understand. I think the Russians are missing the "X" factor.

We have had similar experiences with the East Germans. They too are going about their swimming on a very scientific basis. They select their future athletes on a scientific basis, as they are also doing for their future scientists, mathematicians, physicists. When an East German child shows promise in any area, math, science, sport, etc., he and his family are often moved so the child can be enrolled in a special school or institute that is designed to nurture this skill. The East Germans, like the Russians, wonder why they are not having greater success in these areas. The answer is, again, I believe the "X" factor.

In the United States we throw our 500,000 age group swimmers into the pool and let the best survive. The ones that come out on top have the physical ability and have fought their way to the top through hard, merciless work. We do not coddle our swimmers. Our swimmers, also the Canadian and Australian swimmers, are not pampered. We throw them all in the pool and let the best survive. I favor this system over the scientific approach of the Russians and East Germans. They approach things too scientifically and forget that it is a dog-eat-dog competition. The Americans, the Australians, the Canadians and a few others, produce the toughest swimmers because of the system that forces them to fight their way to the top. This is why these swimmers are the toughest in the Olympics and other international meets.

In business they have a saying, "You never see a good-looking salesman." I don't know bow really true this is, but possibly he doesn't sell much because he is too busy with the farmer's daughter. The point is, I believe, you want to stay away from people who have everything going for them. I've yet to have a good swimmer who was talented physically and also well-adjusted. A person can have all the physical and mental attributes and not do well, because the person with everything going for him does not have a strong ego drive. Perhaps this ego drive is part of the "X" factor we have been talking about.

Now back to Frank Zilch. He had everything going for him. We trained him to be a good physiologist, now we will train him in stroke mechanics. He studied physics, fluid mechanics, he studied underwater movies, he learned all about Bernouili's principle, he studied every aspect of stroke mechanics. Another area in which the Europeans seem surprised to find that American coaches are not spending more time on the deck is with stroke mechanics. I do not believe any coach could teach Mark Spitz to swim the way he does; much of this he has done on his own. The better a swimmer is, the less he really has to be coached. If you have a Mark Spitz, just sit back and enjoy him and try to learn from him.
How does a swimmer learn? He learns through trial and error. Why doesn't everybody learn the same? Because we all have varying abilities. We have photographed dogs swimming, and have learned that not all dogs swim naturally, in fact some nearly drowned. We found that at first most dogs tried to swim with all four feet, then gradually learned to pick up the hind feet and swim only with the front feet. However, in the case of the Labrador Retriever, they learned to swim this way usually on the second time in the water, much sooner than other types of dogs. We studied the Dachshund and on the twentieth time in the water he was still trying to work all four feet and nearly drowned.

I believe the Gary Halls, the John Kinsellas, the Mark Spitzes, are the Labrador Retrievers. Unfortunately, most of you will get a lot of Dachshunds in your programs. Say, many of our great swimmers swim well in spite of us lousy coaches. Those of us who work only with the Labrador Retrievers have a real advantage. So, you club coaches keep on sending us the Labrador Retrievers and keep the Dachshunds.

Those of us with the top twenty college teams just go out and recruit the Labrador Retrievers from the local coaches so we don't have to know very much about stroke mechanics. The better the swimmer, the less you have to work on stroke mechanics. I believe stroke mechanics are extremely important, but at the lower levels. The best stroke mechanics men in the U.S. are the lesser known coaches in the local programs.

We now have Frank Zilch well qualified in physiology, and in stroke mechanics. Next we go to what I feel is the most important area of all: psychology. This is one area in which the Russians and East Germans were very complimentary to the Americans They marveled at the rapport the American coaches have with the American swimmers. They have remarked at what great psychologists the American coaches are, how they can motivate the swimmers in spite of the fact that we don't do scientific testing and don't work with stroke mechanics. I believe that if you gave three different coaches - one a psychologist, one a stroke mechanics expert, and one a physiologist identical teams - that the psychologist would win every time. A good psychologist can motivate his swimmers to work hard and to dedicate themselves to the sport. They can keep the swimmers happy so they will enjoy the sport and stay with it; they can recruit the best swimmers, they can handle the city council and the parents. The good psychologist in time will become a good organizer and administrator and will have a large team and attract the Mark Spitzes and the Gary Halls to his team. So, this is the way to become a good coach.

Finally, let me tell you what I think the “X” factor is in successful coaching. The “X” factor is, to quote an old saying, “The ability to separate the wheat from the chaff.” Another way of expressing it is to say, “you must be able to recognize the important things and work on them; and to minimize the unimportant.” Let me give you an example: we have seen mothers and fathers, and a few coaches, walking up and down the pool deck as the swimmer is swimming with dropped elbows, over-kicking like mad, and he is being yelled at, “kick, kick, kick.” In other words, they ignore the important item, the dropped elbows, and emphasize the unimportant by yelling “kick, kick.”

I feel that the present trend of doing everything for the athlete is not good. For example, I could put a timer on every swimmer in my practice, keep all their splits for them with managers, but I do not because I want them to be aware of what they are doing. Too often we do so much for them that they stop using their brains, they stop thinking about their own activities. It is important for the swimmer to know his own times so that he understands the significance of what he is doing.

Another place in which the coach fails the swimmer is when be allows parents and others to come on the pool deck and engage him in conversations during practices. The coach’s responsibility is to the swimmer not to the parent or others. The swimmer is important, the parents are not important. This is another example of where the coach must recognize the important thing, the swimmer, and ignore the unimportant - the parent.

The “X” factor is then, in other words, the ability to see what has to be done and doing it. The great coach recognizes what is needed to do the job and then does it. This applies not only in coaching, but in business, in administration, in every aspect of life. Another way of saying it is; cut through all the detail and get to the heart of the matter. The perfectionist usually does not make a very good coach; he is too busy taking care of the little details and seldom gets to the heart of the matter.

At the present stage of development in swimming, the great coach must have two basic abilities: be must be a good organizer and a good psychologist. The good organizer will have the large team; he will attract the good swimmers from other teams, he will develop the Mark Spitzes and the Gary Halls of the future. The good psychologist will be able to handle the parent problems. He will get along with the city council, he will be able to communicate and get along with the swimmers, he will have the “super” team.

The good coach today need have only an elementary knowledge of the areas of conditioning, physiology and stroke mechanics. He does not need these to get the job done today. However, nothing remains static, and in the future these last two areas will become more and more important. As more superior athletes come out for swimming, as more talented people go into coaching, as more and better facilities become available, all of the aspects of knowledge that we have discussed will become important.

I frankly feel that we are on the verge of a tremendous knowledge explosion in the area of competitive swimming which will make the more technical areas of knowledge more important to good coaching. These meetings we are attending here should help us to separate the important from the unimportant and make us better coaches. I would like to attend this clinic a hundred years from now to see what is being discussed. By that time they should have simple electronic devices that can be put in the swimmer’s ear to monitor pulse rates, blood lactate, and other such physiological data. We are not ready for this sort of thing today, but even a hundred years from today, the inherent behavioral patterns of the swimmers will be the same as today; good coaching psychology today will be good coaching psychology then.

In closing, I wish all of the speakers the best of luck in communicating some of their “X” factor so that many of us can gain from this conference.

Finally, if Frank Zilch is here, I apologize to him.

RUNNING

GENETIC HERITAGE: RACE AND SPORT

Let's start with a few safe predictions. All of the sprinters in the men's 100m final at the Athens Olympics in 2004 will trace their ancestry to West Africa. Almost all of the world-class throwers will be white, and mostly of Eurasian ancestry. And, except for the marathon, there will be almost no athletes of Asian ancestry appearing in Athens finals. On the other hand, elsewhere in the Games, Asians will flourish in diving, some gymnastic events, judo, and table tennis.

