



WHITE PAPER

Clinical Use Case of the NeuroCatch[®] Platform: Treating Concussion and Unlocking Peak Brain Performance

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AN OBJECTIVE, PHYSIOLOGICAL MEASUREMENT OF BRAIN FUNCTION

Until recently, a gap in healthcare existed: an unmet medical need for a rapid, objective, physiological measurement of brain function. In essence, a *vital sign* for brain function. Potential brain vital sign measures do exist and are used primarily in research settings.^{1,2} Event-related potentials (**ERPs**), measured by means of electro-encephalography (**EEG**), are well characterized in research literature³ as a physiological measure of brain function. The NeuroCatch® Platform is designed to take research methods from the lab to the playing field, rapidly recording and analyzing ERP responses using portable EEG devices and providing automated, standardized and clinically intuitive results.

Being able to objectively track subtle changes in brain health has large implications for those with impaired brain function. In line with this, after initial validation in healthy adults⁴ and in collaboration with partners at Simon Fraser University and Surrey Memorial Hospital, NeuroCatch® was first deployed to the Mayo Clinic in a multi-year academic research program examining concussions in ice hockey.

The results of this study, published in *Brain (Editor's Choice)*, showed characteristic changes in brain vital signs when hockey players were monitored between baseline, injury, and return-to-play (Figure 1). Importantly, brain vital signs changes in concussion also appeared to be associated with a specific 'profile' shape (triangular), which could help guide healthcare professionals when making clinical decisions regarding the status of recovery in concussed players (Figure 1).⁵ These brain vital sign changes were consistent with previous literature showing that ERPs have enhanced sensitivity to post-concussive changes in brain function, which may not be detected by traditional cognitive assessment tools and neuro-psychological tests that rely on symptom-based reporting.⁶

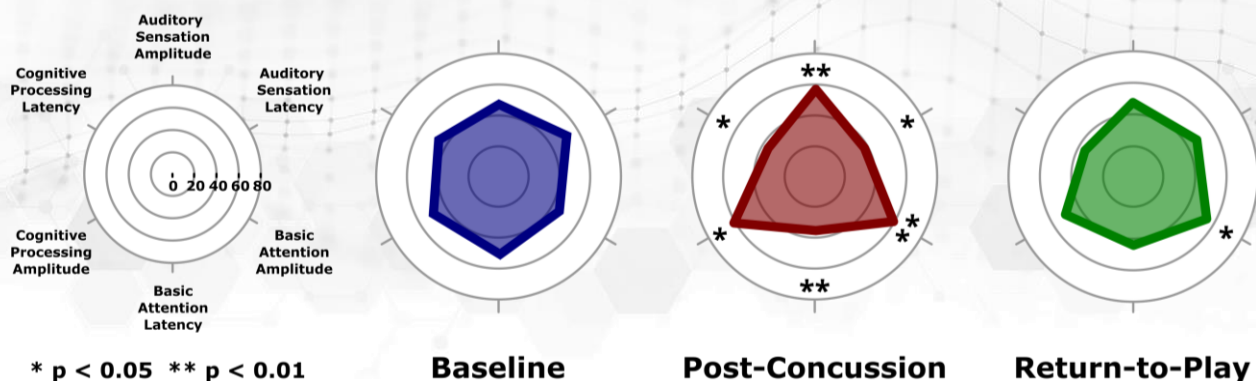
A critical development in the brain vital sign framework was the translation from complex neuro-physiological waveform signals to a simplified and intuitive graphical display using a radar plot. When all six standardized results are plotted using radar plots, it is possible to establish a healthy brain vital signs profile: a symmetric hexagon around the 50th percentile range. The hexagon shape has been verified across increasing normative ranges and provides a critical reference range in which individual results can be compared and tracked. Figure 1 shows brain vital sign changes from healthy baseline to immediate post-concussion to

return-to-play in youth ice-hockey athletes as an example of the visual radar plot display.

The initial evidence demonstrated that brain vital signs can be successfully deployed as a rapid, fully automated, and field-tested scientific framework, which showed strong initial reliability and validity

results in both healthy and impaired brain function.^{4,7} Since then, an array of concussion-focused applications have rapidly developed, which in turn, have highlighted the flip side of the concussion epidemic – switching the focus to brain performance optimization. Below is the Kalyn Ponga Case study highlighting this important concept:

Figure 1. Mayo ice-hockey concussion results. (The research study was designed and carried out by the Mayo Clinic Sports Medicine Ice Hockey Research team, partially funded by USA Hockey and the Johansson-Gund Endowment).



