

Three Critical Scores for Improving Cognitive Performance



PISON[®]

Cognitive abilities—alertness, fast decision-making, and focus—are all fundamental to people performing at their peak. This is especially true for elite athletes and people in high-stress jobs—such as business executives, engineers, first responders, doctors, lawyers, and financial managers. In many professions, the ability to react quickly, often under pressure, makes the difference between success and failure.

The universally accepted method to measure and improve cognitive performance is reaction time testing. Reaction time tests give insights into a person's current ability to perform, reveal factors that enhance or impair performance, and inform on how to train and prepare to consistently hit top cognitive form.

Despite its importance, reaction time testing doesn't receive the attention it deserves in training and preparation routines. That's because traditional testing methods are inaccurate and inconvenient to conduct on a regular basis.

In this white paper, we examine the importance of monitoring reaction time as well as the types of testing and their benefits. The paper also presents advances in reaction time testing from closed-loop, on-the-body sensors that give athletes, frontline workers, managers, and executives insights that can improve their performance.

What Is Reaction Time Testing?

Reaction time is the elapsed time it takes an individual to respond once they are delivered a stimulus prompt, such as a visual, audible, or tactile signal. A common testing technique includes a computer that delivers visual prompts on a screen, and a mouse with a button, which the user has to press for the system to record the user's response.

The value of any reaction time test is that it reflects the information processing capabilities of a person's nervous

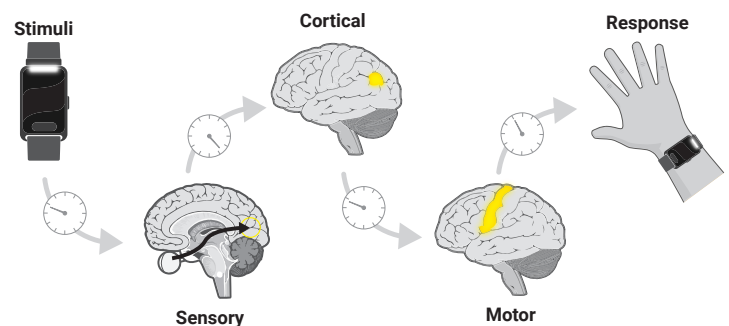
system. The test has become one of the elemental measurements of how quickly and effectively an individual can execute mental operations. A single test can also measure the processing efficiency of a person's brain functions—such as sensory perception, cognition, generation of motor commands, spatial reasoning, and language.

The science of studying processing speed and reaction time for cognitive tasks is known as **mental chronometry**—a rich area of study that has been around for more than 200 years. Studies have shown that there is a direct correlation between reaction time and athletic performance as well as cognitive abilities.⁷

Factors that improve reaction time include not only repetitive training exercises, but also cardio and weight training, hydration, sleep, and a positive mental state of mind.^{2,3,4,5}

Conversely, factors that impair reaction times include the ingestion of drugs and alcohol, brain trauma, fatigue, and cognitive decline from neurological diseases (e.g., dementia, Alzheimer's Disease, and Parkinson's Disease)⁶ For instance, reaction time has been shown to elevate (relative to a baseline) as long as a couple of months after a

Figure 1: Mental Chronometry



1. *Correlation Analysis of Sprint Performance and Reaction Time Based on Double Logarithm Model*, hindawi.com.
2. *Caffeine Reduces Reaction Time and Improves Performance in Simulated-Contest of Taekwondo*, Victor G. F. Santos and others, *Nutrients*, February 2014.
3. *The Effect of Sleep Deprivation on Choice Reaction Time and Anaerobic Power of College Student-Athletes*, Morteza Taheri-PhD and others, *Asian Journal of Sports Medicine*, March 2012.
4. *Sport-specific reaction time after dehydration varies between sexes*, P.H. Falcone and others, *Journal of The International Society of Sports Nutrition*, November 2014.
5. *Reaction Time Improvements by Neural Bistability*, Henk Koppelaar and others, *Behavioral Sciences*, March 2019.
6. *Measurement of Reaction Time in the Home for People with Dementia: A Feasibility Study*, by Catherine S. Cole-PhD and others, *Biological Research For Nursing*, Volume 15, Issue 2, October 9, 2011.

diagnosed concussion.⁷

Today, reaction time testing is an important cognitive measurement technique in various fields. These include sports science, psychology, neuroscience, human factors engineering, and cognitive science.

