

Enhancing Physical and Cognitive Performance

TRAZER[®] Sports Simulator

Simulation delivers spontaneous visual cues that elicit complex 3-dimensional movement responses, challenging the subject's sensory, musculoskeletal and cognitive systems to maintain, or restore, physical and cognitive performance.

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IT HAS BEEN OUR EXPERIENCE THAT ENRICHED VIRTUAL ENVIRONMENTS DESIGNED TO PROMPT COMPLEX MOVEMENT RESPONSES FROM A SUBJECT, WHILE SIMULTANEOUSLY MEASURING THE KEY COMPONENTS OF FUNCTIONAL MOVEMENT, ACT TO ENHANCE PHYSICAL AND COGNITIVE PERFORMANCE. OUR OBJECTIVE IS TO IMPROVE THE QUALITY OF LIFE AND THE SAFETY OF AGING POPULATIONS.

A number of studies have reported that enhancing sensory-motor skills can enhance cognitive skills. Simulation-based training may be the perfect form of mind/body exercise to help stave off future physical and cognitive dysfunction. An emerging body of scientific evidence suggests that enhancing sensory-motor skills can also enhance cognitive skills.

During this present month of January (2012), four studies have been published reporting that certain practices may act to reduce the risk of Alzheimer's. We submit that they lend further support for the use of simulation-based protocols as well.

The study, **"Exergaming Helps Older Adults Improve Cognitive Function"** concluded that *"Virtual reality enhanced exercise can delay cognitive decline more than traditional exercise."*¹

The study's outcome measures included clinical status, exercise effort, fitness, executive function and plasma brain-derived neurotrophic growth factor. Patients in the group using virtual reality enhanced exercise *"experienced a 23% relative risk reduction in clinical progression to mild cognitive impairment."*

The exercise modality employed was identified as "cybercycling," i.e. a "standard stationary bike" with a monitor and video game machine attached in the vicinity of the handle bars. *"The technique combines physical training with a computer-simulated environment and interactive video game features."*

"We did not anticipate such a robust and significant cognitive effect from cybercycling compared with traditional exercise," offered investigator Cay Anderson-Hanley, PhD. *"One explanation for the greater cognitive benefit found with cybercycling compared with traditional cycling is the added*



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mental exercise required. Navigating a 3-dimensional landscape, anticipating turns, and competing with others requires additional focus, expanded divided attention, and enhanced decision making."

The study, "**Exercise Engagement as a Moderator of the Effects of APOE Genotype on Amyloid Deposition**"² concluded that "*our findings suggest that exercise at levels recommended by the AHA may be particularly beneficial in reducing the risk of brain amyloid deposition in cognitively normal $\epsilon 4$ -positive individuals.*" The presence of an APOE $\epsilon 4$ allele is the most established genetic risk factor for Alzheimer's disease.²

The study, "**The Lifelong Brain-Stimulating Habits Linked to Lower Alzheimer's Protein Levels**"³ found a "*significant association between higher levels of cognitive activity over a lifetime and lower levels of beta-amyloid in the PET scans. They analyzed the impact of other factors such as memory function, physical activity, self-rated memory ability, level of education and gender, and found that lifelong cognitive engagement was independently linked to amyloid deposition.*"

The study, "**Genes Affect Intelligence During Aging**" found that "*Genes accounted for about 24% of the mental changes that occur across the life cycle.*"⁴ This means that environment also plays a big role in shaping and maintaining our intelligence and mental ability as we grow older. "*It is not all in the genes,*" . . . "*There is room for manipulation.*"

John J Ratey MD, clinical professor of psychiatry at Harvard Medical School, advised in his book, Spark: The Revolutionary New Science of Exercise and the Brain⁵ to "*...choose a sport that simultaneously taxes the cardiovascular system and the brain...the more complex the movements, the more complex the synaptic connections. And even though these circuits are created through movement, they can be recruited by other areas and used for thinking.*" "*...if the exercise requires complex motor movement, we're also exercising*

the areas of the brain involved in the full suite of cognitive functions."

Dr. Ratey's observations are consistent with the author's experience over the past decade with the use of computer-based simulation; that "complex" movement, where the subject is weight-bearing and is prompted to respond to spontaneous cues via the execution of whole body movements that combine linear and angular motion, is capable of enhancing both physical and cognitive performance.

