

SMART High Intensity Cognitive Training

By Multisensory Fitness Inc.

The Science Behind SMARTfit's Gamified
Approach to Sports Performance Training



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Table of Contents

The Science Behind SMARTfit's Gamified Approach to	3
Sports Performance Training.....	3
Introduction	3
SMARTFit - Multisensory Conditioning for Mind and Body: How it Works	5
SMARTfit's Brain/Body Integrated Training Stimulates the Re-wiring Process.....	5
Opening the Doors to Participation in Sports for youth who would not otherwise be interested	8
SMARTfit Training for Performance Athletes	9
Brain Speed: Delivering the Edge in High Performance	10
SMARTfit's Balanced Programming: Key to Performance & Adherence	12
Summarizing SMARTfit	12
References.....	13
.....	14



"If people will take a good look at the *SMART ProTrainer* they'll see the wave of the future. *It* absolutely correlates perfectly with what you are trying to do in match play and that's very important for high performance training. With the *ProTrainer* players are getting cardiovascular fitness, cognitive based sports training and they're having fun at the same time! Believe me when I say you've never experienced anything like this before. The *ProTrainer* is truly a blast!"

Billie Jean King, Winner of 20 Wimbledon Titles

SMARTfit High Intensity Cognitive Training

The Science Behind SMARTfit's Gamified Approach to Sports Performance Training

University Researchers Rated SMART #1 in User Enjoyment and Energy Expenditure¹

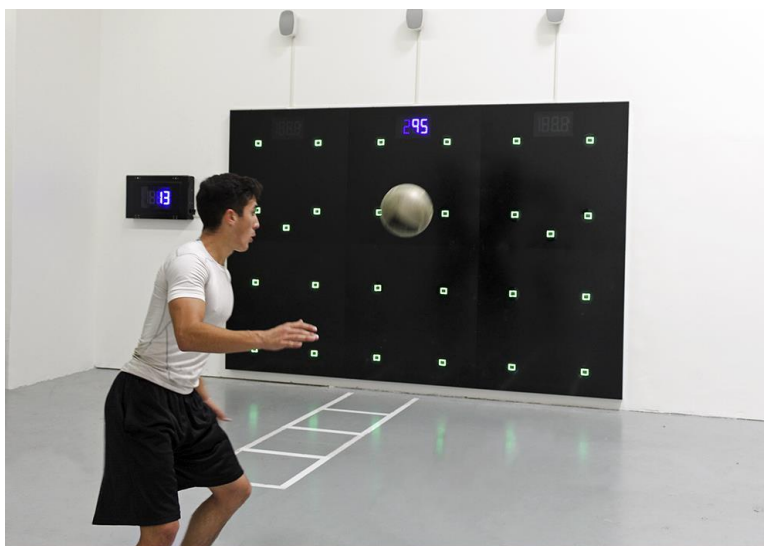
Introduction

Multisensory Fitness Inc. founder, Cathi Lamberti, first realized the potential benefits of using technology to motivate people and improve their physical and neurological performance while observing the talents of video game players on Santa Monica Pier in 1993. Watching one player, she first dismissed the activity as a waste of time and money. She soon became aware, however, that there was something special happening, a remarkable convergence of hand-eye coordination and brain speed combined with the fun and challenge of the striving to improve and attain the best score.

A tennis backboard manufacturer and former teacher, she also realized the limits of what she was seeing. If she could find a way to use similar interactive technology in a real and functional, rather than virtual, play environment with full body physical activity combined with neurological and cognitive processing to achieve success, participants could see improvements in much more than just hand-eye coordination. In fact, she could see a way to implement the Nobel Prize winning Hebbian Theory "Neurons that Fire Together Wire Together" delivered with a concurrent cardio-vascular exercise.

She knew how our multiple senses affected performance in everything we do, from basic everyday functions to high level sports performance. Our senses give us information about the physical conditions of our body and the environment around us. Sensations flow into the brain like streams flowing into a lake. Countless bits of sensory information enter our brain at every moment, not only from our eyes and ears, but also from every place in our bodies. We even have a special sense called proprioception that detects the pull of gravity and the movements of our body in relation to the earth and things around us.