CLINICAL USE CASE: THE KALYN PONGA STORY

Kalyn Ponga is the co-captain of the Newcastle Knights (Australian rugby team) and one of the star players of the National Rugby League (NRL). Kalyn sustained four serious concussions within 10 months (Figure 2). This alarming frequency sparked

widespread debate over whether his latest concussion would force an early end to his illustrious playing career.

His neurologist, Dr Chris Levi, collaborated with Dr. Ryan D’Arcy and was familiar with the NeuroCatch® technology and suggested that Kalyn’s treatment plan could be guided by an objective, physiological measure of his brain function.

Figure 2. [Fox Sports Australia – March 12, 2023](#)

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'Lights out': Ponga's fourth concussion in 10 months puts his 2023 season in question



Knights superstar Kalyn Ponga is knocked out after just 90 seconds. Fox League

Source: FOX SPORTS

 Eamonn Tiernan from Fox Sports
 @eamonn_tiernan

March 12th, 2023 9:59 pm

Following an extensive clinical review by the NRL expert panel, the decision was taken to send Kalyn to Canada for NeuroCatch® evaluation and treatment with advanced concussion intervention protocols that had been previously identified by NeuroCatch® scientific studies. Kalyn made the journey to Vancouver, British Columbia on March 25, 2023, for an intensive visit to the Surrey Neuroplasticity Clinic at HealthTech Connex (Figure 3). While in Vancouver, Kalyn began an intensive cognitive training program.

 Figure 3. [The Guardian - March 24, 2023](#)

NRL star Kalyn Ponga heads to Canada for concussion recovery

- Newcastle captain suffered fourth concussion in 10 months in Rd. 2
- Ponga to undergo brain testing in Vancouver before resuming career



Knights star Kalyn Ponga leaves for a HIA after a tackle against Wests Tigers at Leichhardt Oval in Rd.2. Photograph: Brendon Thorne/AAP

Upon arrival, Kalyn was evaluated with NeuroCatch® along with other assessments to benchmark his functional status. Using NeuroCatch® data, the clinical team created personalized protocols for Kalyn. Throughout the program, NeuroCatch® technology objectively monitored how his brain responded to the training interventions, allowing his clinical team to make informed decisions regarding dosage and treatment intervals. The customized treatment plan, implemented over several weeks, allowed Kalyn to not only accelerate successful recovery, but to quickly shift the focus to enhancing his cognitive processing speeds for performance optimization. The team worked with Kalyn and his team physician to further development in sport-specific cognitive skills, such as decision-making and attentiveness. Kalyn was subsequently cleared and returned to play shortly thereafter (Figures 4 & 5).

Figure 4. [Fox Sports Australia – April 2, 2023](#)

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'It's been a positive trip': Ponga's shock expected return date in huge Knights boost



NRL 2023 RD01 New Zealand Warriors v Newcastle Knights - Kalyn Ponga NRL Photos

Source: The Daily Telegraph

Tom Sargeant from Fox Sports

April 2nd, 2023 5:19 pm

Figure 5. [ABC News – April 13, 2023](#)

Newcastle Knights star Kalyn Ponga to return to field after concussion scare

ABC Newcastle / By Keely Johnson

Posted Thu 13 Apr 2023 at 10:52pm, updated Fri 14 Apr 2023 at 12:23am



Kalyn Ponga will return to the five-eighth position next week. (AAP: Darren England)

Given the high-impact nature of the sport, emergency approval was obtained to send a NeuroCatch® device to Australia to monitor Kalyn's brain function during subsequent "head knocks" concussion concerns (Figure 6).

Figure 6. [Daily Mail – May 20, 2023](#)

Kalyn Ponga lasts less than four minutes in NRL match against Sharks before suffering ANOTHER alarming head knock with Origin selection around the corner

- Kalyn Ponga has suffered another head knock
- Later was cleared and returned to play Sharks
- Queensland name their Origin team on Monday

By ANDREW PRENTICE FOR DAILY MAIL AUSTRALIA

PUBLISHED: 02:18 EDT, 20 May 2023 | UPDATED: 04:52 EDT, 20 May 2023



Kalyn Ponga's chances of Origin selection for Queensland are on a knife's edge after yet another head knock in the Knights' clash against the Sharks on Saturday

Recently, after another potential brain injury, Kalyn was rescanned and cleared back immediately after no notable changes were demonstrated in his NeuroCatch® results. National headlines related to Kalyn quickly shifted to focus on his extraordinary performance. Kalyn currently continues to dominate Australian headlines with reviews of his exceptional performance despite further "head knocks," demonstrating continued confidence and resilience rather than his career's anticipated end (Figure 7).

