SMARTfit Functional and Brain Fitness Training Games

The Science Behind SMARTfit's Gamified Programs for Boomers and Active Agers

SMARTfit™
Functional and Brain Fitness Training Games

2016

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"If people will take a good look at the *SMARTfit 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, 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

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The Science Behind Its Gamified for Boomers and Active Agers

University Researchers Rated SMARTfit #1 in User Enjoyment and Energy Expenditure[1]

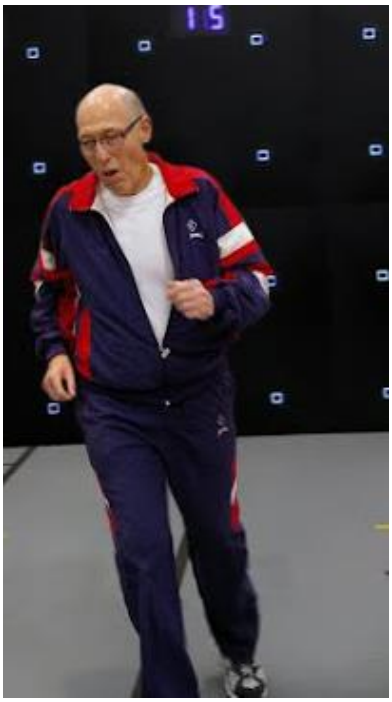
Introduction

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 - 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 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 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.

Being a valued member of a team raises confidence and 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.

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.

Proprioceptive Dysfunction

Proprioceptive Dysfunction is when the proprioceptors are not receiving or interpreting input correctly and manifests itself as clumsiness, lack of coordination, and difficulty performing common daily tasks and activities, which result in the following clinical signs of proprioceptive dysfunction:

- difficulty with motor planning
- difficulty with execution of planned movements
- difficulty with grading movement
- difficulty with postural stability[4]

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. SMART activity helps to promote this type of whole brain thinking.

SMARTfit Programming for Boomers and Active Agers: Physical Activity Affects Quality of Life in an Aging Population

According to the US Census Bureau, 76 million baby boomers were born between 1946 and 1964. Beginning January 1, 2011**,** more than 10,000 baby boomers will reach the age of 65 every day. [7] This will continue to happen daily for the next 19 years. In addition, modern medicine, science and technology have brought the majority of diseases and nutritional deficiencies under control, thereby increasing the average life expectancy from 65 to 85 years. The consequence is an average of 20 years of leisure time for seniors to spend either having a great active life or suffering from numerous age related conditions that rob them of the potential joy of their later years.

The author of the best-selling book *Younger Next Year: a Guide to Living Like 50 until You're 80 and Beyond*, Dr. Henry Loge states, "You are likely to live longer whether you want it or not, but how you live those years is largely under your control, which is a good reason to make the last third of your life terrific and not a dreary panoply of obesity, sore joints and apathy. Normal aging is intolerable and avoidable. You can skip most of it and grow old, not just gracefully but with real joy."[8]

An effective exercise program for an aging population is comprised of several wellness components: aerobic conditioning, flexibility and agility activities, strength training, relaxation techniques and positive social interaction. Maintaining a healthy social connection is imperative for the senior population to thrive. We understand that wellness is a multi-dimensional model for senior lifestyles, with our primary objective to help seniors maximize their independence.

SMARTfit Programming blends these wellness components in a unique way, allowing for a "group play" setting in a safe, effective, and motivational environment. Predesigned senior boot camps, classes and drills consisting of safe, multilevel progressive exercises are available with the SMARTfit system, allowing for easy integration into your wellness program.

Factors Which Optimize Successful Aging

- Engagement with life—social, club and volunteer activities
- Exercise
- Maintenance of high physical function (strength, flexibility, balance, endurance, aerobic capacity)
- Stress control
- Diet
- Sleep

Can Exercise Treat Brain Disorders?

According to Dr. John Medina, "With experiments reproduced all over the world, enrolling thousands of people, often studied for decades, the results are clear. Your lifetime risk for general dementia is literally cut in half if you participate in leisure-time physical activity. Aerobic exercise seems to be the key. With Alzheimer's the effect is even greater: Such exercise lowers your odds of getting the disease by more than 60 percent."[9]

Physical Activity before Developing Cognitive Symptoms

Mounting evidence shows regular exercise helps reduce levels of brain loss and helps our cognitive abilities as we age.

