

SMARTfit Functional and Brain Fitness Training Games

The Science Behind SMARTfit's Gamified Brain Approach
to Addressing and Preventing
Childhood Inactivity and Obesity



SMARTfit[™]
Functional and Brain Fitness Training Games

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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.

At a time in which inactivity and obesity was fast becoming a major health issue, she observed the power of gamification to motivate engagement and participation for a population that was fast becoming seduced by technology. Today, this appeal to all ages and abilities has proven crucial to success for both personal and group classes.

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.

Installed in over 3,000 facilities in 32 countries, this approach continues to incentivize repeated play until mastery takes place.

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.

The recent trend toward inactivity has impacted both the amount people exercise *and* their desire to exercise. To engage them we focus on providing play-based, fun, interactive activities incorporating the same video game technology they already understand and enjoy. Specific training has been developed by

qualified instructors and occupational therapists for mainstream instructors who take individuals and small groups through programs.

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 - Conditioning for Mind and Body: Engaging Play Engages Participation.

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 offer fitness training for all ages and ability levels without intimidation to non-athletic participants. Visual, auditory, and physical tasks are integrated in performing the motor skills required. These protocols, with their profound and SIMULTANEOUS neuro-cognitive and cardio stimulation, are the key element that differentiates this functional training approach.

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 Programming Promotes Social Integration

It is likely that SMARTfit provides a chance to contribute subtle physical and mental attributes such as alertness, intelligence, precision, coordination, quickness, empathy, and even leadership to participating

teams. A sense of belonging mixed with accomplishment is undoubtedly a potent concoction for players of any age.

SMARTfit programs are known to reinforce social skills and interpersonal cooperation through social interaction in a spirit of fun. Opportunities to work together as a team create an environment where participants develop and enhance behaviors such as inclusiveness, cooperation, and mutual support.

On the playground, self-esteem frequently hangs on a child's ability to throw and catch a ball. *Who might* be picked to a team is a primitive measure of social acceptance among children. However, 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 in which to develop their skills at school. For this purpose, the versatility of the system is essential.

Learning how to be part of a team as a valued member raises confidence and a sense of self-esteem. Instead of only one winner, with SMARTfit training there is a new winner every few minutes, so players have numerous opportunities to improve their scores, and experience the feeling of success. Perhaps more importantly, the system provides an easy way to recover and rededicate in the face of a loss, a task often more difficult on the playground.

Proprioception: A Key to Healthy Brain Body Integration

Proprioception is the inner sense of body awareness allowing a person to know where the parts of the body are in space without having to look. Unlike the six exteroceptive senses (sight, taste, smell, touch, hearing, and balance) by which one perceives the outside world, proprioception is a distinct sensory modality that provides internal feedback on the status of the body. It is the sense that indicates whether the body is moving with required effort, as well as where the various parts of the body are located in relation to each other.³

This is the sense that allows people to run up a flight of stairs without looking at their feet. Without this sense, people would not even be able to walk on a flat surface without watching where they put their feet. SMARTfit Programming excels in its ability to sharpen proprioception as all of its training components bring together a demand on the player that is driven by intention and supported by the body's multisensory response to that demand to perform at a higher pace.



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.

Opening the Doors to Participation in Sports for Otherwise Disinterested Youth

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 determined by the player. Changes in feedback and response are instant. Since most systems are installed in a fairly confined space, required skills to maintain play develop

rapidly. The temptation to drive up scores and continue play is irresistible. SMARTfit 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, we dare say even “a love for movement.” Body and brain find a concert of new confidence, which in turn fosters a strong desire to pursue life-long



physical activity, a desire that may not have happened otherwise. For children and adolescents who experience playground discrimination and/or lack of basic athletic skill, the results of participating in SMARTfit programming must feel miraculous. A sense of belonging mixed with accomplishment is undoubtedly a potent concoction as future activity patterns are being created.

“The number of games and activities that might be used is endless,” Health and Physical Education Supervisor Eileen Dibattista told Medford High School.⁴ “The wall is designed to stimulate the body and the brain simultaneously.” 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,” added 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.” In her words, “This is unlike a traditional conditioning program, which focuses on isolated muscle groups.”⁴

Included in the athletic skill development that Dibattista credits to SMART are 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 an agility ladder.

