Sparking *the* brain

Research suggests that 'go-go' exercise improves fitness and academic performance

BY CHARLES EUCHNER | PHOTOS BY MICHAEL MANNING

Music from a homemade CD blares from a crackling sound system at the Millis Middle School in the town of the same name. Twenty eighth-graders stream into the gym and pick up heart monitors lying in a straight line on a desk. The students wrap the long black plastic bands around their chests, slip on wristbands that record the heart signals sent from the bands, and start to move.

Some stretch their legs. Some shoot baskets. Some run laps. After a while they start playing "ultimate ball," a fast-paced game where teams of three kids run up and down the gym floor throwing the ball to each other. Players get the ball, run, and throw. They constantly change direction and sometimes bump into each other. With such urgency to get rid of the ball, no one kid dominates the floor, and no one gets left out of the action.

The one constant in all this activity is nonstop motion. For a visual image, think of the hyper Jim Carrey in the movie *Mask*, multiplied by 20. The goal is to keep students in "the zone"—with their hearts beating at peak rates of at least 175 beats a minute—for 20 or 30 minutes. At the end of the class, students check the data from their heart monitors. In this March class, all but two of the students played in the zone for at least 20 minutes.

Fitness experts have long celebrated the effects of aerobic activity on the body, such as weight loss, increased oxygen supply, lower cholesterol levels, better efficiency in the nervous system, and better lung

Danielle Pellegrine races downfield in a game of "ultimate ball." Chasing her, on right, is fellow Millis Middle School student Alex Golash.

Physical education instructor Scott Kendrick, center, created his own fitness program for Millis Middle School.

and heart capacity. Now Harvard Medical School psychiatrist John Ratey says another benefit can be added to this list: dramatic gains in learning capacity.

Ratey has been traveling around the country promoting a new model of physical education with born-again zeal. In February, he published a provocative new book, *Spark: The Revolutionary New Science of Exercise and the Brain*, that details the growing evidence that exercise gives the brain greater capacity to learn.

"The brain is really no different than any other part of the body, like muscles," says the 60-year-old Ratey, a lifelong athlete who was a high school tennis star growing up in Beaver, Pennsylvania, and began running marathons when he moved to Boston in the 1970s. "We used to think

that once the brain developed, it was set. But that's not true. It's a very dynamic thing. You can shape the brain, make it better. And exercise is one way to do it."

From the pre-teen years to early adulthood, Ratey says, we develop twice as many branches in our brain cells than at any other time, a process that scientists call "exuberance." This cranial festival makes the brain more "plastic," or capable of change, than at any other time after infancy. Not only does the brain's gray matter bloom, but a process called mylenation fosters connections between the right and left hemispheres.

Exercise offers an ideal way to excite the brain, Ratey says. During periods of high-intensity exercise, chemical messengers move more freely among the brain's 100 billion neurons. With exercise, the neurons' dendrites (the antennae that send and receive signals) and synapses (the molecule-rich points of connection between neurons) become more vital, improving their capacity to give and receive messages.

Studies show that learning is greatest in the two or three hours after strenuous exercise, when the physical activity makes the brain more "plastic." Ratey says some kids can keep their learning edge for a whole day, but he suggests two-a-day workouts, once before school and once to fight early-afternoon blahs. The exercise primes the brain for learning; after physical activity it takes in more ideas and retains them longer.

"It's incredible to see all the kids able to do this," Ratey says as he watches the Millis students jump rope. Some of the students whip the rope around in a crisscross like Rocky training for his fight with Apollo Creed. "This is hard work. It's good for the cerebellum. You really give the brain a workout."

A FALLOFF IN PHYSICAL EDUCATION

The spectacle of kids exercising with such frenzy and joy (every kid on the floor in Millis wore a smile) is a rarity in public schools these days. Statewide, and across the nation, fitness programs have suffered deep losses since the 1990s. Like art and music, fitness is considered a frill—nice to have, but not essential for kids getting ready to compete in a global economy.

Massachusetts mandates physical education for all grades, but it does not have any specific requirements for the number or kinds of classes. Theoretically, a school can provide one day of physical education a week and comply with state standards.

As late as 1996, the state required all children to get at least 90 minutes of exercise every week, and 80 percent of all Massachusetts kids took a physical education class at least once a week. Now the state has no minimum exercise requirement, and only 58 percent of Massachusetts kids take a physical education class at least once a week. Anecdotal evidence suggests that gym classes have been hit hardest in poor school districts, which often lack adequate facilities and have cut back on faculty.

The Massachusetts chapter of the American Association for Health, Physical Education, Recreation, and Dance recommends at least 150 minutes a week of physical education for elementary school children and 225 minutes a week for upper-school children.