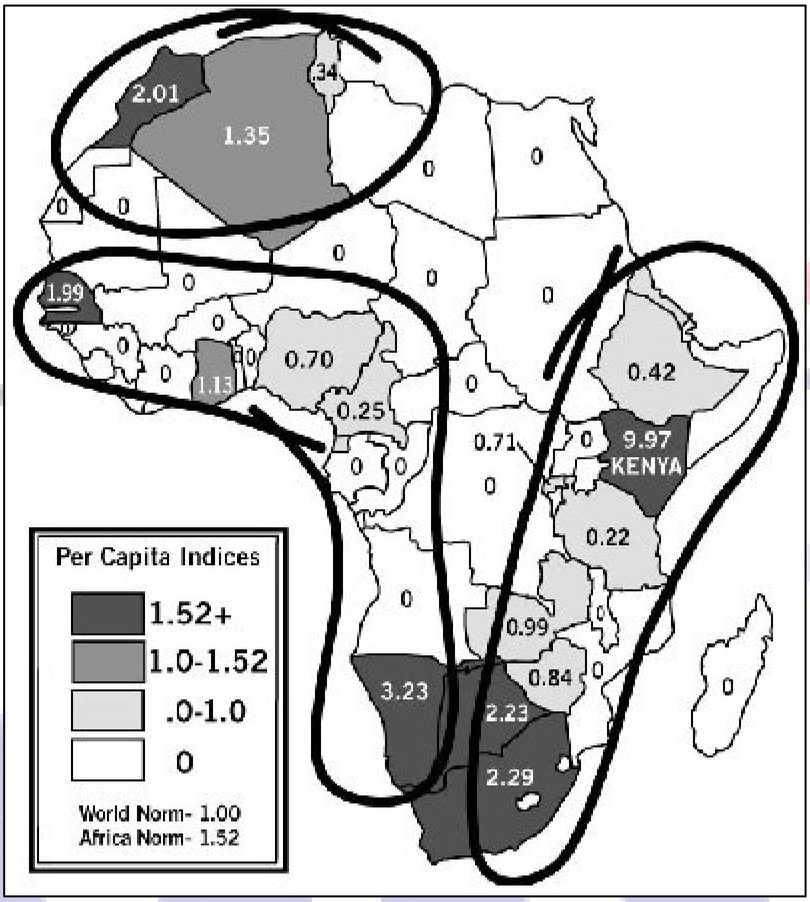
A peculiar but decided trend is unfolding: over the past 40 years, as equality of opportunity has steadily increased in sports, spreading to vast sections of Asia and Africa, equality of results on the playing field has actually declined. The more democracy on the playing field, the less at the finish line. On the one hand, the social and economic barriers limiting participation in sports are crumbling; on the other, the winners in many events are increasingly limited to participants from specific regions of the world.

It's not surprising that the United States would dominate peculiarly American sports such as basketball, but who can fathom the trends in world sports, such as running.

Why is it that every running record from the 100m to the marathon is held by an athlete of African ancestry? Is it racist to be curious about such phenomena?

Nature versus nurture

Absolutely not, say a growing chorus of geneticists, anthropologists, and physiologists. 'Very many in sports physiology would like to believe that it is training, the environment, what you eat that play the most important roles in sports,' states Bengt Saltin, director of the Copenhagen Muscle Research Center and one of the world's premier sports medical researchers. 'But based on the data, it is 'in your genes' whether or not you are talented, or whether you will become talented. The extent of the environment can always be discussed but it's less than 20-25%.'



To many sociologists, however, even discussing these trends trivialises the success of all athletes, but most pointedly blacks. 'What really is being said in a kind of underhand way,' insists Harry Edwards of University of California at Berkeley, 'is that blacks are closer to beasts and animals in terms of their genetic and physical and anatomical make-up than they are to the rest of humanity. And that's where the indignity comes in.' Ellis Cashmore of Staffordshire University dismisses the role of 'special inborn ability' as 'absurd, especially when we consider anthropologists' dismissal of the concept of race itself'.(1)

For many years, such righteous dismissals seemed like the moral and scientific high ground and a bulwark against the historical tendency to misuse genetics to support theories of white superiority. Ironically, today, with a far more nuanced understanding of the relationship of population genetics and environment, the formerly righteous position has become untenable - and even, in its own way, racist.

Do cultural factors matter? Of course: there are no great international cricketers from Texas - black or white! Does that mean that nature - genetically influenced (though not determined) factors such as body size and physiology - are always trumped by nurture - hard work and opportunity?

To help answer this question, let's briefly examine the history of distance running. For decades, the 'Flying Finns' were the world's best, their wins multiplying in tandem with their growing nationalist tradition of success (a situation replicated in the javelin - see page 6). The Finnish were eventually eclipsed by the great Anglo tradition in running, led in the 1980s by Sebastian Coe, Steve Cram, and Steve Ovett. By the last decade of the 20th century, as the door of opportunity opened to less developed nations, the centre of gravity shifted dramatically and decisively toward North and East Africa.

According to some, that cycle of history itself suggests that no population has a lock on distance running success. Surely, they say, Kenyan dominance will eventually fade, much as it did for the Finns and Brits, and the trend will shift once again to another nation?

Not so fast. To flesh out this debate, it's instructive to put Kenya under a microscope. This small East African country, with a population of less than 30 million, is home to the greatest per capita concentration of raw athletic talent in the history of the world (see map on page 5). The national sport is the passion of the masses. Little boys dream that one day, they might soak up the cheers of the adoring fans that regularly crowd the stands at the National Stadium in Nairobi. The best players are national icons. The selection process to spot the great stars begins at a very young age. Coaches backed by government money comb the countryside to find the next generation of potential athletes. The most promising of the lot are sent to special schools and provided extra coaching. It's not an exaggeration to call Kenya's most popular sport a kind of national religion.

According to conventional and socially acceptable wisdom, this is a familiar story - the sure cultural explanation for the phenomenal success of Kenyan distance runners. There's only one problem: the national sport, the hero worship, the adoring fans, the social channelling - all these relate to Kenya's enduring love affair with football! Despite the enormous success of Kenyan runners in the past two decades, running remains a relative afterthought in this football-crazed nation.

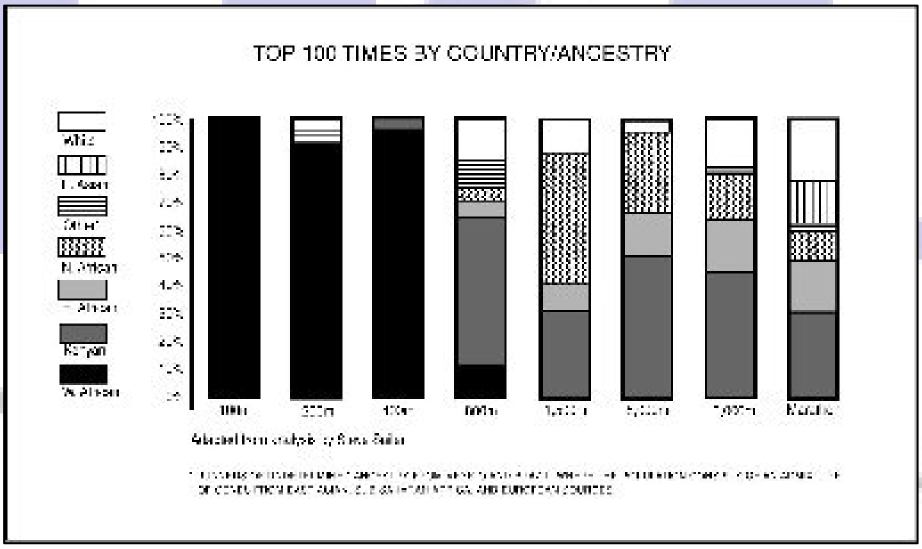
Yet, while Kenyans and other East Africans sweep upwards of 60% of the world's distance running events, they are among the world's worst football players - and sprinters. Despite an elaborate school system and the expenditure of vast amounts of the country's sparse sports resources, Kenya has flopped in trying to replicate its

wondrous distance running success in football. In the sprints, after an intense decade-long national recruitment and training effort, the best Kenyan time ever in the 100m (10.28 secs) ranks somewhere near 5,000th on the all-time list.
So where does that leave the sociological argument that nurture trumps nature? Does anyone really believe that Kenyans, known for their legendary tough training regimes, suddenly become softies when the distance is 100m rather than 42,195m?