The Types of Reaction Time Measurements

Three primary reaction time tests measure a person's cognitive abilities:

- Simple Reaction Time Test—The user is presented a stimulus and asked to respond as quickly as possible. This test measures whether the user is ready to react.
- Choice Reaction Time Test (or Go/No-Go test)—The user is presented with multiple stimuli and instructed to respond to only certain stimuli, such as a test that displays a green light or red light, and the user is asked to respond only to the green light. This test measures mental agility or how quickly a user can process the information provided by the different stimuli and make decisions.
- Psychomotor Vigilance Test—This test is the gold standard for cognitive evaluations such as concussion testing and fatigue testing. It requires the user to respond to a stimulus over an extended time, often three minutes. The results reflect the user's ability to focus or maintain attention.

The Importance of Reaction Time in Sports and Business

Reaction time testing provides valuable information to both elite athletes and knowledge workers in the business world. In the sports world, faster reaction times lead to on-field success.⁸ Detailed reaction time results can guide individual athletes to adjust training regimens that improve their performance or signal when to back off training because of the risk of over-training or head trauma.

Consistently measuring reaction time, mental agility (or decision-making), and focus capabilities as part of a cognitive assessment can help athletes continuously improve in multiple facets across every sport and reach new levels of success. Here are a few examples:

- Simple Reaction Time Testing—football players on defense, timing their rush with the snap of the ball; hockey goalies reacting to slapshots.
- Mental Agility Testing—baseball players at bat, deciding whether to swing at a pitch; basketball players driving to the basket, choosing whether to pass or shoot.
- Focus Testing—race car drivers holding speed and track position after two hours of racing; tennis players continuing to strategically place shots during a long rally.

In the business world, the ability to react, make decisions, and focus is critical in any job that requires quick responses, snap decisions, or extended time on tasks. The three types of reaction time tests can measure a user's ability to perform cognitive tasks, especially when facing stress and fatigue.

Here are a few examples:

- Simple Reaction Time Testing—a CEO answering questions during an investor call or shareholder's meeting; a lawyer presenting opening arguments to a jury.
- Mental Agility Testing—a software engineer testing code to identify the source of a bug; a mutual fund manager evaluating stock market dynamics and deciding whether to buy or sell shares.
- Focus Testing—a truck driver avoiding an accident at the end of a day-long drive; a neurosurgeon completing a lengthy operation.

Measuring simple reaction time, mental agility, and psychomotor vigilance regularly helps track cognitive

7. *Interpreting Clinical Reaction Time Change and Recovery After Concussion: A Baseline Versus Norm-Based Cutoff Score Comparison*, by Jaclyn B. Caccese-PhD and others, *Journal of Athletic Training*, August 2021.

8. *Reaction Time Aspects of Elite Sprinters in Athletic World Championships*, by Espen Tønnessen and others, *Journal of Strength and Conditioning Research/National Strength & Conditioning Association*, April 27, 2013.

abilities. This helps establish a baseline and allows users to manage sleep, diet, hydration, physical training, and stress to improve their reaction times.

The Challenges of Traditional Reaction Time Testing Systems

Traditional reaction time testing has often been conducted using online computerized assessments—where users interact with a testing website through a laptop, desktop, or mobile device. These systems have significant drawbacks:

Inaccuracy due to system delays—Testing systems that involve monitors, computers, keyboards, mice or touchscreens introduce errors that render reaction time readings unreliable. For example, the time to show the stimulus on the screen, press the mouse button, and register the signal each introduces timing variability that masks the cognitive issues being measured.⁹

Lack of access—Elite athletes may have access to reaction time testing systems through their performance coaches and sophisticated training facilities. Casual and serious athletes as well as business people rarely, if ever, have access to reaction time testing systems.

