
Recent seminal research epitomizes how TRAZER can radically improve concussion management programs.

TRAZER and Concussion. TRAZER's global performance assessment replicates game play to challenge visual, vestibular, cognitive, neuromuscular/ musculoskeletal and cardiorespiratory systems by progressively elevating the athlete's heart rate to game levels.

To characterize "kinetic" health, TRAZER measures and reports moment-to-moment reaction time, acceleration, speed and distance traveled in each movement vector. Physiological parameters measured and reported include heart rate by telemetry and work rate expressed as METs. The athlete's reaction time to unplanned visual cues provides a measure of the athlete's cognitive prowess during game-like conditions. The athlete's work capacity and can be compared to baseline or normative data.

TRAZER's 6 – 9 minute test serves both as a baseline and return-to-play assessment by providing both movement and cardiorespiratory data.



Finding 1: There is a definite link between concussion and lower extremity musculo-skeletal injury.

"Regardless of causality, the hypothesized link between concussion and musculoskeletal injury is that altered movement due to one type of injury increases the risk of the other..."

This quote is from a recently published paper (attached) titled "Concussion Frequency Associates with Musculoskeletal Injury in Retired NFL Players;" the lead author is Kevin Guskiewicz, Professor and Co-Director of the Sport-Related Traumatic Brain Injury Research Center at UNC Chapel Hill.

It provides compelling evidence of "a link between concussion and lower extremity musculoskeletal injury." That "....Concussed players may be advised to return to athletic participation based on resolution of concussion symptoms and/or neurocognitive testing scores even though they may have an underlying inability to properly initiate motor task via excitation of the primary motor cortex." These aforementioned findings are consistent with the philosophical underpinnings of TRAZER®. Sports simulation, as embodied in TRAZER, represents the sole methodology to assess cognitive function (decision-making) under

"game conditions" (increasing metabolic rate, etc.), while simultaneously measuring the athlete's reaction-based movement capabilities.

All other known approaches (ImPACT, Biodex, etc.) fail to address the reality that concussed athletes suffer symptoms from disruptions in multiple physiologic systems, resulting in diminution of overall physical performance. Increased metabolic demands associated with physical activity typically exacerbate these symptoms.

TRAZER replicates with fidelity the global (holistic) demands of game play to challenge the athlete's visual, cognitive, neuromuscular/musculoskeletal and cardiorespiratory systems.

The simultaneous measurement of both cardiorespiratory and movement performance assists in determining whether an athlete exhibits movement deficits that may potentially place her at higher risk of concussion and/or musculoskeletal injury. The athlete's reaction time to unplanned visual cues provides a measure of the athlete's cognitive prowess at progressively higher work rates. In summary, TRAZER detects movement deficits that may expose a healthy athlete to a higher risk of concussion, and conversely, to determine if a concussed athlete return fully recovered his motor skills post brain injury.

Finding 2: Current concussion assessment tools fail to account for the contribution of increased metabolic activity.

"An advantage of provocative exercise testing is that with increasing exercise intensity there is a fairly rapid and visible onset of signs of symptom exacerbation, such as vertigo, headache, or difficulty maintaining attention in those who have not fully recovered. A potential benefit for athletes who successfully complete the BCTT (treadmill test) without symptom recurrence is that they could bypass stage 2 of the Zurich graduated RTP protocol (light aerobic exercise) and move directly into stage 3 (sport-specific exercise), hastening RTP for those who are physiologically recovered."(1)

"In conclusion, this study suggests that the BCTT in combination with the Zurich guidelines predicts a successful and safe return to sport. Programs may therefore want to consider using standardized exercise testing to help in the concussion RTP decision-making process."(2)

The aforementioned quotes extracted from the seminal research by John J. Leddy MD, Barry Willer PhD et al at the University of Buffalo. (see attached paper)

The Buffalo study demonstrated "for the first time that PCS ("Post-Concussion Syndrome") may be safely treated using a program of quantitative, individualized, and progressive subsymptom threshold aerobic exercise rehabilitation."(3)

"Our study suggests that some patients with PCS have a persistent physiological disequilibrium and that controlled aerobic exercise training assists in the recovery of physiological homeostasis. We propose that symptom-limited exercise testing and progressive subsymptom threshold aerobic exercise training are safe and, as opposed to treatments that modify symptoms (e.g., pain or antidepressant medications), address a fundamental physiological dysfunction in some patients with PCS."(4)

TRAZER's HRA (Health Risk Assessment) presents spontaneous visual cues to elicit realistic movement responses that act to progressively elevate the athlete's heart rate to

game levels. A TRAZER assessment is approximately 7 – 9 minute test that serves both as baseline and return-to-play assessment by

providing both orthopedic and cardio-respiratory data.