IN CONTRAST TO THE CONSTRAINED, PLANNED AND REPETITIVE MOVEMENT PATTERN OF A STATIONARY BIKE OR TREADMILL, 3-DIMENSIONAL SIMULATION ELICITS REACTION-BASED COMPLEX MOVEMENTS.

The subject is immersed in a simulated (virtual) environment that replicates the spontaneous, rapidly-changing nature of real world events. Both unplanned and planned visual stimuli prompt 3-dimensional (multi-vector) movement responses that appear to offer physical and cognitive benefits over non-weight bearing exercise modalities with limited complexity, i.e.: variety of movement responses.

THE TRAZER[®] SIMULATOR DELIVERS UNCONSTRAINED, WEIGHT-BEARING EXERCISE THAT CHALLENGES THE SUBJECT'S PERCEPTUAL, COGNITIVE AND KINESTHETIC LINKAGE.

These weight-bearing challenges are computer adjusted to accommodate nearly all user populations, from training the elite athlete to rehabilitation and senior health and fitness.

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CHALLENGING THE SUBJECT'S SENSORY, COGNITIVE AND NEUROMUSCULAR SYSTEMS IN THIS MANNER IMPROVES REACTION TIME, BALANCE, COORDINATION, AGILITY AND MOVEMENT SPEED AND THEREFORE SAFETY.

It also improves physiological factors, as measured by telemetry heart rate, such as anaerobic and aerobic conditioning.

TRAZER delivers unpredictable sequences of reaction-based directional changes that require the subject to maintain coordination and control of body center of gravity. Movement-decision-making processes are challenged with cues that cannot be predicted in either timing or required response. In this way, TRAZER duplicates the neuromuscular and biomechanical stresses of actual real world situations.

To simulate the visual perception and sensory-motor integration demands of real-world activities, TRAZER customarily incorporates a large screen display that requires head-tracking, eye-tracking and peripheral vision skills.

A very favorable Perceived Exertion Rating ("PER") is a byproduct of TRAZER's game-like interface; subjects are engaged during the exercise sessions. This low PER is also a byproduct of exercise that is weight-bearing and 3-dimensional, as significantly more muscle groups are exercised. Conventional fitness machines, such as treadmills, bikes and ellipticals, only exercise the muscle groups that propel the subject forward. And strength machines typically only work a single plane of movement.

Whether opening a car door or swinging a golf club, the primary forces required for accomplishing daily activities are horizontal and rotational. Most daily physical activities include starting, stopping, rotating, pushing, pulling, running or walking; building horizontal and rotational strength and power is beneficial for both performance and safety. Three dimensional exercise works the muscle groups that propel the subject backward, side-to-side, up and down, and that allow them to twist and turn and stop and start. The result is

enhanced caloric expenditure. By contrast, traditional resistive strength training is reliant on gravity for resistance, and therefore, improves movement in the vertical plane.

TRAZER IS A TOOL FOR ASSESSING PERFORMANCE OF THE COMPLEX TASKS INVOLVED IN DAILY LIVING.

Simulation uniquely reproduces the challenges the subject faces without the constraints or risk factors inherent in the real world. Performance is evaluated in a realistic context. Thus, the subject's cardiac status is measured during functional (real world) activities, not while on a stationary piece of cardio equipment. Reaction time and decision making skills are tested against a program designed to elicit reaction responses to real time, interactive and random challenges, rather than to a pre-planned test.

UNLIKE THE RESULTS OF MOST OTHER TESTS, TRAZER DOES NOT HAVE TO BE CORRELATED TO FUNCTION.

It provides a direct, reproducible and reliable measurement of functional ability. Such measurements can be used to immediately improve performance factors which are directly transferable to the execution of daily activities involving movement. TRAZER measurements can be used to assess the subject's ability to control and adapt to their environment and their likely response to new physical and cognitive challenges.

Unplanned movement demands create different musculoskeletal stresses than do pre-planned or controlled movement patterns. Accordingly, with TRAZER, the subject must maintain coordination and control of body center of gravity during an unpredictable sequence of changes in direction.

TRAZER-based exercise improves compliance with an exercise prescription via its entertaining, "game-like" format.