One of the greatest predictors of successful ageing was the presence or absence of a sedentary lifestyle. The chief reason for the difference seems to be that exercise improved cardiovascular fitness, which in turn reduced the risk of diseases such as heart attack or stroke…. A lifetime of

exercise can result in a sometimes astonishing elevation in cognitive performance, compared with those who are sedentary.[9]

A Florida study demonstrated that exercise at midlife may reduce the odds of dementia in older adults by up to 60 percent. Such extraordinary findings were corroborated by several other studies, including a University of Lisbon study that found that physical activity benefits happen independently of age, education, vascular history or diabetes.[10]

"Basically, whatever's good for your heart is good for your head," says Dr. Lawrence Whalley, a researcher at Scotland's University of Aberdeen. "Mortality of vascular disease in the United States was halved between 1965 and 1995, and this is one of the great public-health successes of the 20th century. And what people are looking for in dementia prevention is the same because the factors that everyone knows predispose to heart disease also predispose to dementia."[10]

In addition to reducing risk for dementia, regular exercise has also been found to help stave off the onset of Alzheimer's and dementia, another reason for not only seniors, but all age groups to exercise.

Physical Activity at Early Stages of Alzheimer's or MCI

For those affected with MCI (Mild Cognitive Impairment) or the early stages of Alzheimer's, regular exercise should be a priority.

In a six-year study with 1,740 participants in Seattle, researchers found that those with early Alzheimer's disease who were less physically fit had four times more brain shrinkage than those who were more physically fit. The findings suggest physical fitness helps slow the progression of the disease.[10]

Nothing else so far has demonstrated such dramatic, positive impact in the fight against the onset of dementia. Currently available dementia and Alzheimer medications can alleviate some of the symptoms, but they do not slow the progression of the disease. Including regular exercise in one's personal strategy against dementia will help preserve cognitive skills in addition to enhancing fitness levels.

Physical Activity at Mid-Stages of Alzheimer's

Professionals working in dementia care have long observed that exercising at the mid-stages of Alzheimer's disease helps patients maintain independent living skills, preserve muscle memory, reduce fall risk and promote balance and mobility. Exercise also helps reduce stress, anxiety, depression and insomnia — problems that often affect people in the mid-stages of Alzheimer's.

In our own experience as care specialists, we have seen that clients with a continued history of physical fitness and exercise do far better into all stages of dementia than those who don't.

Patients in mid-stages also benefit greatly from a more individualized exercise regimen with the guidance of a physical therapist. Thanks, in part, to the advocacy efforts of the Alzheimer's Association, physical therapy is now covered by Medicare for Alzheimer patients.

What Kind of Physical Activity Is the Best?

Some published studies emphasize the benefit of strength training (e.g., lifting weights) for cognitive enhancement. Others have looked at high calorie-burning activities such as running or bicycling. Most studies focus on moderate levels of activities such as walking or dancing done frequently (three or more times a week). Although the findings in cognitive benefits vary slightly between studies, most of them have reported a high correlation between physical activity and brain health.

Maximizing Bone Health

As a result of our longer life span, we find that degenerative diseases are increasingly becoming the largest health care issue in the US today. Age related changes to joints, bone, muscle and cognitive ability have become significant deficits in the decreased functional ability of the senior population.

Bone Health is dependent upon two specific factors. The first is the total level of bone mass we were able to achieve during our growth and early development. The second factor for healthy bones is our ability to slow the rate of bone loss as we continue to age. According to Spirduso et al., "Women lose approximately 1% of bone per year up until 50 years of age. This loss of bone mass then increases to 2-3% per year at the start of menopause and continues for 5-10 years. On average, women may lose between 1/3 and ½ of their bone mineral density during menopause." [11]

The Importance of Daily Exercise in Maintaining Bone Health for Successful Aging

According to Henry S. Loge, M.D, "Twenty million American women have osteoporosis, a preventable disease. There are one and a half million fractures each year from osteoporosis. Research has shown that women have a 50 % lifetime risk of breaking a bone from osteoporosis, and the vast majority of those fractures are caused by falls you would have bounced right up from in younger years."

Astonishingly, “Twenty percent of women who fall down and break a hip die within one year.”[12]

One of the most modifiable ways to improve bone health is through weight bearing exercise. Many seniors take vitamin supplements which are only intended to slow the loss of bone. Weight bearing exercise, on the other hand, has been consistently shown to increase bone mass. Research has demonstrated that a loss of muscle strength precedes loss of bone.[13]

Weight bearing activities stimulate bone formation and increase muscle mass, strength and balance. Many senior programs are using virtual reality gaming products such as Wii. Whereas these products do promote mobility, the SMARTfit Systems allow for more: functional weight bearing training using resistance of both the upper and lower extremities. Resistance training is imperative to stimulate joint proprioception and thereby subsequent appropriate reactive muscular force. Lack of resistance, as in using the Wii-type products, can frequently result in an over-exertion relative to the motor task, causing soft tissue irritation or injury.