She began to develop applications that would offer fitness training with an emphasis on neuro-cognitive integration for a wide variety of applications especially for the most at-risk populations.



The result of this epiphany was the original Sportwall, which became one of the most unique, most highly rated and best selling products in a developing new industry that came to be known as exergames.

Today, brain research has evolved substantially, and Lamberti's early conclusions about the relationship between physical activity, neuro-cognitive training have been confirmed. The concept of neuroplasticity, the brain's ability to change and adapt, even rewire itself, is now accepted science.

Science is also discovering that while all physical activity has a positive effect on the brain (“miracle grow for the brain”), exercise that combines the use of multiple senses with full body movement, including impact and resistance based activities, challenges the brain at higher levels, requiring more complex cognitive function to make decisions and execute skills. The brain adapts, improving physical, sensory and neurological performance.

Interactive technology further enables this process in ways that traditional fitness can't, simultaneously prompting and providing feedback to participants' physical and cognitive actions, tracking results and setting benchmarks for improvement.

In 2014 the company released its new SMARTfit technology in 6 product lines which draw on the latest in brain research, exercise science and sports science, then combines this information with cutting edge interactive technology to create the next generation of neuro-cognitive training solutions. This white paper explores the research and science behind SMARTfit as it relates specifically to boomers and active agers.

Instead of simulating play, SMARTfit systems engage players in a real multisensory kinesthetic experience including dynamic, integrated, multi-planar athletic movement with tactile contact and resistance using real sporting, playground, or PE equipment. The result is a powerful combination of cardio fitness, brain fitness, functional fitness, sports specific training and action-based learning in one system.



Success with SMARTfit systems is measured by the ability of participants to keep the game in play as a result of real physical and mental responses rather than emulated movement such as waving a wand as called for in many exergaming products that have incorporated some physical movement with video game play. The original concept behind the creation of SMARTfit technology was to create fun, short, full-brain-body games that engage cognitive decision making, motor control, and reaction skills with results measured via electronically generated scores and rewarding sounds.

This concept has evolved into a wide range of applications from sports performance training at all levels to highly engaging, brain integrated, physical and occupational therapy, physical exercise classes for school PE and after-school programs, boomers and active agers, and children with special needs. This enormous flexibility is one of the most unique aspects to SMARTfit programming. Coaches and Instructors are free to choose from a wide array of drills/curriculum/lesson plans.

Engaging the brain and body in a comprehensive multisensory experience requires a close look at SMARTfit programming. The following sections review its impact on learning, fitness, motor skills, obesity, mood, social interaction, team building, and brain plasticity (aka neuroplasticity) through feedback with existing users.

SMARTfit - Multisensory Conditioning for Mind and Body: How it Works

When it comes to localizing and tracking moving objects, it is likely that the human brain evolved to develop, learn, and operate optimally in multisensory environments.² Thus, multisensory training protocols can better approximate natural settings and are more effective for learning.²

SMARTfit programs are multisensory training for all ages and ability levels. Visual, auditory, and physical tasks are integrated in performing the motor skills required. These protocols, with their profound and SIMULTANEOUS brain/body stimulation, are the key element that differentiates a functional training program from a general conditioning program.



This unique form of exercise stimulates greater input to the proprioceptors of the motor system, and with it, greater subsequent refinement of movement patterns. The resistance and motor patterns encountered by the use of real sports equipment creates more dynamic neuromuscular control in a functional setting of play.

SMARTfit programs are specifically designed to stimulate the body and the brain concurrently. This is accomplished by:

- Encouraging team participation and engaging sustained focus with short-attention grabbing computer games that are played sequentially to pursue mastery of skills and score
- Providing full body exercise by stimulating the hands, feet, eyes, ears, and vestibular system (stimulating the proprioceptive input to the motor and vestibular systems) in playing real games with real sporting goods (not simulated)
- Requiring high levels of attention and focus for success (staying consciously “in-the-now”)
- Engaging in cognitive decision-making under pressure
- Delivering a cardiovascular workout in a game format

“Functional Training” is used by physical therapists as a comprehensive form of rehabilitation to return patients to daily living activities as well as competitive sports by using movement in multiple planes while bearing weight. In contrast, “Strength Training” might use a weight machine, bands, or free weights and usually focuses on uni-planar, one joint motion to build muscular strength.