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Exercise that includes 3-dimensional movement retraining, postural control, cardiovascular and muscular strengthening, and visual/cognitive processing may be the best performance enhancement and injury prevention program. The Cleveland Clinic study titled, "Response time is more important than walking speed for the ability of older adults to avoid a fall after a trip", demonstrated "that older adults who are at risk for falling can achieve a dramatic increase in safe walking velocity by improving their response time." TRAZER measures both reaction time and movement speed.

SUBJECTS SOLVE STIMULATING COGNITIVE CHALLENGES WHILE PERFORMING REACTION-BASED COMPLEX MOVEMENT PATTERNS THAT WORK TO EFFECTIVELY ELEVATE THEIR HEART RATES AND INCREASE CALORIC EXPENDITURES.

Controlled complex physical movement responses are required to solve cognitively demanding challenges. The subject doesn't exercise their mind and body in isolation from one another, but rather exploits the power of synergy by exercising the mind and body together, producing greater results than exercising either separately.

Dr. John Ratey provides insight into why the concurrent delivery of physical and cognitive challenges solved via complex movement may create a synergistic effect: *"As we adapted to an ever-changing environment over the past half million years, our thinking brain evolved from the need to hone motor skills. We envision our hunter-gatherer ancestors as brutes who relied primarily on physical prowess, but to survive over the long haul they had to use their smarts to find and store food. The relationship between food, activity, and learning is hardwired into the brain's circuitry."* Perhaps the evolution of our early "moving brain" to become our "thinking brain" lends further support for the efficacy of kinesthetic learning.

TRAZER elevates the subject's metabolism via complex movement patterns. Measurable improvements are observed in the subject's

reaction time, movement speed, distance traveled, agility, etc., for enhanced safety and independence.

TRAZER-BASED TRAINING MAY BE THE PERFECT FORM OF MIND/BODY EXERCISE TO HELP STAVE OFF FUTURE PHYSICAL AND COGNITIVE DYSFUNCTION. AN EMERGING BODY OF SCIENTIFIC EVIDENCE SUGGESTS THAT CHARACTERIZING PHYSICAL PERFORMANCE CAPABILITIES PROVIDES VALUABLE INSIGHT INTO THE RELATIONSHIP OF MOVEMENT AND HEALTH:

- Simple reaction time measured at 45 years of age is a predictor of future physical disability and perhaps even an early death.
- How adeptly one moves at 70 years of age is a predictor of Alzheimer's and cognitive dementia in the next 5 years, regardless of the apparent current state of the brain.
- Movement ability in the 60s and 70s is a strong predictor of a future disabling fall.

Dr. John Ratey stated that *"...aerobic exercise elevates neurotransmitters, creates new blood vessels that pipe in growth factors, and spawns new cells, complex activities put all that material to use by strengthening and expanding networks."*

As such, it may be a valid biomarker of "functional age" by assessing the subject's ability to respond to dynamic, unpredictable and complex real-world challenges.

"The body was designed to be pushed, and in pushing our bodies we push our brains too. Learning and memory evolved in concert with the motor functions that allowed our ancestors to track down food, so as far as our brains are concerned, if we're not moving, there's no real need to learning anything." John Ratey MD, Spark

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References:

¹ "Exergaming and Older Adult Cognition; A Cluster Randomized Clinical Trial." Cay Anderson-Hanley et al. American Journal of Preventive Medicine

² "Exercise Engagement as a Moderator of the Effects of APOE Genotype on Amyloid Deposition." Denis Head et al. Published online January 9, 2012

³ "The Lifelong Brain-Stimulating Habits Linked to Lower Alzheimer's Protein Levels"

⁴ "Genes Affect Intelligence During Aging" found that "Genes accounted for about 24% of the mental changes that occur across the life cycle."

⁵ Spark: The Revolutionary New Science of Exercise and the Brain, John J. Ratey, 2008.

The Authors:

Barry J. French, the inventor of TRAZER, pioneered the application of simulation for the enhancement of health/fitness, physical performance and kinesthetic learning. He has been awarded more than a dozen U.S. patents. The technologies claimed by these patents are currently being used by the vast majority of mainstream video game makers. He has demonstrated TRAZER on Oprah for the Surgeon General, and has appeared on numerous other national TV shows.

Mark Schickendantz, MD is an orthopaedic surgeon, director of the Cleveland Clinic Center for Sports Health and head team physician for both the Cleveland Indians and the Cleveland Browns.