No amount of political correctness can obscure the reality that East Africans have a very distinct genetically endowed body type and physiology. Kenyans are ectomorphs, short and slender, with huge natural lung capacity and a preponderance of slow-twitch muscles, the vital energy system for endurance sports. It's a perfect biomechanical package for distance running, but a disaster for sports - like sprinting and football - that require anaerobic bursts of speed.

Science certainly does not support the popular notion that Kenyans prevail in distance running because they train harder or run huge distances as kids - myths frequently peddled by the media. For every Kenyan athlete who runs 100 miles a week, there are others who get along on 30, and did not regularly run extraordinary distances as children. 'I lived right next door to school,' laughs Kenyan-born Wilson Kipketer, world 800m record holder. 'I walked, nice and slow.'

Though individual success is indeed largely about opportunity and 'fire in the belly', when it comes to the patterns that we see in sports, genetic traits proscribe possibility. While a driven Kenyan could potentially transform himself into a decent sprinter in spite of having the ideal genetically endowed body type of a distance runner, thousands of years of evolution have left a distinct footprint. 'Kenyans and other East Africans are born with a high number of slow-twitch fibres,' notes Saltin, who outlined his widely-embraced findings in a cover story, 'Muscles and Genes', in Scientific American last year(2). The bio-cultural epicentre for world-class distance running - where evolutionary factors and social conditions come together in a feedback loop - is the Great Rift Valley adjacent to Lake Victoria. This is home to the Kalenjin, a loosely named population of 1.5 million people, who win almost 40% of major international distance events. One tiny district, the Nandi, with only 500,000 people - one-twelve-thousandth of the planet's population - sweeps an unfeasible 20% of such races.



While Kenyans and other East Africans hold more than 60% of the world's top endurance times, athletes of West African ancestry, including most North American, British and Caribbean blacks, are among the world's worst distance runners. The ectomorphic body type so common among East Africans is not very common in whites and is almost non-existent in those with roots in West Africa. They tend to have small and efficient lungs, muscular 'mesomorphic' lower bodies, and a high proportion of fast-twitch muscle fibres which contribute to explosive speed. This is an exceptional biomechanical package for sports requiring fast bursts of effort. West African ancestral populations represent about 8% of the world's population, 12% in the US, and a mere 2% in Britain - but are vastly over-represented, especially when social and cultural factors are taken into account. Twenty-five per cent of England's Premiership footballers, 84% of American basketball players, 70% of US footballers, and 40% of baseball players are blacks of West African ancestry. The figures in sprinting are even more overwhelming: in the 100m, the purest test of speed, blacks of West African ancestry hold the top 220 times and 494 of the top 500 times. Yet, while runners of West African descent win upwards of 95% of the elite races (not all of course - human variation and individual drive ensure there are no guarantees in sports), there is not a single elite distance runner from West Africa.

For the nurturist argument to prevail, one would have to believe that British and American blacks are hard-training sprinters but lazy distance runners; or that they respond to financial incentives in the 100m but shrug at the prospect of six-figure fees and purses in elite distance races. In other words, all the determination in the world cannot turn 100m champ Maurice Greene into a first-rate marathoner - or Kenyan distance runner Joseph Chebet or Moroccan Khalid Khannouchi into a world-class sprinter.
Frankly, such claims that blacks succeed for cultural reasons diminish the reality that sports achievement is all about individual accomplishment, that 'fire in the belly'. It's hard work, courage and serendipity that separate champions from other elite sportsmen and women.

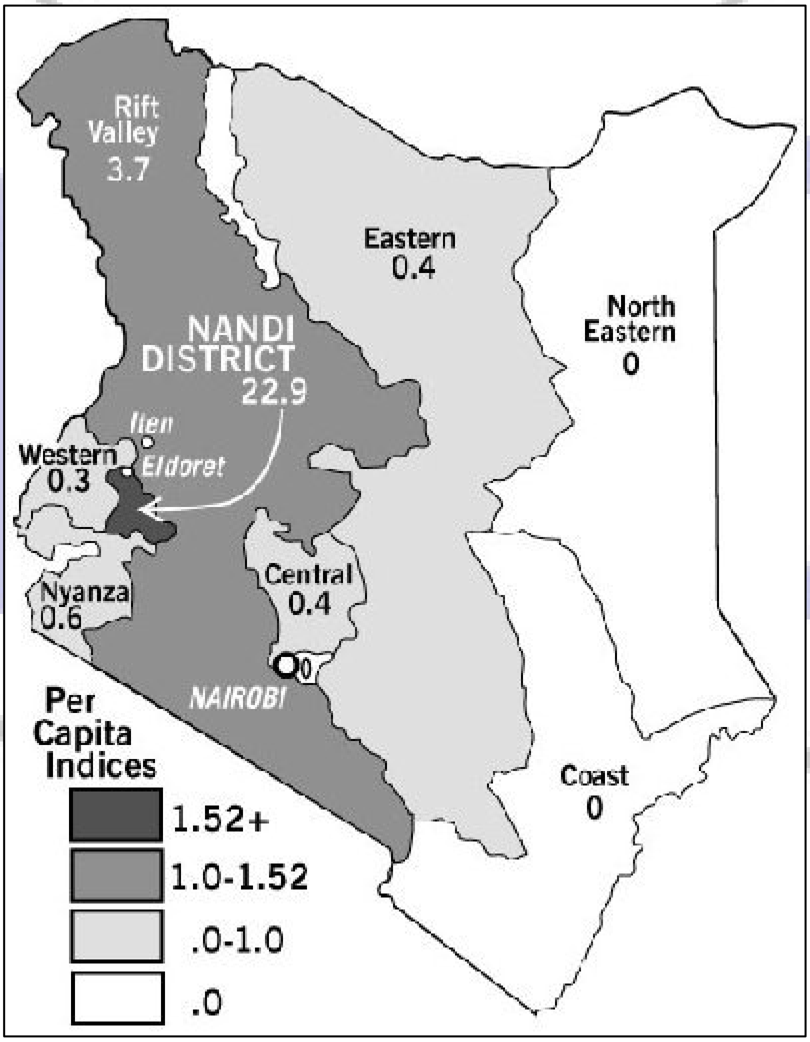
Consider Michael Jordan, who grew up in the security of a two-parent home in comfortable circumstances. Or one of the world's top sprinters, the Canadian Donovan Bailey, who was certainly not motivated by a desperate need to escape destitution: he already owned his own house and a Porsche, and traded life as a successful stockbroker to pursue his dream of Olympic gold. More and more top black athletes are from the middle class.

Why is the success of blacks and other minorities such as Aboriginal Australians explained away by cultural channelling? Sports success is too complex a phenomenon to be tidily settled by such facile sociology. How do we explain the success of the majority of athletes, of all nations and ancestral heritage, who live in comfortable circumstances? The classic argument that blacks succeed in sports to escape poverty is less and less plausible and more and more racist every day.