SMARTfit’s brand of functional training uses a variety of activities that can focus on the core/torso, agility, speed, balance, flexibility, power, and strength while SIMULTANEOUSLY developing high levels of neuromuscular efficiency. This process of engaging the hands, feet, ears and eyes develops not only eye-hand, but also visual-perceptual motor skills.

SMARTfit’s Brain/Body Integrated Training Stimulates the Re-wiring Process

According to neurologist Dr. Carla Hannaford in her book *Smart Moves*,

Research indicates that when both eyes, both ears, and both feet are being equally used, the corpus callosum (responsible for whole brain processing) orchestrating these processes between

the right and left hemisphere becomes more fully developed – cognitive function is heightened and ease of learning increases.⁵

SMARTfit training provides this level of stimulation and enables individuals to merge the mental and the physical while continually encouraging higher levels of accomplishment, which in turn pushes demands on the neurological system to rewire itself more efficiently. Regular use will literally improve the level at which the mind and body function competently together.

How?

In a Q & A session on Facebook, movement specialist M.A. Greenstein, Ph.D., wrote that exercise is “important for generating blood and oxygen flow. This results in neurotransmitter release (which) has been shown to boost strength of synaptic bonding, stimulating glial cell activity for information flow.” The faster the mind works, the more time seems to slow down, leaving more time to apply to conscious decision making as opposed to constant thoughtless reaction to stimuli. That is what athletes refer to as being in the “zone” or what sports psychologists call the “flow.”

SMARTfit programs accomplish this by encouraging right and left brain intelligence and balance. They coax the player to perform movements that develop the corpus callosum, the super highway of connective motor and sensory axons that connects the two hemispheres of the brain.

Dr. Greenstein writes, “There is an important correlation between the use of spatial intelligence and long term memory. Movement and cardiovascular exercise can help to grow the area of our brain that creates new memories: the hippocampus.” She notes the work of Harvard psychiatrist, John Ratey, who says that 20-30 minutes of cardiovascular exercise enables more “fruitful synaptic bonding.”⁶

In fact, movement is essential to the development of all four lobes of the brain. As activity in all lobes of both hemispheres increase with movement, more dendritic connections form, myelination increases, and those dendritic connections extend across the corpus callosum.

The better the connection between hemispheres, the more intelligently we are able to function. Maximum proficiency at critical thought, or skilled movement, requires peak activity of both hemispheres. SMARTfit activity helps to promote this type of whole brain thinking.

Brain Plasticity – SMARTfit is Cognitive Candy for Athletes

In his groundbreaking book, *Brain Longevity*,⁴ Dr. Dharma Singh Khalsa, M.D., reports, “several researchers revealed stunning evidence that powerfully supports the efficacy of exercise in achieving and maintaining optimal mental function in people of all ages”.⁴ He also reports that exercise, when it is combined with thinking, is most valuable because it grows the largest number of dendritic connections.

Increasing evidence suggests that the brain operates in many ways like a muscle – atrophying from disuse and increasing capacity with active use, even late in life. This is the “use it or lose it” adage espoused by Dr. Joseph Jankovic, professor of neurology and director of the Baylor College of Medicine Movement Disorders Clinic in Houston.⁵



The brain thrives on stimulation. Unlike other organs that wear out after a certain number of years the brain becomes sharper the more it is used. Physical exercise can increase cognitive capacity just by driving blood and oxygen to the brain.

Strong evidence suggests that exercise stimulates production of neurotrophic factors (also called brain-derived neurotrophic factor or BDNF), which helps repair brain cells, prevent cognitive decline improve learning and promote mental as well as motor performance.⁴ It may slow the onset of degenerative brain diseases like Parkinson's syndrome.⁴

Harvard psychiatrist John Ratey, refers to BDNF as "Miracle-Gro for the brain."⁶ He calls BDNF "a crucial biological link between thought, emotions, and movement." So how do you get more BDNF?