Nationally, the share of students participating in daily physical education classes declined from 42 percent to 28 percent between 1991 and 2003, according to *The Shape of the Nation*, a 2006 report from the National Association for Sport and Physical Education. American Association of Health, Physical Education, Recreation, and Dance. At the time of the report, only two states, New York and Illinois, mandated specific time for physical education. Only 5 percent of schools required PE classes in the 12th grade, compared with 50 percent in grades one through five and 25 percent in grade eight. Only 8 percent of elementary schools and 6 percent of high schools provided daily PE for all grades.

Learning potential may be at its peak a few hours after strenuous exercise, when the brain is more 'plastic.'

The falloff in physical education requirements has coincided with a bulge in childhood obesity and sedentary lifestyles. *The Shape of the Nation* reported that the percentage of young people who were overweight had tripled since 1980. Sixteen percent of children aged 6 to 19 were overweight, and 60 percent of children aged 6 to 10 faced some risk of cardiovascular disease, such as high blood pressure or excessive levels of cholesterol. One-quarter of the children in this age group had two or more risk factors.

LIKE 'MIRACLE GRO' FOR THE BRAIN

Naperville, a Chicago suburb, is ground zero for the revolution in fitness-based learning. Physical education classes in Naperville once focused on skills and strength, which frustrated the vast majority of students who simply needed to get fit. The district's innovators wanted to change the dynamic of physical education, so they invented high-speed games and tried to make socializing an important value. A square-dancing class, for example, not

John Ratey, Harvard Medical School psychiatrist and author of *Spark: The Revolutionary New Science of Exercise and the Brain*

only gets kids moving but also gets them talking. Heathers have to chat up nerds; jocks chat up brains.

Students gather at school for "Zero Hour PE" every morning at 7:10. After strapping on heart monitors, they run a mile around the outdoor track, hitting a red button that gives them times for every lap. The instant feedback gives the kids a time to beat next time around the track. The fitness routines take place before school starts so that kids are ready to learn.

The effort has paid off. In the district of 16,000 students, only 3 percent are overweight, while nationwide 30 percent of school-age children are overweight and another 30 percent are "on the cusp." Craig Broeder, a researcher at nearby Benedictine University, dismisses claims that Naperville students are more fit because their parents are generally affluent and well-educated. "The numbers are too high for it to just be that," he says. "Let me put it this way. You can't say for sure that the PE program does it, but their fitness is so far off the scale that it can't be just because it's *Naperville*."

The Chicago suburb of Naperville transformed phys ed by focusing on speed and fitness rather than strength.

A fitness-learning link may also be emerging, according to research conducted by Ratey. Students at Naperville Central High School (where annual per-pupil spending was $8,939 in 2005) outperformed the students of New Trier High School in Evanston (with per-pupil spending of $15,403) on the state's mandatory tests. On the Trends in International Mathematics and Science Study, a rigorous test that matches selected American schools with its toughest global competitors, Naperville's eighth-graders finished first in the world in science and sixth in the world on math, according to Ratey. "Obviously there are a lot of factors," he says. "But exercise is definitely one of them."

Dozens of studies have found that when subjects are placed in physically demanding environments, they develop their brains more quickly. A landmark 1995 study by Carl Cotman found that exercise strengthens not only the cerebellum and other motion-oriented parts of the brain, but also the hippocampus, which is essential for learning. A 2005 study of nearly 900,000 students in California found strong correlation between fitness standards and scores on the SAT and other standardized tests, and a 2007 German study indicated that people learn vocabulary words 20 percent faster after exercise. Another 2007 study found that one 30-minute session on a treadmill increases information processing and cognitive flexibility.

Research suggests that people today burn 62 percent less energy, per unit of body mass, than our Paleolithic ancestors. So how much exercise should we be getting? Ratey suggests a simple formula: Multiply body weight by eight for the total number of calories to burn in a week. A 150-pound boy, for example, would need to burn 1,200 calories a week—say, by exercising six times weekly and burning 200 calories with each workout.

High-impact exercise, Ratey says, fertilizes the brain "like Miracle Gro." The lusher the brain's landscape, the greater the opportunity to reshape the brain every day. Exercise, he says, strengthens virtually every section of the brain, including those devoted to memory and problem-solving.

(Ratey also says he has weaned patients of all ages off medication by putting them on high-intensity exercise regimens. Prescriptions for Prozac, Ritalin, and Zoloft, he acknowledges, can help patients with depression or attention deficit disorder, but he says they do not work on the whole brain or the whole person. Exercise reshapes the brain's whole landscape, Ratey says, without debilitating side effects.)

He practices what he preaches. Watching TV at night, he runs outside to jump rope during commercials. He says he likes what it *feels like* to play. "Play is something worthwhile in itself," he says. "But it's also social skills training, it's trying things out and learning how to get along."

Since reports of Naperville's success have circulated, other districts have gotten into the act. Titusville, a declining industrial town in western Pennsylvania with a median income of $25,000 and 75 percent of its kindergarteners on the school-lunch program, started a new fitness program in 2000. Since then, scores on standardized tests have risen from below the state average to 17 percent above on reading and 18 percent above in math. Titusville officials also claim that the junior high school has not had a single fistfight since 2000.