Genes may not determine who are the world's best runners, but they do circumscribe possibility. Kenyans and other East Africans have an innate capacity, not an innate ability, to thrive in distance running; individual effort and courage separate the pretenders from the stars. Success in sports is a bio-social phenomenon.

Rethinking race, science and sports

Why does the claim that sports success depends in part on genetics get some people so nervous? After all, it's conventional science that different body types have evolved in response to differing environmental conditions in different regions of the world. The elephant in the living room, of course, is 'race'. Fascination about black physicality and black anger about being caricatured as lesser human beings have been part of the unspoken side of the dialogue on race for hundreds of years. The fear is that some might conclude that if blacks are faster on average, they must, as part of zero-sum reasoning, be weaker mentally. But that's a conclusion not supported by science.



What have scientists documented? 'Evolution has shaped body types and in part athletic possibilities,' says Joseph Graves Jr, an evolutionary biologist and author of The Emperor's New Clothes: Theories of Race at the Millennium. 'Don't expect an Eskimo to show up on an NBA court or a Watusi to win the world weightlifting championship. Genes play a major role,' adds Graves, himself an African American.

What does that mean? After all, the fact that significant differences exist between populations would seem to conflict with a spate of declarations proclaiming that 'humans are 99.9 % the same' and 'race is biologically meaningless'. Indeed, the arguments by Edwards and Cashmore rise (or in this case, fall) from such beliefs.

The paradox revolves around a common misunderstanding about the notion of 'race' - in particular, the popular notion that races are discrete groups, each with distinct genetic profiles. Race is a term soaked in much folkloric nonsense. The concept of race is somewhat akin to an omelette masquerading as an egg. It's a pretty messy concept, sometimes referred to as 'fuzzy sets' or extended families.

Despite its notorious history, racial terminology can be helpful, such as when used in medicine. Many traits are correlated, such as dark skin colour and the presence of the sickle cell gene. But such links are not absolute. Blacks who have evolved in cooler climates are no more likely to contract sickle cell than are non-blacks. Genetic factors help explain the prevalence of any number of population-specific diseases and physiological responses to drugs. Tay-Sachs is a neurological disease more common among European Jews and their descendants. Northern Europeans are more susceptible to cystic fibrosis. Blacks are genetically more susceptible to any number of diseases, including sickle cell and heart disease. These are all 'racial' differences of a kind, although the interaction of genetic and environmental factors is extremely complex.

With these many exceptions in mind, no serious scientist would subscribe to the dogma that grips the post-modernist sociological community. Today, no credible scientist disputes that evolution, along with local social conditions, has helped shape Kenyan distance runners, white power lifters, with their enormous upper-body strength, and athletes of West African ancestry who are explosive runners and jumpers. In discussing basketball, for instance, Jared Diamond, the UCLA physiologist and Pulitzer Prize winner (for Guns, Germs and Steel), writes that the disproportionate representation of African Americans is not because of a lack of socio-economic opportunities, but on account of

'the prevalent body shapes of some black African groups'.(3)
Most scientists are quick to point out that this is not a 'black and white' issue, but the consequence of thousands of years of evolution in varying terrains. Modern humans are made up of overlapping, soft-edged genetic clusters. Although humans share most of their estimated 40,000 genes, there are as many as 500,000 gene components, or single nucleotide polymorphisms (SNPs), many of which are more common among people from one geographical region than from another.

'The fact that monolithic racial categories do not show up in the genotype does not mean there are no group differences between pockets of populations,' stresses Graves. 'There are some group differences. We see it in diseases. But that's a long way from reconstructing century-old racial science.'
Each sport demands a slightly different mix of biomechanical, anaerobic, and aerobic abilities. As a result of evolutionary adaptations to extremely different environments that became encoded in the genes, athletes from different insular populations tend to have rather distinct physical and physiological characteristics. As a result, they frequently excel in specific events.

Whites of Eurasian ancestry, who have, on average, more natural upper-body strength, predictably dominate weightlifting, wrestling and field events, such as the hammer (whites hold 46 of the top 50 performances). Evolutionary forces in this northern clime have shaped a population with a predilection toward a mesomorphic body type - large and muscular, particularly in the upper body, with relatively short arms and legs and thick torsos. These proportions tend to be an advantage in sports in which strength rather than speed is at a premium.

Certain East Asian populations tend to be small with relatively short extremities, long torsos, and a thicker layer of fat - part of the evolutionary adaptation to harsh climes encountered by homo sapiens who migrated to Northeast Asia about 40,000 years ago. As a result, athletes from this region are somewhat slower and less strong than whites or blacks, but are, on average, more flexible. These characteristics are key potential advantages in diving, some events in gymnastics (hence the term 'Chinese splits'), and figure skating. They also have very quick reaction times, which undoubtedly contribute to their success in racket sports (see case study 2 on page 9).
And though they generally are not very competitive at jumping and sprinting because of squatter bodies and the predominance of slow-twitch fibres, East Asians are very competitive at long distance races, including the marathon, in part because of higher levels of body fat. It should come as no surprise that the world's most remarkable ultra-endurance runners, the 4,000 or so Native American Tarahumara of Mexico, have East Asian ancestry. (The Tarahumara are considered the least-assimilated people in the Americas; like the Nandi, they subsist by herding, agriculture and hunting. They also love to run: it is not uncommon for women to run up to 40 miles as part of social game-playing.)
Popular thinking still lags behind the genetic revolution. Genetically linked, highly heritable characteristics such as skeletal structure, the distribution of muscle fibre types, reflex capabilities, metabolic efficiency, lung capacity, and the ability to use energy more efficiently are not evenly distributed among populations and cannot be explained by known environmental factors.

'Differences among athletes of elite calibre are so small,' notes Robert Malina, Michigan State anthropologist and editor of the American Journal of Human Biology, 'that physique or the ability to fire muscle fibres more efficiently that might be genetically based... it might be very, very significant. The fraction of a second is the difference between the gold medal and fourth place.'
Although scientists are just beginning to isolate the genetic links to biologically-based differences, it is indisputable that they exist (see 'Genetic engineering and sport' - page 9). Such characteristics are not distributed equally among populations. The genetics revolution has decisively overturned the belief that all humans are created with equal potential, a tabula rasa for experience to write upon. Some functional characteristics do differentiate population clusters - most clearly in the proclivity to certain diseases and in body types.

Why do we so readily accept that evolution has turned out groups with distinct susceptibilities to different diseases - yet find it racist to acknowledge that blacks of West African ancestry have evolved into the world's best sprinters and jumpers and East Africans into the best distance runners? In light of recent advances in genetics and the science of human performance, extremist claims that we should not discuss these 'racial' or patterned biological differences appear quaint, dangerous and perhaps even racist. Limiting the pejorative use of that problematic concept of race - an admirable goal - is not going to make the patterned biological variation on which it is based disappear. Although people share a common humanity, we are different in critical ways.

The question is no longer whether genetic research will continue - but to what end. Athletic competition, which offers a definitiveness that eludes most other aspects of life, is a perfect laboratory for a serious exploration of the complex relationship of genes and culture.

'I believe that we need to look at the causes of differences in performance between races in sports as legitimately as we do when we study differences in diseases,' says Canadian Claude Bouchard, sports physiologist and geneticist, and director of the Pennington Biomedical Research Center at Louisiana State University. 'I have always worked with the hypothesis that ignorance fosters prejudice. (Critical inquiry) is the greatest safeguard against prejudice'

Indeed, if we do not welcome the impending genetic revolution with open minds, if we are scared to ask and to answer difficult questions, if we lose faith in science, then there is no winner; we all lose. The challenge is in whether we can conduct the debate so that human diversity might be cause for celebration of our individuality rather than a source of distrust.