Daily aerobic exercise is best but including intervals of sprints are even better. In a recent German study volunteers who did two 3-minute sprints separated by 2 minutes of lower intensity during the course of a forty-minute treadmill session demonstrated higher increases in BDNF than non-sprinters. Not only that, the sprinters learned vocabulary words 20 percent faster than non-sprinting exercisers. It seems even a small amount of high-intensity exertion can have a profound effect on the brain.⁷

When the brain is engaged by having to make decisions under pressure while playing interactive ball sports, the benefits are enhanced significantly because gross motor skills must be incorporated. Neurons develop only when the player is confronted with a demand for greater efficiency (skill development). As far as the brain is concerned, if you need a skill, you develop it only when you are confronted with the need, and then practice performing it.

The SMART makes training more fun while taking the brain-body connection to a level beyond typical sports in that the games are short, specific, more intense, and tuned to the appropriate level of difficulty until the player is ready for the next. Motivation to play for long periods occurs as a new score is established every few minutes.

Unlike other computer simulated games where a player holds a device and pretends to play by waving it around, the SMART systems engage the whole body in a real-play game with real sporting goods where the hands, feet, eyes, ears, and vestibular system are all involved in the activity. This produces a computer-generated score, which measures actual athleticism, cardiovascular fitness, and intellectual agility.

The value of the computer-generated games is that successive demands at each level of difficulty are randomly produced. This requires the player to stay "in-the-now", ignoring any internal or external



distractions, in order to prepare for the next challenge. Profound focus on the present allows the SMARTfit programming to target development of all five core brain areas:

- Memory (Short Term/Long Term)
- Speed, Accuracy, Reaction Time
- Attention/Focus
- Problem Solving
- Cognitive Agility

Opening the Doors to Participation in Sports for youth who would not otherwise be interested

“Many schools, gyms, community centers, and hospitals include (SMARTfit’s) digital target games that challenge players on speed and motor skills as they throw a ball allowing for sports simulation games that allow users to feel like they’re playing games such as soccer, tennis or baseball.”⁸

SMARTfit is a perfect match for any participant. It is an opponent that never misses and always plays the ball back at the speed and direction established by the player. Changes in feedback and response are instant. Since most systems are installed in a fairly confined space, the required skills to maintain play develop rapidly. The temptation to drive up scores and continue play is irresistible and invisibly pushes levels in player strategy, focus, power, precision, balance, and footwork. This is exactly what all sports demand.

Beyond enhancing these natural skills, the system promotes an intrinsic human need, which we would describe as a love for movement. Body and brain find new confidence, which in turn fosters a strong desire to pursue life-long physical activity, a desire that may not have happened otherwise.

On the playground, self-esteem frequently hangs on a child’s ability to throw and catch a ball. This is a primitive measure of social acceptance among children in terms of who is chosen and who is not as teams



are chosen. We continually observe children previously marginalized to the sidelines being integrated back into playground activity just weeks after SMARTfit practice because the system provides a more protected, unthreatening environment for learning the basic skills needed for sports. For this purpose, the versatility of the system is essential.

“The number of games and activities that might be used is endless,” Health and Physical Education Supervisor Eileen Dibattista told Medford High School.⁹ “The wall is designed to stimulate the body and the brain simultaneously.”⁹ The set-up allows for individual activities or team activities when students might compete to attain the highest scores, and both traditional game skills and total body conditioning can be accomplished.

“With childhood obesity being the epidemic that it is, I think it is great that this is available for our kids,” said Medford High School Committee member and coach George Scarpelli. As for the specific physical benefits of the ProTrainer, Dibattista said, “The functional training program of the SMART ProTrainer provides a mind and body connection. This is unlike a traditional conditioning program, which focuses on isolated muscle groups.”⁹

Some of the athletic benefits Dibattista credits to the ProTrainer include throwing accuracy through a series of targets, increased arm strength, improved speed, agility, and passing techniques. Body balance, stability, core strength, and coordination can be improved as well by adding other elements, such as agility ladders.

