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Below find a reprint of the 6 relevant pages of the article "adi-pub-01109" in "":

The timeless striving of athletes to break record of the past and extend limits of human performance

By Jay Stuller

Sports scientists train athletes to defy old limits

By analyzing many neuromuscular functions with treadmills, test tubes and computers, researchers are learning what it takes to win

is symbolized in this painting, by Guy S. Fairlamb, of a runner who is competing in a race against himself

The skies above Olympic Stadium in Mexico City threatened a mid-afternoon rain as long jumper Bob Beamon, representing the United States in the 1968 Olympic Games, sucked deep breaths of the thin air and gazed at the takeoff board more than 100 feet away. He had fouled twice during the previous day's qualifying round, and he told himself one thing: "Don't foul. Don't foul." Accelerating down the path, he reached a speed of approximately 24 mph, hit the board perfectly and converted his speed to an upward and outward thrust, the torque and force lifting his body five and a half to six feet in the air. He kicked his legs, running in space, raised his knees to an awkward, froglike position and then stretched them forward as he hit the sand in the pit. "It felt like a regular jump," Beamon said later. But it wasn't.

According to Dr. Ernst Jokl, a neurologist and professor emeritus of physiology at the University of Kentucky, it was "a mutation performance." Other physiologists claim it took forces that could have torn the athlete's muscles and broken his bones. Beamon's jump carried him an amazing 29 feet, 2½ inches, smashing the old record by nearly two feet. Jokl calls it the greatest single feat in the recorded history of athletic competition.

Was it? Did Bob Beamon reach the limits of human athletic performance on that October day in 1968? In the past, questions like these were likely to be settled by an argument and a wager. But a new field of research into the nature of athletic performance is providing a more scientific basis for the answers. Sports and exercise scientists are measuring and testing everything from athletes' muscle twitches to their mental traits, redesigning their diets and analyzing their physical movements by computer. Although sports science cannot yet predict whether a record like Beamon's will ever be broken, the information accumulated by analyzing outstanding athletes is benefiting aspiring athletes and improving their performances at all levels of competition.

In a sense, the development of sports science is an extension of the older discipline of sports medicine, which can trace its origins to the ancient Greek Olympics. Greek physicians called "gymnasts" were involved in all aspects of an athlete's training. One of the most renowned was Herodicus who was, purportedly, the teacher of Hippocrates, the father of medicine. The American College of Sports Medicine, founded in 1955, continues this tradition with a wide range of physicians and other specialists as members (including dentists, podiatrists, osteopaths, even veterinarians).

But sports scientists are now interested in far more than the prevention and treatment of injuries. At laboratories from coast to coast, they are studying athletes' physiology, biomechanics, biochemistry, psychology, kinesiology (the science of movement)—from toe to teeth.

An underlying assumption of sports science is that by analyzing the elements of athletic prowess, it should be possible to teach athletes to perform better. But how much room for improvement is there?

For other athletes, improvement may come from understanding physical problems they could not see themselves. Dr. Gideon Ariel, who has specialized in both computer science and exercise science, is training the athlete's neurological patterns and functions as well as the traditional muscular functions by applying computer technology to sports.

The 41-year-old Ariel, a former discus thrower and member of the Israeli Olympic team, has a sports research center near Trabuca Canyon, California, and also conducts studies at CBA (Computerized Biomechanical Analysis, Inc.) in Amherst, Massachusetts. A current prize pupil is Al Oerter, the 43-year-old, four-time Olympic gold medal winner in the discus, who retired after the 1968 Games and is now making an amazing comeback. Oerter's longest Olympic throw was 212.6 feet (the current record is 233.5).

When he came to me 14 months ago," says Ariel, "we took some high-speed film of him throwing and compared his performance with those of previous years. He is slower, of course; age has slowed him down. But what we noticed was how inefficiently he had been throwing. He released the discus at the wrong angle, causing the throwing forces to be misdirected. The angle of his arm relative to his trunk was wrong for maximum leverage and his feet were leaving the ground when he needed maximum contact with the throwing circle. He was throwing only 180 feet when he came to us."

Ariel made a computer model of the Oerter film, which appears on a graphics display screen like a complex stick man. From this, Oerter could see on the screen right in front of him the elements of his throw. "Coaches can't see the subtleties of where technique is wrong," claims Ariel. "Your eyes can't 'see' forces or velocities. You have to calculate the results of numerous equations and present these graphically on the computer display to see the movements, to see what the athlete must change to optimize his actions and get the most from his force."

Using the computer and exercises to work on Oerter's neurological patterns—you train the muscles and the nerves, says Ariel—Oerter is much closer to his optimal performance. That may not be as high as some of the younger throwers, who may have a better biological advantage, but Oerter is now throwing 221.4 feet, far better than he did during his "prime."

If sports science has already begun producing better athletes, it is still a relatively unsophisticated science, and its developing techniques will undoubtedly produce even better results in the future. The use of steroids is an example.