Finally, it should never be forgotten that genes are not the ultimate factors in elite performance. While genetics will determine if you have a chance to be an elite athlete, intelligence, dedication, and serendipity are the final arbiters of who wins and loses.

'It's the brain, not the heart or lungs, that is the critical organ,' Sir Roger Bannister told me on a visit to his home at Oxford University. 'But one would have to be blind not so see a pattern here. I hope we are not at a time and place where we are afraid to talk about remarkable events.'

Jon Entine

DOPING

TAINTED GLORY – DOPING AND ATHLETIC PERFORMANCE

Is it possible for the "natural" athlete who competes without chemical assistance to achieve record-breaking performances in sports requiring strength, power, speed, or endurance? Because doping tests are infrequently positive in international sports, it has been widely believed that the answer is yes — and that few athletes competing in major sporting events, including the Olympic Games and the Tour de France, use performance-enhancing drugs. But multiple sources of evidence, including personal testimony[1,2] and an ever-increasing incidence of doping scandals, suggest the opposite: that widespread use of performance-enhancing drugs has fundamentally distorted the upper range of human athletic performance. [1,3-5] Unfortunately, a global code of silence has kept the problem hidden from public view. [4,5]

Drugs have been in sports for a long time. In the earliest modern Olympic Games, the drugs of choice included strychnine, heroin, cocaine, and morphine, [4] which were probably more harmful than helpful. The first "effective" performance enhancing drugs, the amphetamines, which were used widely by soldiers in the Second World War, crossed over into sports in the early 1950s. [4] These drugs — nicknamed *la bomba* by Italian cyclists and *atoom* by Dutch cyclists — minimize the uncomfortable sensations of fatigue during exercise. By setting a safe upper limit to the body's performance at peak exertion, these unpleasant sensations prevent bodily harm. The artificial manipulation of this limit by drugs places athletes at risk for uncontrolled overexertion. The first cases of fatal heatstroke in athletes using *atoom* were reported in the 1960s. In the 1967 Tour de France, elite British cyclist Tom Simpson died on the steep ascent of Mont Ventoux, allegedly because of amphetamine abuse. The precise extent to which amphetamines enhance athletic performance is unknown, since, as with all performance-enhancing drugs, there are few modern studies quantifying their effects. The convenient absence of such information represents further evidence of a hidden problem. A popular opinion is that *la bomba* can turn the usual Tour de France *domestique,* or support rider, into a stage winner.

Since amphetamines must be present in the body to be effective, the sole method of avoiding the detection of their use during competition is to substitute a clean urine sample for the doped specimen. A multitude of innovative techniques have been developed to accomplish this swap. [2] Cortisone, a potent but legal performance-enhancing drug used to dampen inflammation, also reduces the discomfort of heavy daily training and competition and lifts the mood. It is also widely abused by professional cyclists. [2]

Testosterone propionate (Testoviron), the prototype of the anabolic steroids, the second major group of potent performance-enhancing drugs, was synthesized in 1936 and appeared in sport sometime after the 1948 Olympic Games. The subsequent synthesis of methandrostenolone (Dianabol) in the United States in 1958 and oral chlordehydromethyltestosterone (Turinabol) in East Germany after 1966 marked the beginning of the "virilization" of modern sport. [4]

By increasing muscle size, these drugs increase strength, power, and sprinting speed; they also alter mood and speed the rate of recovery, permitting more intensive training and hence superior training adaptation. For maximal effect, anabolic steroids are used in combination with other hormones that have similar activity, including insulin, growth hormone, and insulin like growth factor. They have multiple side effects, some of which are serious, including premature death. The true extent of the use of performance enhancing drugs is uncertain for a variety of reasons: athletes avoid detection by using scheduled testing for illicit drugs to plan their drug use [1,3,5] ; those conducting "out-of-competition" testing of athletes may intentionally avoid testing known drug users [1,3,5] ; hormones such as testosterone and insulin are initially undetectable, since they are so similar to the naturally produced substances, and designer drugs such as tetrahydrogestrinone (THG) are initially developed specifically to elude detection by all the current testing protocols; and positive tests are often not reported, and even proven drug users are generally not prosecuted. [1-5]

The exact magnitude of benefit from the use of combined anabolic agents is unknown. Previously secret East German records indicate that anabolic steroids alone reduce 100-m sprinting time by as much as 0.7 second and improve performance in the 400-m, 800-m, and 1500-m running events by 4 to 5, 5 to 10, and 7 to 10 seconds, respectively. [1,3] Equivalent benefits have been found among swimmers. [3] Effects in throwing events are also substantial: a gain of 2.5 to 5 m in the shot put, 6 to 10 m in the hammer throw, 8 to 15 m in the javelin throw, and 10 to 20 m in the discus throw. [1,3] Benefits are greatest in women, since the natural secretion of testosterone in young women is negligible.

The third type of potent performance-enhancing drug is erythropoietin, the hormone that regulates the red-cell mass. A popular theory holds that performance during high-intensity exercise is limited by the rate of oxygen delivery to the exercising muscles. By increasing the red-cell mass and hence the oxygen-carrying capacity of the blood, erythropoietin should increase performance only during all-out exercise lasting a few minutes. Yet it spectacularly increases performance in events that last anywhere from minutes to hours [2] and in events in which oxygen delivery is not the primary determinant of performance. It therefore seems likely that erythropoietin has another type of action, with effects on the brain that may resemble those of amphetamines, cortisone, and anabolic steroids. Currently, erythropoietin can be detected in the urine for only a few days after the most recent injection, although the related blood changes (in particular, the increase in red-cell mass) last much longer. Indeed, the benefits of even a short course of erythropoietin may last for many weeks.

The dangers of erythropoietin use include sudden death consequent to a fatal reduction in the heart rate, usually at night, and the development of antierythropoietin antibodies, which may cause a paradoxical reduction in the red-cell mass (pure red-cell aplasia). Eighteen young professional cyclists died from unknown causes in the late 1980s, when erythropoietin was first introduced into the world of cycling. Eight additional unexpected deaths of professional yclists have been reported since January 2003, including that, reportedly from an accidental cocaine overdose, of Marco Pantani, the winner of the 1998 Tour de France who was banned from cycling after testing positive for markers of erythropoietin use while leading the Tour of Italy. The widespread use of performance enhancing drugs may be associated with an increase in the use of recreational drugs by some of the same athletes. [2]

Performance-enhancing drugs pose a great threat not only to the health of users, but to the moral integrity and hence the continued relevance of modern sport. [4,5] For, when used by fully trained, elite athletes, these drugs can improve performance to a much greater extent than any combination of the most intensive, sophisticated, and costly nonpharmaceutical interventions known to modern sports science. [1-4]

Scientifically based training regimens, special diets, and complex physiological and biomechanical measurements during exercise and recovery cannot match the enhancing effects of drugs. The attraction of performance-enhancing drugs is simply that they permit the fulfillment of the mythical promise of boundless athletic performance [1,4] — the hubristic “faster, higher, stronger” motto of the Olympic Games. An ethically based medical science cannot compete. Thus, drug use in a subgroup of athletes who — even in the absence of drugs — are able to compete at an elite level causes their separation into a distinct athletic population, distanced from “natural” humans by a margin determined by the potency of the drug combinations that are used. These athletes, quite simply, have moved off the natural bell-shaped curve of normal human performance.

In disclosing his own drug-enhanced performances, former Australian world discus champion Werner Reiterer, who chose to retire rather than risk winning a tainted medal in the 2000 Olympic Games in Sydney, has written, “There was something pathetically wrong with the fact that a packed home arena — an entire country — would urge me on without any concept of the truth behind my ultimate athletic achievement, or of the sham of which they were unwittingly a part.” [1]

Our burden is that no longer do we share this ignorance. We can no longer pretend that we do not know.