Inconvenient for the performance environment—Reaction time testing systems are currently set up outside of the actual performance environment, such as in the trainer's office, clinic, or a computer room. That means that measuring abilities are limited, making it difficult to get a sense of reaction time when it matters most. They are on the field under stress, or in the morning when users can't monitor themselves under all conditions, such as when trying to increase alertness.

An Accurate Platform to test Mental Agility and Cognition

To accurately measure and track cognitive performance—including readiness, mental agility, and focus—athletes and people in stressful jobs can turn to Pison. Pison's novel neural sensor and artificial intelligence algorithms are built into a lightweight device that measures neural reaction time directly at the wrist.

The device allows you to measure your reaction time, mental agility, and ability to focus by using standardized protocols. You can then monitor your results over time and compare your results to other users.

Pison provides three test types to measure cognitive performance:

- **Cognitive Readiness**—a 15-second simple reaction test.
- **Mental Agility**—a 60-second Go/No-Go recognition and reaction time test.
- **Cognitive Focus**—a 3-minute psychomotor vigilance test showing your ability to maintain attention and focus on tasks.

By measuring reaction, recognition, and focusing capabilities, Pison devices provide insights that improve the performance of athletes and people in high-stress jobs. They and their coaches and managers get data they can use to identify factors that improve and impair performance with tests that are easy to take and generate accurate, consistent results.

Pison testing devices also improve safety by identifying longer reaction times that might indicate an impairment, such as a head injury. With the ability to analyze results in context with impairment factors, athletes, frontline personnel, executives, and managers can get the data they need to monitor and improve their health.

Pison devices provide two advantages over other reaction time monitoring systems.

The first is **convenience**. With the ability to run three tests 24/7, taking anywhere from 15 seconds to three minutes, you can measure more often and under different conditions. Regularly conducting these cognitive tests provides new insights into lifestyle habits and choices that optimize versus impair cognitive performance.

Athletes, performance coaches, and businesspeople can use reaction time testing methods to establish a baseline and drive training programs that improve in-game and at-work cognitive performance.

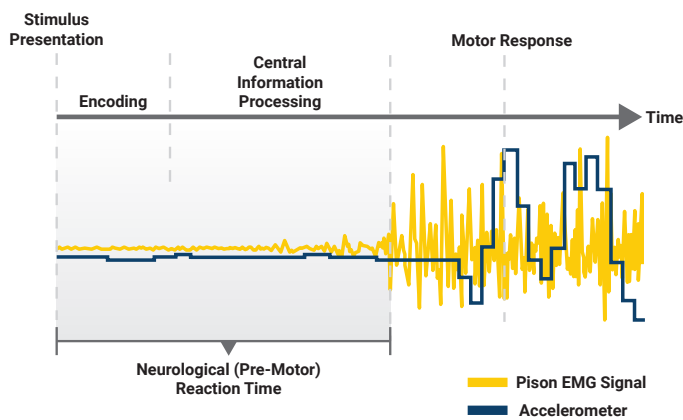
9. *Methodological Problems With Online Concussion Testing*, Jameson Holden and others, *Frontiers in Human Neuroscience*, October 1, 2020.

These tests can be conducted throughout the day and in any environment, including in the gym, on the field of play, at the office, or at home.

The second advantage is **accuracy**. The self-contained Pison devices generate stimuli and then measure neural reactions directly off a common system clock. This eliminates the delays of computer-based testing systems and allows Pison to measure reaction time without the variability introduced by computer-based reaction time tests. This results in repeatable and reliable test times with one millisecond (0.001 seconds) precision.

In addition, Pison provides an accurate measurement of the pre-motor time, which is the time it takes for the individual to sense the stimulus and the brain to send electrical signals to the hand to excite the muscles to respond. With this information, users gain an objective measure of the responsiveness of the nervous system and can measure the impact of mental and physical exercises on the nervous system.

Figure 2: Pison Pre-motor time



Start Using Neural Sensor and Reaction Time Monitoring

For more information on Pison reaction time testing devices, or to get started with neural sensor and reaction time monitoring, visit www.pison.com.