Finding 3: Reaction-based sports challenge the athlete's cognitive, sensory, and neuromuscular systems. These three systems must be assessed concurrently.

"...Sports-related concussions are often diagnosed using a battery of tests, including clinical evaluations, cognitive functioning, postural control, and self-reported symptoms. While single-task paradigms effectively measure either cognitive functioning or postural control, these paradigms may be limited as they only evaluate domains in isolation and not the interaction of these domains across concurrent tasks. Performance in sport requires simultaneous processing of cognitive, sensory, and motor information. A paradigm including concurrent assessments of these domains is needed to understand capabilities related to complex tasks."

This quote was extracted from "Balance and cognitive performance during a dual-task: Preliminary implications for use in concussion assessment", by Kevin M. Guskiewicz et al. The methodology employed in this study had the subject read a sign out loud correctly. Other previous state-of-the-art Dual Task paradigms had the subject walking up stairs while tasked with counting down by 3s out loud. Protocols that have little fidelity with reaction-based sports.

TRAZER "sports simulation" inherently, and uniquely, simultaneously integrates the "cognitive, sensory and motor systems."

TRAZER's novel approach to DT paradigms recognizes that persons moving within their environment, whether athletes on the field or court or geriatric patients ambulating across a room, must, based on visual observation,

navigate their path. And in many cases, they must also simultaneously "modulate", either

consciously or subconsciously, the rate at which they move.

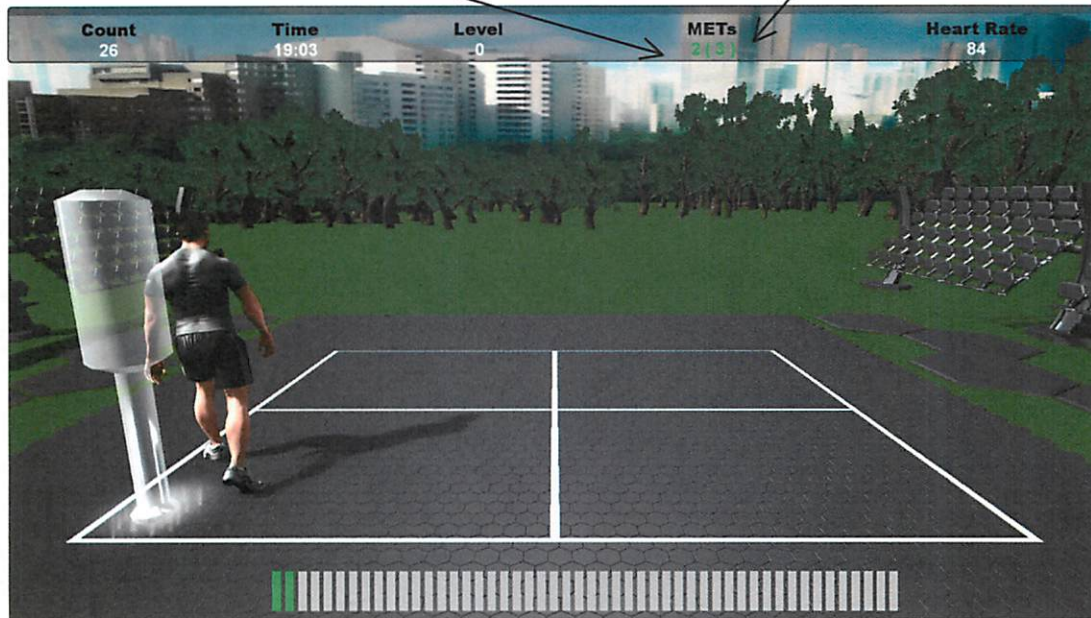
With TRAZER's two distinct, but related continuous visual cues create a compelling Dual Task Paradigm that more precisely replicates real world challenges. TRAZER's DT is, by its very nature, fundamental to the ability of a subject to successfully navigate his or her environment, regardless of whether the subject is a geriatric patient, a wounded warrior, or a healthy athlete. Plus, it generates unprecedented data.

For example, a football running back carrying the ball will, from moment-to-moment, select a movement path that offers the greatest potential to gain maximum yardage. At times, the runner may elect to modulate his running speed to elude tacklers. The same paradigm may apply to a basketball player driving to the net.