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. Indeed, according to a recent Los Angeles *Times* article, “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.”³



Preventing Youth Inactivity, Obesity, & Morbidity

Now called the “childhood obesity epidemic,”⁵ the prevalence of overweight children and adolescents has increased dramatically over the past several decades. With it comes unheard of incidence of chronic diseases like obesity, diabetes, and heart disease in our children. As children become heavier worldwide, increasing numbers are at risk of having Coronary Heart Disease (CHD) as adults.⁶ The culprits in this



assault on our health are not hard to imagine.

Screen time, including watching television, surfing the internet and video gaming, have been associated with promoting the inactivity which has led to this rapid increase in obesity. How much screen time? Children ages 8-18 spend approximately over an hour playing video games, 1.5 hours on a computer, 4.5 hours watching TV, and 7.5 hours on entertainment media...PER DAY!⁷

Though video gaming has been only partially blamed for the rapid increase in the prevalence of overweight children and adolescents, there has recently been a rise in interest in *active* electronic games that require physical movement as a way to engage children in activity.

But why not engage children in real sports? The answer is that sports are not universally engaging to them.

Dr. Bruce Bailey, Assistant Professor of Exercise Science at Brigham Young University says, "Previously we've focused on sports as a way to get children physically active," but not all of them are interested in organized sports. He adds, "Schools are trying to make their P.E. classes more inclusive to children of different sizes and interests, and I think SMARTfit is one way of doing that."¹

Experts agree that finding activities that most, if not all, children will embrace is a challenge. Enjoyment appears to be the key element in promoting adherence to strenuous physical activity for them and deserves detailed study. The concept of enjoyment is important to understand as it is a powerful factor in convincing children to participate in physical activity.⁸ We must ask: if exergames are a potent way to engage youth interest, how do the major exergame products compare to each other in terms of their level of engagement and physical exercise?



Energy Cost of Exergaming Study: A Comparison of the Energy Cost of 6 Forms of Exergaming¹

For the first time, we have significant scientific research comparing the effects of exergaming on children. The details are worth noting because the perceptions of the children, as well as their physiological response to the exercise, are described.

In a study published in March of 2011, 39 boys and girls averaging 11.5 years of age were examined via indirect calorimetry for energy cost and surveyed for enjoyment/perceived exertion while playing 6 exergame systems and treadmill walking (3 mph) at the University of Massachusetts, Boston. Three of the games were commercial products, SMART (Oxnard, CA), Bug Invasions--Lightspace (Lightspace Corp.), Goalie Wars--Cybex Trazer (Medway), and three were consumer products, Dance Dance Revolution (Konami Corp.), Boxing--Wii (Nintendo of America Inc.), and Jackie Chan Alley Run--Xavix (SSD Company Ltd.).

Each of these systems includes multiple games and multiple levels of difficulty within games. For most players, some levels are too easy both physically and mentally, and other too frustrating. Pilot research revealed which levels for each game would likely be the most aerobically challenging (via ratings of perceived exertion or RPE), while still maintaining the fun gaming experience. Before testing the study

group, each child was supervised while getting familiar with each game for 10-15 minutes, twice a week, for a 2-week period.

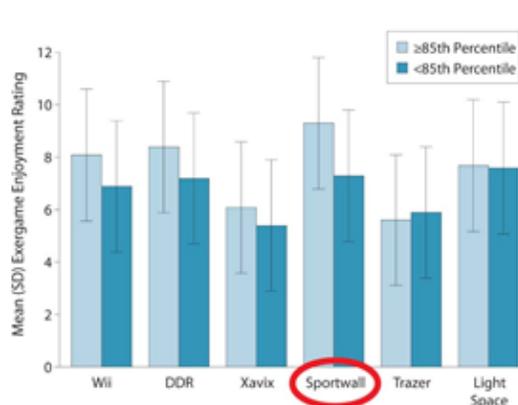
The SMARTfit was unique in that participants were divided into 4 or 5 per team to compete in relay type sprints (intervals) for 15 feet to the wall to score points. Each game was played in 4-minute blocks with 30 seconds rest between games.

During 5 minutes of rest between each activity, children were asked, “How much did you enjoy this activity?” The 10-point discrete analog scale ranged from “not at all” to “very much”. This type of analog scale has been successful in measuring physical activity enjoyment in children.¹

Appropriately, the University of Massachusetts study addressed the needs of at risk children (more than half of the children were classified as overweight or at risk for becoming overweight), and gender (the differences in the appeal of physical activity to boys and girls).