Figure 7. [Daily Mail – June 10, 2023](#)

Kalyn's back! Ponga puts his concussion worries behind him with stunning try against the Broncos as Knights skipper delivers Origin message to Billy Slater

- Kalyn Ponga scored a superb try as the Knights took the lead in Brisbane
- The Newcastle skipper was dropped for Origin I in favour of Reece Walsh
- Billy Slater attributed the decision to concern over Ponga's welfare

By DAN CANSIAN FOR DAILY MAIL AUSTRALIA
PUBLISHED: 04:42 EDT, 10 June 2023 | UPDATED: 06:46 EDT, 10 June 2023

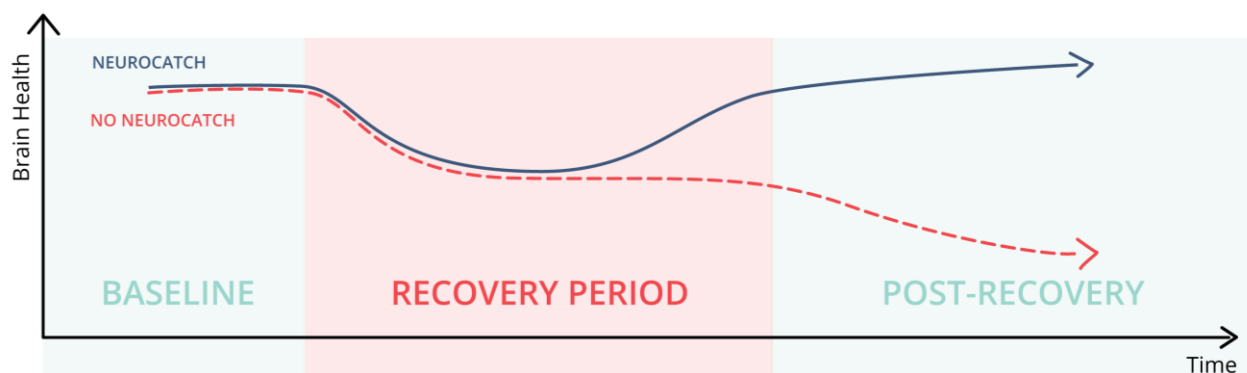


Kalyn Ponga scored a superb try for the Knights against the Broncos on Saturday night

Objective biomarkers of brain health can be used to help characterize a positive outcome trajectory, and minimize the dangers associated with current "best guess" tools. Figure 8 depicts a theoretical recovery trajectory using an objective physiological marker of brain function, like

the NeuroCatch[®], compared to traditional cognitive assessments. Many of these cognitive assessments are susceptible to extraneous influences and are only a best-guess approximation of current brain function state. For example, indirect behavior-based tests are reported to have misdiagnosis rates as high as 43%,^{1,8} and results are often confounded by interrater variability and lack of sensitivity to mild changes.⁹ More comprehensive tests of cognitive function often rely on neuropsychological batteries of attention, perception, memory, and executive function. Unfortunately, these assessments depend on a person's ability to produce on-demand responses, and are restricted by limitations in communication and motor movement - which may be a secondary issue and not reflective of actual brain function.¹⁰⁻¹⁶ The risks of an incorrect diagnosis to athletes applies in both directions: they may be incorrectly benched, or return-to-play too soon (Figure 8).

Figure 8. Theoretical recovery trajectory using NeuroCatch[®] compared to traditional cognitive assessments.



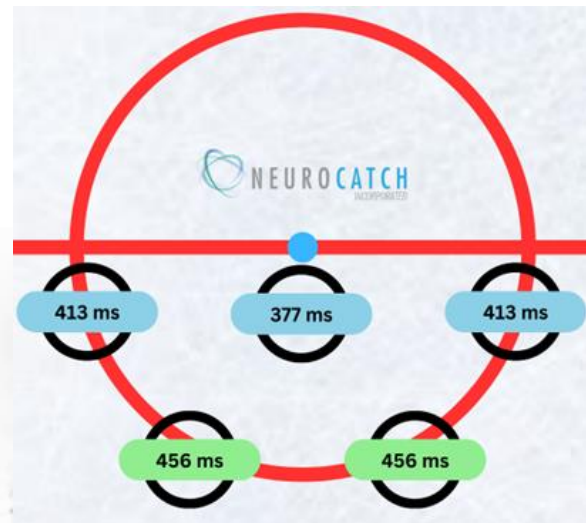
Kalyn’s prominent clinical case study attracted significant attention in Australia, leading to official NRL authorization for NeuroCatch® implementation across all 17 of its teams. Interest also sparked among other contact sports organizations, including Rugby Union, Australian Rules Football, and the Australian Institute for Sports. Australian collaborators are working to expedite regulatory approvals for an extensive rollout of NeuroCatch®, extending into the women’s NRL league as well as high school level contact sports. Since then, the HealthTech Connex team has been working closely with a growing network of specialists in Australia who are interested in quickly scaling the clinical collaboration fully through a wide span of concussion priority sports such as the NRL Women’s Rugby League, Rugby Union, Australian Rules Football, high school rugby, and other contact sports.