Dibattista summarized her impressions by saying, “It is exciting to provide our students with this additional opportunity. The ProTrainer enhances our physical education classes by providing a modern and improved delivery model. Technology is what students expect in today’s world.”⁹

SMARTfit Training for Performance Athletes

In today’s competitive sports environments, athletes are continuously seeking ways to improve performance and ultimately gain an edge over the competition. SMARTfit programming helps skilled athletes push their limits *and* cross train.

The versatility of the SMARTfit gaming system allows for the integration of sport specific and cross-training activities in one comprehensive product. SMARTfit programming not only supplies ideal off-season physical challenges but also a break from the monotony of sport-specific training. The advantage is that athletes need not train away from their chosen sport to improve the athletic characteristics they require nor be concerned that seasonal facilities may not be available.

With SMARTfit training, even elite athletes can find not only the challenges to strength, power, and endurance that they need, but also the general athleticism required by their sport. In addition, application of speed, agility, strategy, and technique under pressure are also found with SMARTfit training.

SMARTfit is the first training system to fully utilize technology to improve conditioning in athletes of all ages and abilities *while at the same time* improving their decision-making under pressure.

Because the SMARTfit ProTrainer ramps up its demands in a systematic fashion, it is appropriate for athletes of all abilities and levels of competition. The system challenges professional athletes as far as they are willing to be pushed, yet is equally accessible to amateurs and beginners. The level of the athlete will determine which training is initiated as well as its specific progression.

SMARTfit has the ability to quantify/score the success of individual movements. The athlete or coach receives accurate assessment and can track progress. To an accomplished athlete, an improvement of only one percent can represent a huge competitive gain, but that gain is correspondingly difficult. Accurate scoring/feedback become extremely important when the athlete is digging deep for effort, endurance and accuracy, and the highest levels of motivation are required. SMARTfit meets these needs.

Athletic improvement can be accomplished in a systematic and highly engaging format, resulting in the highest level of sports specific endurance.

Athletic Training—SMARTfit ProTrainer can be utilized to improve:

- First step (reaction) quickness
- Reaction time
- Dynamic balance and postural stability
- Plyometric adaptation in sports specific movements
- Explosive change of direction
- Kinetic chain linking and complex movement patterns

Brain Speed: Delivering the Edge in High Performance

Elite athletes are superior in three main areas: strength, skill, and speed. Strength training should be general and focus on maximizing cardiovascular and muscular capability. Skill training is functionally specific; practice makes perfect only if one practices perfectly.

Speed is what truly separates the elite athlete from the good athlete -- not sprint speed, but rather *information processing speed*, also called reaction speed, or the recognition of stimulus and the ability to react quickly and efficiently to that stimulus. Efficiency also depends on peripheral awareness and



visual memory. It is recognition of patterns, memory, and mental preparation combined with the ability to apply strategy and technique under pressure.

For years, coaches have searched for the “ultimate tool” for speed development. Physical speed is the manifestation of what goes on in the athlete’s mind before he reacts. Mind speed is the essence of greatness. According to neurologist Dr. Carla Hannaford,

Research indicates that when both eyes, both ears, and both feet are being equally used, the corpus callosum (responsible for whole brain processing) orchestrating these processes between the right and left hemisphere becomes more fully developed – cognitive function is heightened and ease of learning increases.¹⁰

SMARTfit training enables athletes to merge the mental and the physical. It continually pushes the athlete to higher levels of intensity, which in turn pushes performance by the neurological system. Regular use will literally improve the speed at which the mind functions.

How?

In a Q & A session on Facebook, movement specialist Dr. M.A. Greenstein, wrote that exercise is “important for generating blood and oxygen flow. This results in neurotransmitter release which has been shown to boost strength of synaptic bonding, stimulating glial cell activity for information flow.”¹¹ In other words, the faster an athlete’s mind works, the slower the game appears, leaving more time to apply strategy and technique. That is what is meant by being in the “zone” or what sports psychologists call the “flow.”



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The better the connection between hemispheres, the more intelligently we are able to function. Maximum proficiency at critical thought, or skilled movement, requires peak activity of both hemispheres. This is how SMARTfit activity promotes whole brain thinking.