Ratey has been working with schools in San Diego, Charleston, and Chicago, and at a recent wellness conference in Boston, he pushed for the Boston public schools to be next. Meanwhile, a Kansas City–based organization called PE4Life has taken up the challenge of training teachers, collecting information on best practices, and helping districts develop new programs. (PE4Life provided materials for the fitness programs in Millis and Natick.) And now parents and school administrators are calling Ratey to ask permission to start "spark clubs" so kids can play high-speed games to keep in shape. He claims no control of the word "spark," despite his book's title.

"I say, 'Go ahead,'" Ratey laughs. "Why not have as

many of these clubs form as possible? That's how change is going to happen."

FORGING BETTER CONNECTIONS

Scott Kendrick discovered the body-brain connection while taking distance courses with Ratey as a master's student at Bridgewater State College. The former National Guardsman has read *Spark* and carries a binder full of academic journal articles on the body-brain connection. When he took the Millis job in the summer of 2006, he had only weeks to prepare for the fall, but he visited the schools in Naperville and came away impressed.

A three-year $150,000 grant from the Metro West Community Health Care Foundation allowed Kendrick to create his own fitness program. The school's principal carved out one period a day for seventh and eighth graders, and Kendrick gets the kids every day for one semester. (During the other semester, the time is used for MCAS prep classes.) "I wish I had them for 180 days, not just 90," Kendrick says.

> The irregular movements of 'ultimate ball'—like those in ballet, skating, and karate—engage many parts of the brain.

During one of Kendrick's classes, the students play "ultimate ball." Because the game moves so fast, the kids have to be alert at all times. Their eyes are wide open, like Little Orphan Annie, and they move with sudden stops and starts. The irregular movements—like those in dancing, ballet, gymnastics, figure skating, Pilates, and karate—engage many parts of the brain and force them to work harder, says Ratey. That leads to better connections among the brain's 100 billion neurons, he adds.

When the kids aren't playing go-go games, they learn about nutrition and other health issues. Students calculate the fat content of fast food. They watch as their teacher spoons out globs of fat from a can of Crisco, just to show how disgusting fat buildup can be. To show what's in a can of Coke, the teacher pours tablespoon after tablespoon of granulated sugar into a glass.

The 29-year-old Kendrick stresses fun. He tries to get kids to be in the zone for as much as possible of their 30-minute games. He cheers when students tell him that their heart rates have reached 175, 180, or even 190 beats a minute. "Good going," he tells a student who reports a heart rate of 190 and peak rates for 23 of the game's 32 minutes.

"The heart-rate data and the weight issue [are] secondary," Kendrick says. "I would never ever, ever, *ever* mention their weight or even heart rate unless they asked about it. I could be really brutal with an exercise routine. But when the kids have a great time, they're more likely over the long time to be healthy. The weight issue is so sensitive. They're so self-conscious. Once you focus on things like that, it makes them obsess. If they're having fun and feel great about themselves, they'll do it and keep doing it."

The emphasis on fun helped seventh-grade student Vanessa Pourier thrive during the roughest period in her young life. Vanessa's parents worried that family tensions—the breakup of their marriage, her mother's struggle to get back on the job market, her older brother's battle with depression, and Vanessa's ongoing problems with being overweight—would sabotage Vanessa's school work and social life.

But despite the family problems, her grades and spirit actually improved after she started participating in the Millis exercise program. She also lost weight and started feeling better about herself. When she came home from school, she sought out her mother to chat about fitness and nutrition. "We never talked about any classes like this before," Janine says. "Something was happening. It was an emotional relief and gave her hope that maybe [by] getting in shape, with the right tools, she could achieve her goals."

Another Millis mother, Shefali Desai, also noticed changes in her child's health and learning after taking the fitness class. Karishma, also a seventh grader, lost more than 10 pounds and became more energetic and alert throughout the day. "She manages her time much better, and she's less distracted," says her mother. "She is more enthusiastic about all subjects. If she sees an A-minus now, she wants better. She's paying more attention."

Other parents and teachers tell similar stories—of kids losing weight, embracing exercise for the first time, improving their scores on tests, arriving in class ready to learn. But with the Metro West grant expiring after the 2008-09 school year, who knows whether the program will become a permanent part of the school's offerings? The program is easy to set up—all the district needs is a teacher who cares about go-go exercise and a time slot for students to meet—but the traditional gym class is the only program guaranteed to continue.

Kendrick, who hopes to stay and earn tenure after the 2008-09 school year, is philosophical. "It's all pretty simple, you know?" says Kendrick. "You just have to do it." CW

Charles Euchner, a New Haven writer, was the executive director of the Rappaport Institute for Greater Boston at Harvard University from 2000 to 2004.