The assessment and rehabilitation of populations ranging from those suffering brain injury, such as concussion, to movement disorders and dementia in geriatric populations benefit from the introduction of dual "challenges" of the subject's processing power via the recreation of real world challenges. TRAZER's graded test "environment" enables the most realistic, relevant and quantifiable Dual Task Paradigm yet developed.

TRAZER GPA's "Virtual Environment" (i.e.: what the subject sees)

Heart Rate is displayed in real time. Current and target Work Rate (in METs) is displayed in both analog and digital formats. The target Work Rate is in parentheses at the top of the screen; to its left is the 30 second METs average.



The segmented bar at the bottom of the screen provides analog feedback of the subject's compliance with each Stage's Work Rate. When the subject is moving at the prescribed rate, the segments light in green. Red signifies the movement rate is too fast; blue too slow. The number of segments corresponds with the number of METs.

Two different modes of visual cueing (feedback) instruct the subject as to: 1. where to move, and 2. how fast to move. The challenge is analogous to driving an automobile, where the driver must continuously scan the road as well as frequently glance at the speedometer.

As discussed, this technique creates a novel and uniquely powerful Dual Task Paradigm ("DT") that more precisely replicates real world challenges.

TRAZER® Versus the Competition

Baseline Concussion Assessments



TRAZER®

Industry-Leading Baseline Concussion Assessment Technology

- Description: Movement Simulator
- Objectively measures functional performance

TRAZER® places the athlete in a game-like environment & challenges vision, mind, and body with unplanned cues prompting sport-specific movement responses to elevate the heart rate to game levels.



BIODEX® Balance System SD

- Description: NEUROCOGNITIVE TEST via assessment of static balance
- Mode of Operation: Detects oscillations of the user positioned on the device



ImPACT® TEST

- Description: NEUROCOGNITIVE ASSESSMENT
- Mode of Operation: Tests attention, processing speed, memory while the athlete is sedentary

TRAQ Global Ltd
Powered by **TRAZER®**

440-835-9191 | www.trazer.com

Capabilities

	TRAZER®	ImPACT	BIODEX
Assess global athletic performance	X		
Elicits sport-relevant movement	X		
Elevates heart rate to game levels	X		
Measures heart rate continuously	X		
Measures movement speed	X		
Challenges vision/vestibular in sport relevant manner	X		
Detects movement deficits	X		
Controls rate, distance & direction of movement	X		
Assess static balance	X		
Reports balance in 4 directions			X
Has extensive normative data		X	X
Dual Task	X		
Supporting research	X	X	X

Traq Global Ltd | 28901 Clemens Rd, Suite 100 | Westlake, OH 44145 | www.trazer.com

REFERENCES:

- (1) Scott R. Darling, M.D., John J. Leddy, MD, John G. Baker, PhD, Amy J. Williams, MA, Anthony Surace, MD, Jeffrey C. Miecznikowski, PhD, and Barry Willer, PhD, "Evaluation of the Zurich Guidelines and Exercise Testing for Return to Play in Adolescents Following Concussion," *Clinical Journal of Sports Medicine*, vol. 24, no. 2, pp. 131, March 2014.
- (2) Scott R. Darling, M.D., John J. Leddy, MD, John G. Baker, PhD, Amy J. Williams, MA, Anthony Surace, MD, Jeffrey C. Miecznikowski, PhD, and Barry Willer, PhD, "Evaluation of the Zurich Guidelines and Exercise Testing for Return to Play in Adolescents Following Concussion," *Clinical Journal of Sports Medicine*, vol. 24, no. 2, pp. 132, March 2014.
- (3) John J. Leddy, MD, Karl Kozlowski, PhD, James P. Donnelly, PhD, David R. Pendergast, EdD, Leonard H. Epstein, PhD, and Barry Willer, PhD, "A Preliminary Study of Subsymptom Threshold Exercise Training for Refractory Post-Concussion Syndrome," *Clinical Journal of Sports Medicine*, vol. 20, No 1, pp. 21, January 2010.
- (4) John J. Leddy, MD, Karl Kozlowski, PhD, James P. Donnelly, PhD, David R. Pendergast, EdD, Leonard H. Epstein, PhD, and Barry Willer, PhD, "A Preliminary Study of Subsymptom Threshold Exercise Training for Refractory Post-Concussion Syndrome," *Clinical Journal of Sports Medicine*, vol. 20, No 1, pp. 26, January 2010.