Exercise Results

Every child expended significantly more energy in all studied exergames than at rest *and* significantly more energy than 3 mph treadmill walking while playing Trazer, LightSpace, Xavix, and SMART.



Energy expended by Wii Boxing/Dance Dance Revolution (DDR) was similar to 3 mph treadmill walking, but the other games were significantly more aerobic, with Xavix and SMART highest. Since 3mph is considered brisk walking for children as well as adults, this is a significant endorsement of the cardiovascular benefits of these particular exergames.

This level of exertion was termed “moderate to vigorous,” consistent with US Dept. of Health and Human Services recommendations for children.¹ The experts chose each game and level to maximize the exertion while maintaining player engagement to better study any

therapeutic effect.

The question of whether children, or the games themselves, will push the cardio challenge deserves further study. Clearly, gaming environment, game choice, and game level can greatly influence energy expended. This is influenced where parent, teacher, and coach guidance come in for most exergames. The exergames showed impressive potential for augmenting cardiovascular exercise needs. [Non-research side note: It is our experience, that SMART is unique in that it intrinsically pushes players to higher levels of exertion, without outside influence.]

Enjoyment Results

Self-reported enjoyment was very high for all the activities in this study with SMART at the top position. Dance Dance Revolution (DDR) was rated second, followed by LightSpace, Wii, Cybex Trazer, and Xavix.

Generally, boys enjoyed the exergames more than girls, but there were other noteworthy gender differences found. Not surprisingly, Boys liked Wii Boxing and the Xavix Jackie Chan game a bit more and Girls liked Dance Dance Revolution a bit more. Now for the “eye openers:”

1) Both genders similarly enjoyed LightSpace, CybexTrazer, Walking, and SMART regardless of classification of weight. As noted, appeal to both genders will likely be an influence on exergame purchase.

2) Children classified as *above* norms for weight enjoyed the exergames more than the other children. This is important because it is the the group less likely to participate in regular sports, and more at risk for weight-related health issues.

Adolescents and teenagers of *normal* weight struggle with self-esteem, identity, and fitting in with peers. At the same time, in this age group the risk is high that they will develop sedentary routines with extreme amounts of screen time that could last for the rest of their lives. For those *overweight* in this age group, discrimination on the PE/sports field likely multiplies this risk exponentially.

For an exergame to win the battle that these young people face, it will have to do more than raise heart rates. It must show those in the above weight norms that they can succeed physically alongside their more fit cohorts. That this group enjoyed exergames more than the others probably reflects surprise, relief, and encouragement simultaneously.

SMARTfit Rated Highest for Enjoyment

3) Interestingly, **children in these above weight norm groups also preferred SMARTfit more than the other children.** Among the exergames examined, only SMART forms teams and features short bursts of high intensity.. This preference for SMART held up against the other games for this group despite measurements of greater exertion. Remarkably, **SMARTfit represented *more exercise and more enjoyment for them.***

The researchers believe that while exergaming is “most likely not the solution to the epidemic of reduced physical activity in children, it appears to be a potentially innovative strategy that can be used to reduce sedentary time, increase adherence to exercise programs, and promote enjoyment of physical activity. This may be especially important for at-risk populations, specifically children who carry excess body weight.” Of course, longitudinal studies are needed to document exergaming’s lasting effects.

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, SMARTfit’s interval training regimen (intensity balanced with recovery, 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 (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 interval training, which is a key to its adherence and performance results, especially among at-risk populations. Inactive people often report that pain is the greatest barrier to adopting an exercise regime. SMARTfit's format of short, intense games, followed by short rest in preparation for the next turn, is believed to be a factor in successfully encouraging individuals to conquer this "pain barrier."

The thrill of play and competition, balanced with intermittent rest, holds the player's focus on the game rather than on the length of time spent exercising. Add the neurochemical release of "happy hormones" and the drudgery of regular exercise is replaced with the pleasure that play brings.

Summarizing SMARTfit

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

First, the programming is extremely diverse. It can be tailored to all players regardless of age or ability.

Second, 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 perhaps 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 above 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.

Fourth, instructional growth is encouraged. 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.

SMARTfit has developed a wide variety of program manuals designed to get instructors started in their own field of interest, whether for Special Education and Adapted PE, sports training, 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/>. In 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 SMART products and programs in their facilities during the past seven years.

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