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XC SKIING

THE PHYSIOLOGY OF CROSS COUNTRY SKIING

My approach to learning and doing a new sport starts with a lot of reading about the specific demands and physiology of the event. The basics of any endurance sport are similar, but I like to look for the details. Fortunately, there is a great deal of research on the physiology of cross country skiing. Most of it has been performed here in Europe and Scandinavia, because of the high level of participation in the sport in this region of the world. A lot of the work I have been reading is written in English, which is good. Some is in Norwegian, which is ok. And one useful dissertation I have in my hands right now is written in Danish, which is pretty darn challenging. So let's just say that studying XC has been good for my language skills!

What does an elite skier look like?
Good question. On average, top class skiers are between 27 and 29 years old when they reach their peak, but the standard of deviation is 4 years. This means that you can see Olympic medallists in their early 20s to late 30s! One important point which speaks to the need for patience and persistence is this: No junior skier has ever won an Olympic gold or World Championship. It takes years of training to achieve the highest levels of performance.

The interesting thing about XC is that there is no "perfect" body type. In sports like swimming, distance running, and rowing, observing an assembly of the elite often looks like a clone festival. In contrast, World champion male skiers have ranged in height from 5' 6 (1.68 m) to 6'6" (2.0 m). The elite skiers usually has little body fat, but not to an extreme. As a group, elite XC skiers are heavier than distance runners, but lighter than rowers. Female elite skiers tend to have a lower body mass index (mass in kg divided by height in m2) than non-athletic women of the same age.

Fiber Type Composition

What about how they look under their skin? Type I muscle fibers are predominate in the leg muscles of elite skiers, but there is considerable variability even among the elite. In the normal population the fiber composition in the vastus lateralis (a thigh muscle that is often biopsied in athletes) will approximate a 50-50 ratio between fast and slow fiber types. The fast fibers will be made up of a mixture of type II a and II b fibers. In elite skiers the percentages are more like 66% (62-75% in different studies) slow and the remainder type II a. The "pure" fast fiber, the type II b subtype, is practically non-existent in well trained skiers (and other endurance athletes). This is due to type II b to II a conversion (II a fibers are still "fast", but with much greater fatigue resistance). Now, in comparison, biopsy studies on elite distance runners suggest a slightly higher slow twitch percentage among the elite runners (78-79%). Perhaps it is adaptive for skiers to possess a higher type II a percentage, due to the varying terrain and non steady-state conditions that comprise XC racing.

Unlike running and cycling, XC is a whole body sport. Major endurance demands are also placed on the upper body musculature, including the latissimus dorsi, deltoids, and triceps groups. Surprisingly, there has been far less work done to determine upper body fiber composition in elite skiers. From what we know, the average population has more fast twitch fibers in upper body musculature compared to lower. The triceps for example is about 65-70% fast in untrained people. Consequently, the XC skier must work deligently to maximize the endurance capacity of these normally under utilized upper body muscles. Even in elite skiers, triceps fiber composition is less slow twitch dominated than the lower body, about 50-50 in one major study. Some investigators have suggested that in specific muscles like the triceps, it is advantageous to have more fast twitch fibers due to the high movement velocity of the distal arm during the "push" phase of the double poling movement.

Movement Speed on Skis

As in running, skiing velocity is a function of stride frequency and stride length. Increasing either one, without decreasing the other will result in increased movement velocity. So, which factor, distinguishes the elite skier from the "also-ran"? Elite skiers have longer strides compared to less successful skiers both in skating and in the diagonal stride. The faster skier is not faster due to greater skating or striding frequency However, when we look at the upper-body only, during double poling, then the elite skiers achieve greater velocity by using a higher rate of poling; increasing poling frequency. Finally, elite skiers are better able to change potential energy into kinetic energy than recreational skiers. This reduces the demand for changing the velocities of body segments. For example, the elite skier makes better use of the pre-stretch on the arm musculature achieved during the initial pole plant during double poling.

The average speed of world cup races is about 6-7 meters/sec depending on the conditions. In running, there is a progressive decrease in average velocity with increasing race distance (beyond 200 meters). Top marathoners run about 19% slower during the race compared to 5000 meter runners. In contrast, the difference in average velocity during a 50k classic style ski race compared to a 10 k race is on the order of only 5-7%. The main reason for this better speed maintenance is that the longer courses are constructed with slightly less demanding climbing segments, allowing greater velocity. One other possibility is that the skier has more total glycogen available for generating energy at high intensities, due to the greater involvement of the upper-body musculature. This may allow the skier to maintain a higher average exercise intensity over the race duration without reaching performance limitation due to glycogen depletion.

For the same reasons, it is not simple to compare the racing speeds of men and women. The problem is that they often compete on different courses. However, if we use the Vasa løpet in Sweden, then both men and women go on the same course at the same time every year. In this race, physiologist Bjorn Ekblom has reported that the male winners were, on average, 16% faster than female winners. Other studies suggest differences of 14-15% in average velocity. This is a larger difference than we see in running or rowing.

VO2 max in Elite Skiers

The single physiological variable that most clearly distinguishes the champion cross-country skier from the average person, or even the highly trained but less successful skier is the maximal oxygen consumption. In the unforgiving world of XC racing, there seems to be no substitute for a BIG ENGINE!

A major question in XC skiing research has been "what is the most appropriate way to compare VO2 max values among different athletes?" One way is to just compare the absolute consumption during a maximal exercise test in liters/minute. This value is representative of the maximum capacity of the athlete to generate power through aerobic metabolism, which is what ski racing is all about. If we do that, the values are impressive (5.5 to 6.5 liters/min these days), but they don't take into account differences in body mass. The typical solution in many endurance sports is to compare values corrected for body mass. For example a 70 kg skier with a 6.0 liter VO2 max has a weight corrected VO2 max 85 ml/kg/min (yep, that's high, but typical among the world elite). Let's say another skier has an even "bigger" 6.5 liter/min max. However, he weighs 80kg, so his VO2 max is "only" 81 ml/min/kg. Consequently, our heavier skier appears to come up a little short. The problem with this very typical method of comparison is this: Skiing conditions change from minute to minute. The power needed to ski at a given speed on level terrain does not increase in proportion to bodyweight. When climbing a steep hill, added body mass is a more powerful negative factor. During a downhill it is a plus! Considering the varying conditions, physics, dimensional analysis, test data, etc., it appears that the most valid expression of maximal oxygen consumption for XC skiing is achieved by dividing VO2 max by body mass2/3. Ingjer (1991) demonstrated that the average VO2 max of world class skiers was significantly greater than that of less successful skiers only when it was divided by body mass2/3, not when it was divided by simple body mass. (In our previous example, the two skiers with maximal oxygen consumption values of 85 and 81 ml/min/kg come out to nearly identical values of 350 when expressed relative to the 2/3 power of bodyweight.) One thing is clear. The teams with the most success have skiers with the highest maximal oxygen consumption.

What is limiting Maximal Oxygen Consumption?
I have discussed the limiting factors in VO2 max before, but some additional comments are worth mentioning here. There is strong agreement among the research community that it is the pumping performance of the heart (and therefore oxygen delivery) that limits the maximal oxygen consumption in most non-athletes and athletes. However, there now seems to be a catch. In those athletes with the really high absolute VO2 max values, driven by really high maximum cardiac output, it appears that other links in the oxygen delivery chain can become the weak link. If the flow rate of blood through the lungs becomes great enough, a point is reached where the de-oxygenated blood coming from the right ventricle of the heart is passing through the lungs before it is fully re-saturated with oxygen. At this point we say that the oxygen diffusion capacity of the lungs is limiting total oxygen delivery, and therefore, VO2 max. That may be a little more information than you want to know. The bottom line is that the single most identifying factor among the world elite will be a very high maximum stroke volume, and high max cardiac output. As a rule, you can assume that the guys winning the medals in the Olympics have maximal oxygen consumption values over 6 liters/min, maximal cardiac outputs of over 40 liters/min, and stroke volumes over 200 ml. They may look pretty ordinary on the outside, but they have a pretty extraordinary pump inside their chests. If you want to find a better heart, you probably should go out to the horse tracks and check out the thoroughbreds!