The Importance of Maintaining an Ideal Body Weight for Successful Aging

Maintaining a healthy body weight is an important way to protect joints from degenerative osteoarthritis (OA). The development of OA is influenced by environmental and lifestyle factors which are modifiable. Obesity, muscular weakness, heavy physical activity, inactivity and decreased joint proprioception all play significant roles in the development and degree of osteoarthritis joint changes. According to the American Geriatric Society Panel on OA and Exercise in 2001, 85% of sufferers are 75 years of age or older. Degenerative osteoarthritis affects 1 out of 2 adults over 65 years of age.[14]

The SMARTfit System provides seniors with an excellent curriculum for promoting joint health, maintaining ideal body weight, and functional mobility for common activities of daily living. This is attained through participation in rapid movement, socially engaging, low impact, “quick thinking” gaming that is the hallmark of SMARTfit programming. Participation challenges players physically and cognitively, creating a self-competitive environment that keeps them engaged and motivated to continue to play and succeed.

The Importance of Maintaining Muscular Strength and Power for Successful Aging

Age related changes also occur in muscles, tendons and ligaments. Changes in these soft tissue structures can translate to an overall decrease in normal joint biomechanics and mobility and also increase the overall risk of injury. Maximum muscle strength is achieved by age 30 and then begins to decline. This decline is due to a decrease in overall muscle mass, which translates to loss of muscle strength. Changes occur in the muscle fiber size, decrease in the overall number of fast twitch fibers, the ability of the nervous system to carry signals quickly to the brain, and also a decrease in overall blood flow to the muscle as a whole.

Muscle is the most modifiable of all of these structures to improve flexibility and is most easily changed with exercise using both dynamic and static activities. Loss of lower body muscular strength in aging causes decreased locomotion and increased risk of fall. Messier et al. demonstrated the positive effect exercise has on increasing overall lower extremity strength and balance, and decreasing subsequent risk of fall.[15]

A comprehensive exercise regime for seniors should include activities which develop both strength and power. The difference between strength and power is in the speed at which the participant is asked to move a resistance; that is, how fast one can move a resistance through a particular movement pattern. Compared to strength, power declines at a 10% greater rate per decade. High velocity training is essential for increasing performance power. Studies comparing the difference between strength and power training have found power training to be more effective than strength training for improving physical function in community-dwelling older adults with muscle weakness. Several studies indicate minimal power gains with strength training programs alone.[16]

The SMARTfit System creates an environment of motor programming that promotes both rapid (power) and slow (strength) muscular contraction using light resistance in various gaming activities. The SMARTfit gaming system is designed to progressively influence power by integrating safe, rapid methods of individual or group play which can be easily tailored to the functional level of seniors. As this level improves, the difficulty and speed of the SMARTfit System gaming is adjusted to push the limits and ability. Only the SMARTfit Systems offer this unique style of play, challenging resistance and velocity training in a safe and effective manner.

Age Related Effects on Behavioral Speed, Motor Control, Balance and Posture

As older adults age, significant changes occur in gait speed, trunk rotation, arm swing, and in the overall time of double limb support during gait. Seniors tend to be more cautious and deliberate when performing activities such as sit-to-stand, ambulation immediately upon standing and when negotiating obstacles in their path. All of these changes can be attributed to the aging of the neuromuscular, vestibular, visual and proprioceptive systems which often ultimately affect the ability of older adults to remain independent in their community. Often these changes translate into loss of balance and higher risk of falling in this population.

Balance is our ability and process how we control our body's center of mass with respect to base of support whether it is stationary or moving. SMARTfit programming influences and refines both the anticipatory and reactive postural control of seniors by incorporating both static and dynamic balance activities. These activities include reaching, lifting, pushing, pulling and change of direction, thereby mimicking the senior's physical requirements for normal activities of daily living.

The progressive style active/reactive physical gaming promotes the senior's ability to adapt to movement patterns quickly and accommodate to a changing environment. Results of cross sectional, correlational and interventional studies all support the fitness-cognition relationship. Games/drills involving a high level of attention, movement, change of direction and speed help to:

- Increase processing speed
- Increase controlled processing (cognitive tasks that start by requiring controlled, effortful processes but that can be processed automatically through practice)
- Increase execution control (planning, scheduling, coordination and inhibition of working memory functions of the brain)

Studies show that physical activity influences cognition but cognitive competency also influences the nature and amount of physical activity. Many participants using the SMARTfit System have experienced an increase in perceived mental acuity for days following play![17,18]

SMARTfit for Maintaining Neurological Competence

Movement is essential to maintaining physical and emotional health. Unfortunately, the past two decades have witnessed a drastic reduction in physical movement in industrialized countries. The risks associated with sedentary living continue to increase as technological "advances" impact our lifestyles.

SMARTfit technology has been designed to provide a safe space for group exercise based on engaging activities and games with particular emphasis on those who typically do not otherwise choose to exercise or work out at a gym. Since 2003, various professional treatment centers have been using the Sportwall, SMARTfit's predecessor, to treat a range of neurological disorders.

Summarizing SMARTfit for Boomers and Active Agers

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

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. Since 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 pay. Often, trainers have to "pull the plug" to end play.

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

Participants have affirmed that play is for the "kid in all of us." They report that their mental clarity is sharper for days after participating in a class. In an appealing way, SMARTfit represents a form of time machine; adults get to visit the playground again.

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.

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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