SMARTfit’s Balanced Programming: Key to Performance & Adherence

While even mild exercise will have a positive effect on our neurochemicals, exact effects vary with the severity of exertion. While exercise at very high intensity and long duration can cause adrenalin levels to become elevated while serotonin levels drop. However, serotonin production can increase with very demanding exercise as long as the body is not over stressed.

To that end, SMART’s interval training regimen (Intensity balanced with recovery during a thirty to sixty minute workout, or “short-burst-short-rest”), when delivered to groups, is an excellent way to achieve the balance needed to optimize results without over-producing adrenaline or under-producing serotonin. This may explain why schools that have adopted the SMARTfit programs are noticing a significant reduction in aggression and out-of-school suspensions.⁹

Interval training is now well documented to hold the key to maximizing performance. The body must rest (also called compensation) following a period of activity in order to replenish its biochemical sources of energy. Too much stress without recovery increases risk of injury and burnout. Too much rest without stress will lead to atrophy and weakness. Balancing stress and recovery is essential to increasing performance and adherence. All SMARTfit training programs utilize this method of training, which is a key to its superior adherence and performance results.

Summarizing SMARTfit

While it may be thought that many of the components discussed in this document may be fulfilled with other programs, SMART excels in the following areas:

The programming is extremely diverse. It can be tailored to all athletes regardless of sport or level of expertise.

The programming does not discriminate with regard to skill level as it meets players at their own abilities. Each player will find it easy to prepare the system for his or her level.

Third, and most importantly, these are programs which have mainstream appeal. They break through the social barriers and gender stigma found in regular sports. They even engage the traditionally inactive.

The “Energy Cost of Exergaming” study described shows that SMARTfit’s programs can provide appropriate levels of exercise, and more importantly the LEVEL of appeal required, for children who traditionally do not want to exercise or are repelled by competitive sports.

Because the structure of the programming involves multiple short games played in teams, there are no permanent winners. Instead, the chance for everyone to succeed is repeated every couple of minutes, which incentivizes continual play. Often, trainers have to “pull the plug” to end play.

Since groups can play together or one team can play against another, a high level of camaraderie is quickly built. The combination of rapid skill development along with social connection leaves players inspired with a sense of belonging after each class ends.

The net result is that SMARTfit provides players with all the essential skills required to learn a sport thus opening the doors to sports participation to a significant percentage of the population that would be lost.

Installation convenience: Since the programming is so diverse, facilities have preferred to install the systems in general purpose rooms where everyone can have access to them, rather than dedicating them to a room for a particular group. An added advantage is that when not in use the systems take up only 4” of depth on a wall, which also helps alleviate the need for a dedicated room or outdoor/indoor court.

Instructional growth: When instructors fully engage with the wide range of programming available, they begin to create their own routines and programs. This is when a level of excitement ignites and true believers are born as they discover the limitless possibilities of SMARTfit programming. Passive supervisors often become inspired physical educators.

We have developed a wide variety of program manuals designed to get instructors started in their own field of interest, whether for sports training, Special Education and Adapted PE, , group exercise classes, or personal training sessions. Using our drills initially provides a feel for how the process and results come together.

Finally, Score Tracking: An effective way to ensure sustained use is to incorporate score tracking and team competitions. This can be done in two ways: by using the score tracking charts or by encouraging players to post their scores on a social networking site (such as Facebook) along with a video clip of the play to validate the authenticity of the score.

Facilities can either dedicate their own page to tracking scores or they can use the company’s official score tracking site. Some facilities also hold competition days where teams challenge each other for the high score of the day in a particular game. Since games average sixty seconds, it is easy to get a lot of action happening quickly.

In our experience new ideas quickly emerge as instructors find themselves easily adapting drills to achieve their desired results. We encourage instructors to share ideas on our blog, <http://www.multisensoryfitness.com/blog/> This way, resources available to both new and experienced users will grow continually.

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Evidence in this document has been gathered from scientific research, interviews with medical and science professionals, as well as experienced observations by seasoned trainers who have worked with the SMARTfit products and programs in their facilities during the past seven years.

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