Pill parity in the steroid race

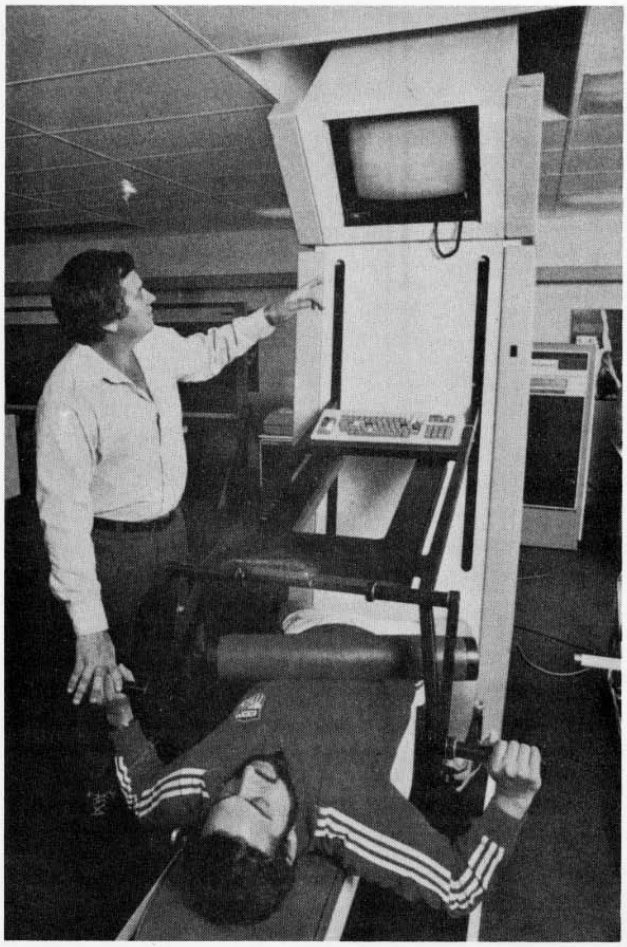
Anabolic steroids are basically androgens, or male hormones, which help build muscle bulk and strength and are favored by athletes in many events from weight lifting, the shot put and discus to, more recently, running. Although illegal by international athletic rules (testing is conducted at all major international meets and during the Olympics) and available by prescription only, many athletes take them indiscriminately, with the attitude that "if two pills (or injections) are good, ten can get them a medal."

And this has them flirting with potentially dire consequences; prolonged and overuse of steroids can lead to sterility and sexual dysfunction. In some Eastern European nations, elite young female athletes are said to be given hearty doses of the substance at key points in their careers. In the United States, athletes take steroids by choice, but the effect is quite similar to an arms race; if the Soviet throwers are getting so many steroids a day, an American must have pill parity or lose. "You can't be world-class without steroids," says one flatly. But Ariel sees sports science as only at the first stage of understanding such chemicals. "Next is looking at the chemistry of the body," he says. "And I hope it can be done naturally.

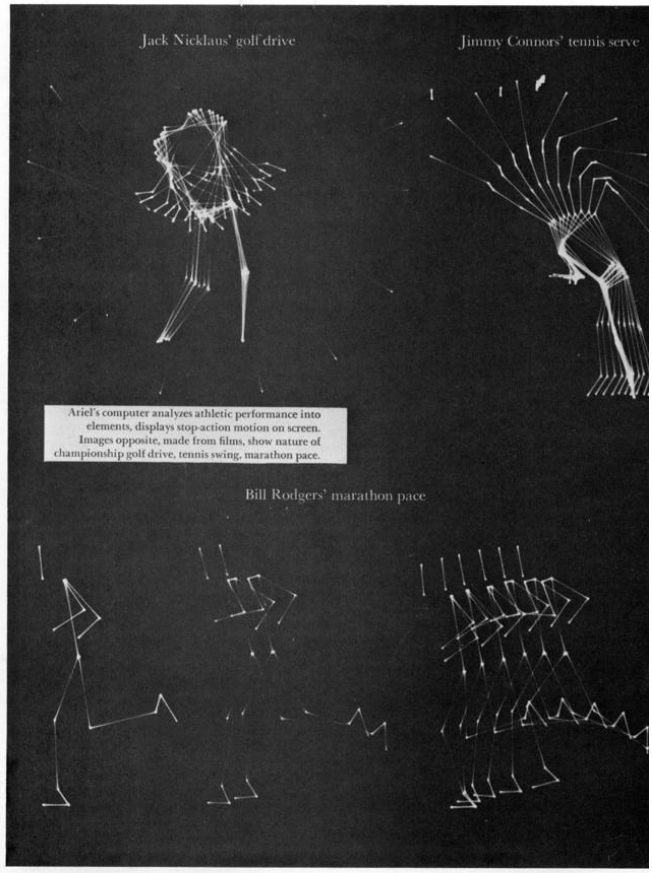
"The muscle cells store fat and carbohydrate [the latter as glycogen] which break down chemically to

restore ATP [adenosine-triphosphate], the body's immediate source of energy for muscle contraction. You only have so much ATP in your body and in a sprint, for instance, you burn it up. A 100-meter man can exhaust his supply, accelerating all the way. But a 400-meter man must pace himself or he will exhaust his supply too early in the race and slow down."

Ariel feels that there may be a nutritional way to stimulate ATP production naturally, to give an athlete more to work with. "Then there is no reason a sprinter can't go all out in a longer race."



Dr. Ariel gives colleague a workout on computerized exercise device that provides readouts of performance.



Ariel's computer analyzes athletic performance into elements, displays stop-action motion on screen. Images opposite, made from films, show nature of championship golf drive, tennis swing, marathon pace.