Are the skiers of today better than in the past?
Most of the increase in speed demonstrated by the XC elite in the 90s compared to say, the 60s, is due to equipment, technique and track improvements, not better trained or more talented athletes. However, the very best are still getting better physiologically, slowly but surely. Higher training volume and more total skiers competing for the top are two reasons for the progression. Here is some data from Swedish male medallists in the 60s, 70s, and 80s (from Ulf Bergh and Artur Fosberg, 1992).

		Maximal Oxygen Consumption		
	Body mass (kg)	liters/min	ml/min/kg	ml/min/kg2/3
1960s (n=4)	68	5.56	82	335
1970s (n=4)	72	6.14	84.9	353
1980s (n=4)	73	6.33	87.2	363

Although I don't have data for Swedish medal winners from the 90s, I have talked to some Norwegian sports scientists who have been involved in physiological testing of Norway's national team (which has dominated Sweden in the 90s). Currently, Bjorn Daehlie sits on top of the team list with a reported maximal value of 90 ml/min/kg. He is also reining World Cup and Olympic Champion. There are one or two reports of athletes VO2with values at or above 90 ml/min/kg in the endurance sports world (in cycling and distance running). Remember though, they are very, very, rare; way out there; off the scale; WHAT PLANET IS HE FROM? type values.
Indurain.......Morcelli........Daehlie.....NOT US. The air keeps getting thinner and thinner at the TOP!

The Upper Body in Skiing
Propelling the body on skies requires intense work by both the arms and the legs. When we ski hard we are "asking" the heart to deliver high blood flow in several different directions at once. Once an exercise employs a large quantity of muscle (running, rowing, cycling in experienced riders), then the oxygen consumption limitation falls back to the heart and it's ability to deliver oxygen. So, what happens in skiing when we add maximal arm exercise to maximal leg exercise? The answer is: little or nothing. Studies in the laboratory have demonstrated that adding arm exercise to maximal leg exercise during a VO2 max test increases oxygen consumption by only a tiny percentage, or not at all. The cardiovascular system works under a constant limitation related to maintaining sufficient blood pressure in the system. It is a lot like what happens in an old house when you're taking a shower and somebody turns on the faucet in the kitchen, while someone else flushes the toilet. Pretty soon, the shower becomes a drizzle. To maintain water pressure in the pipes, you can't have too many valves open at once. The same is true in our cardiovascular "pipes". When arm exercise is added to leg exercise, blood flow to the legs actually decreases due to constriction of the leg arteries. This extra blood flow is than available for the arms. The body maintains blood pressure, by controlling how how much each artery is "opened."

During skiing the contribution of the upper body to movement velocity varies from perhaps 10% during the classic diagonal stride to 100% during double poling. During skating uphill (the double dance), the upper body contributes 50% or more of the total force. The endurance capacity of the upper body has always been important to the skier. Today, with the addition of arm-intensive skating techniques, this is even more true. Consequently, there has been a lot of recent research investigating the endurance capacity of the upper body of elite skiers, and its relationship to performance.

Special ergometers have been developed for measuring oxygen consumption during either double poling, or during the alternating arm movements used during the diagonal stride. The devices range from turning a rowing machine on end to highly advanced ergometers that measure force output and movement velocities at each ski pole, while simulating the free-floating movement of the legs. One meaningful comparison to make is the "peak oxygen consumption" achieved during double poling relative to VO2 max measured during uphill treadmill running or roller-skiing. In untrained populations, upper body VO2 peak will only be about 60% of whole body max. In recreational and well trained skiers, the ratio increases to 70 to 85%. Remarkably, in the elite skiers tested in Norway and Sweden (and no doubt other word class skiers from around the globe), this ratio averages 90% and sometimes approaches 95%! I think this is a valuable point for all of us who wish to improve our skiing. One of the areas where most endurance athletes are weak is upper body endurance and power. Among elite skiers, an interesting pattern occurs during the season. Whole body maximal oxygen consumption peaks very early in the seasonal build-up. However, performance peak during the season seems to correspond to the peaking of upper-body endurance capacity, measured as upper body peak VO2.

Muscle Strength

Now we come to a common question: If I weight train, will this improve my endurance capacity? Unpublished observations by Swedish investigators (Ekblom and Berg) indicate that the maximal leg strength is only slightly greater than what is seen in the average person. However, when an endurance test is used in the same movement, such as 50 consecutive leg extensions, the skiers are clearly superior, even compared to most other endurance athletes (rowers may be the exception). What this means is that there is no relationship between maximal leg strength and leg endurance. In practice, elite skiers do little or no general weight training for the lower body. For the older (50+) skier, I would still recommend a lower body weight training program only for the purpose of maintaining muscle mass.

The upper body is a different story. Performance time for a 60 meter sprint double-poling test is strongly related to peak torque produced by the triceps group during strength testing. Faster times are produced by those with greater arm strength. Furthermore, there is preliminary evidence here in Norway that even a short term, intense upper body strength training program results in increased upper body VO2 max and endurance time in standard load testing on a special ski ergometer.

What is going on here?

I have told you repeatedly that whole body maximal oxygen consumption is limited by the heart (along with the endurance capacity of the muscles), not how much muscle or strength you have. So how can strength training improve upper body endurance and peak oxygen consumption? Here is the difference. The total muscle mass of the upper body is not great enough to maximally stress the heart during high intensity work. For example, peak heart rate achieved during a double poling test may be 10-20 beats lower than observed during maximal treadmill running. What this means is that in the unique condition of upper-body only endurance exercise, the heart is no longer the limiting factor, the muscle is. Consquently, dedicated specific training designed to increase skiing specific strength AND endurance can result in more total muscle available during double poling, or other arm-intensive skiing techniques. In the summer training of the elite, it is common to see arm-intensive work like kayaking added to the program in order to help close the endurance gap between the upper and lower body. This is a useful lesson many masters skiers can take away from observing the "big-boys."

Race Day

So far, I have not mentioned the two other major endurance qualities, the lactate threshold, and movement economy. Both are important in skiing, just as in other endurance venues, but the conditions in skiing are pretty special in two ways. First, XC race courses are laid out on terrain that is constantly changing. Uphills, downhills, flat areas, curves etc. Consequently, the athlete is almost never in a condition that could be considerd a steady-state. This makes the lactate threshold somewhat less powerful as a predictor of performance. Second, unlike rowing, running or cycling, the techniques used in skiing vary from moment to moment during the race. This makes a simple investigation of economy impossible. I will discuss these issues futher in the context of data collected under race conditions.

A good cross country race course will have equal proportions of flat, uphill, and downhill segments. It is possible to estimate the energy expenditure during a race by analyzing the heart rate responses during a race plus body core temperatures and lactate levels after the race. The average workload during 5-30k races by both elite men and women is between 90and 90% of VO2 max. This is similar to what we would see in running or cycling time trials. However, unlike these events, during a ski race the climbing portions of the course present tremendous physiological demands. Heart rates of elite skiers reach maximum levels during every significant climbing portion of a course. In fact, some skiers will reach slightly higher heart rates during a race climb than during a mximal treadmill running test. What this tells us is that the top skiers are working at 100% of VO2 max many times during a race. When a down hill segment comes, the heart rate drops, but not as much as you might think. Even though oxygen demand for downhill skiing is much lower, the skier doesn't get much of a break. That heavy oxygen deficit accumulated during the climb is being repaid during the fast downhill, so heart rate may drop only 20 beats. Then we are on a flat. Now heart rate climbs again, to 10-15 beats below max. Analysis of world cup races reveals that the winners make their biggest time gains during the climbs. This is why having the biggest engine is so important for the skier. They guys with the biggest engines climb the fastest, then descend at about the same speed. Bjorn Daehlie does his damage on the hills.

Measurements of lactate threshold using standard laboratory tests reveal what we would expect in the elite. Lactate accumulation during a progressive load test doesn't occur before about 85% of max. The problem is "lactate threshold" seems to have little to do with XC ski racing. Dr. Erik Mygind in Denmark did extensive testing of Swedish and Danish elite skiers under both laboratory and racing conditions. In order to ensure ideal conditions and conditioning, the testing was performed during the racing season, so the athletes were "race ready." For just this reason the Swedish senior elite declined to participate. So the Swedish skiers were national and world-class juniors (19 yrs old). What he discovered was that blood lactate concentration reaches very high values within minutes of the start of a competition and then stays reasonably stable throughout a 40-50 minute race. The lactate levels averaged about 10 mM at the end of the race. In one skier, lactate levels were 14 mM after the first 2.5 km and finished at 18mM 10km later! These findings are supported by previous investigations from other labs in the 60s and 80s.

One could argue that the lactate levels were really rising and falling from minute to minute during the race, and only high at the point in the race were the measurements were made. This is unlikely, because blood lactate levels do not recover on such a short time scale, even using ideal active-rest recovery methods. Even 7 minutes after the race was over, lactate levels were nearly unchanged in all the skiers.

What all this tells us is that "velocity at lactate threshold", or other lactate based measurements have little predictive value in a short to medium length XC ski race. This doesn't mean that increases in lactate threshold percentage aren't an important training adaptation for skiers. It just means that unlike a marathon in running, the LT doesn't set the speed limit for the athlete. Both the winners and the losers are tolerating very high lactate levels throughout the race. The capacity to race at such high average lactate levels is probably also a training adaptation. One study in skiers who were untrained for racing measured lactate levels after a 10km race and found values of only 5-7 mM Blood samples were not taken during the race in this study.

Economy and Skiing Technique(s)

Now we come to another unique aspect of XC skiing. There are Many different ways to go from Point A to Point B, even on the flats: Diagonal stride, kick double-pole, double pole, marathon skate, V1 skate, double skate without poling, to name just the flat ground techniques. There is no simple answer to questions about skiing economy differences among competitors.

Skating vs Classic

The reason we now have "freestyle" races and "classic" races is that without this distinction, everyone would be skating every race, and classic skiing would eventually disappear into the ranks of the wilderness trail blazers. Skating is faster, plain and simple. Depending on temperature and snow conditions, skating races are 5-15% faster over the same distance. In very wet snow or extreme cold conditions, the difference in speed between skating and classic decreases. As a rule of thumb, we can say that skating is 10% faster for a given group of athletes. Why?

There have been several hypotheses presented and tested:

1. Skating allows the athlete to achieve a higher aerobic capacity compared to classic. In other words, perhaps skating creates a bigger work capacity.
2. Skating allows more of the work output of skiing to be delivered to the skis and forward progress.
3. Skating results in decreased frictional resistance.

Here is what the studies have shown so far. First regarding possibility #1. This is not correct. Several studies have indicated no difference in VO2 max when measured in the same athlete performing either skating or classic techniques. Of course, this could be a different story if the skier is technically weak in one or the other technique. However, at the top levels, this is rarely the case. Even as early as 1986, a study of junior world class skiers demonstrated that the race placement in classic and skating races was very similar. Watching the world cup season also indicates the same. The same skiers are dominating the top 10 places in both skating and classic races.

Possiblity #2 seems to play a role. On flat terrain at a constant speed, skating (V1) has been shown to require 10% less oxygen compared to the same speed via the diagonal stride. Heart rate, perceived exertion and lactate accumulation are all lower at similar intensities while skating compared to diagonal striding. One explanation for this seems to be that the velocity changes by the limbs are much smaller in the skating technique. Skating results in a longer force development period for the limbs. Minimizing repetitive acceleration and deceleration of the limbs increases movement economy.

Finally, regarding #3, the elimination of the grip wax during skating results in a small but significant decrease in friction, and increased speed for the same effort. Since skating results in a slightly lower body position, air resistance may also be a little lower during skating, but data to support this contention is lacking.

There ARE exceptions to the general trend of skating based techniques being more economical than classic techniques. The classic double pole technique is even more economical than skating on level ground. (Double poling on ski-skates is the MOST economical technique). However, since double poling involves a smaller muscle mass to generate the work, the strain on the muscles is higher and so is the perceived exertion. If double poling is the most economical, why not use this style all the time? Double poling does not allow the athlete to use his/her maximal work capacity. Being efficient is not effective if too little power is generated! So when push comes to shove, and you are climbing a hill, the prize still goes to the guy with the biggest engine and economy goes out the window!

The LEAST economical style is the classic diagonal stride. A study by Hoffman and Cliffard (1990) measured several physiological variables during skiing at a constant speed while using different techniques on level ground. The oxygen cost was 33% higher during the diagonal stride compared to double poling on classic skis. This isn't hard to believe when you consider how much limb movement is going on for a given amount of forward progress. Consequently, this technique is most frequently seen during hill climbing (in Classic races), when distributing the high workload over the largest muscle mass possible is important. The V1 technique required about 15% more energy than double poling but 15% less than diagonal striding.

Can Technique Decide a Race?

Well, sure it can. And, there are significant differences in skiing efficiency between the elite and the recreational skier at a given speed. The elite are technically superior. But, who cares about that comparison. The world class guys and gals could ski with no poles and kick our butts (I once saw Thomas Alsgaard finish a major relay with one pole and a broken hand. He was still skiing pretty darned fast!). What I am really getting at is "how big are the technique differences among the best skiers?" Again, this is a tough question. Part of racing efficiency probably involves optimally timing technique selection at different stages along the course. You can't measure that in a lab test. Several studies suggest that you can find national class skiers who are no better technically than good recreational skiers. There is pretty good variation at this level. However, if you just look at international class skiers, the variation gets much smaller (7% in one study). At this level, efficiency is not a strong predictor of performance placing. Inefficient skiers never make it to the international level. Again, we go back to who has the biggest performance engine. A good example of this was 8-yime Olympic gold medalist Bjorn Daehlie. Among those with discerning eyes for this stuff, they would tell you that he was not necessarily the smoothest skier on the list. His double poling stood out as frenetic. And, he hated to get into a sprint situation, because that was a major weakness for him. However, he rarely NEEDED to sprint at the end, and he WON and WON. Why? A 90 ml/min/kg VO2 max, a love of training, and an unquenchable competitive spirit. When it's all said and done, that’s ALL you need to win in World Class Cross country skiing!

Association of Rowing Coaches

Membership Application Form

First Name: ____________________________________

Surname: ____________________________________

Gender: ____________________________________

Nationality: ____________________________________

ID Number (RSA): ____________________________________

DoB: ____________________________________

Postal Address: ____________________________________

____

Cell Phone: ____________________________________

Email: ____________________________________

Club/Institution: ____________________________________

Volunteer/Half paid/Full Paid: ______________________________

Coaching Qualification Level: ______________________________

Representation: International/National/Provincial:_________________

This form must be completed and returned by fax to Jamie Croly (National Secretary) at 011 781 2987 or by Email at jcroly@stithian.com. You will be notified by email of the receipt and acceptance of the membership application.

Membership fee of R100.00 per year will be invoiced after membership has been accepted and processed.