PERFORMANCE OPTIMIZATION

In addition to guiding clinical decision making, having a trackable metric like ERPs can help track cognitive performance optimization changes over the course of an athletic season, and can help empower athletes with a metric that can be changed. A recent example from an all-star Junior-A hockey league in British Columbia, Canada showed significant differences in N400

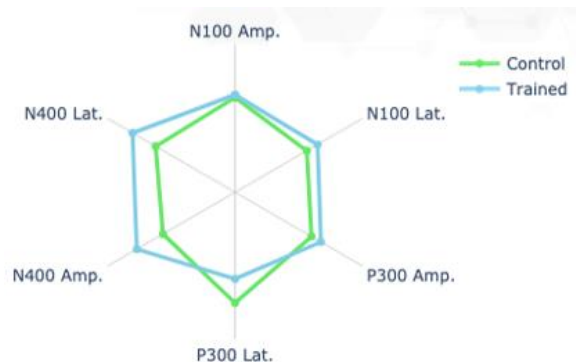
latencies between the forwards (in blue) and the defensemen (in green; Figure 9).

Figure 9. Differences in N400 latencies between hockey forwards (blue) and defensemen (green).



The N400 latency (speed) is a measure of cognitive anticipation. Hockey forwards are responsible for processing the surrounding environment to identify opportunities to the net, while defensemen are more reactionary, spending more time reading the ice and responding accordingly. Mental processing speeds (N400) aligned with these differences. Knowing this, both coaches and players can train to optimize a player’s performance based on their individual needs (Figure 10).

Figure 10. Impact of cognitive training (seven 30-minute sessions) on the N400 in hockey players. Control N = 13, Trained N = 7.



CHANGING THE NARRATIVE: BRAIN PERFORMANCE AND HUMAN OPTIMIZATION

Kalyn’s example demonstrated a successful shift from (a) widespread concerns that multiple concussions would force possible retirement to (b) Kalyn objectively measuring recovery and quickly focusing on brain performance optimization. Kalyn himself flipped the conversation from “concussions ending a professional career” to accelerated return-to-play and cognitive performance training.

It might be initially frightening to consider the emerging objective evidence around the concept of “subconcussive” impacts that accumulate over a season and may contribute to chronic traumatic encephalopathy (CTE).¹⁷ As undetected

contact events, which exist below the threshold of medical care or management, subconcussive damage is certainly worrisome.

Enter dynamically evolving technology factors that are simultaneously influencing the evolution of elite sport, contact or no contact. Sensitive objective physiological measures are increasingly linking the extent of subconcussive changes in cognitive processing are linearly related to the extent of exposure to accumulated impact. Key point: accumulated impact damage is preventable and manageable.

While some argue the problem of contact in contact sport, this notion is quickly becoming outdated in a rapidly changing world. Evaluating impacts in terms of adverse effects on cognitive brain function creates the opportunity to re-focus perspectives on peak brain performance.

Forms of cognitive enhancement, such as optimizing cognitive anticipation, have applications for a myriad of other demanding cognitive workload tasks. The potential to measure the enhancement of cognitive skills has widespread implications, for example, in the context of maximizing military performance. In another sphere, optimizing brain performance in the business world could lead to improved productivity, creativity, and overall well-being. Companies could invest in technologies and programs to help employees maximize their cognitive

function and avoid burnout. This shift in focus could have broader implications beyond just the world of sports. With a physiological measuring stick of brain function available, anyone can be empowered to optimize their brain health.

Complementing Kalyn's example, HealthTech Connex has partnered with Junior A hockey in British Columbia, Canada, to scan the nearly 500 elite athletes in the league. These results are equally noteworthy in 1) helping to safely

and quickly return players who have sustained concussions; and 2) demonstrating brain performance differences in cognitive anticipation between forwards and defenders, is trainable. Currently, the clinical and research work is rapidly scaling this approach across a wide array of performance sports, both contact and non-contact.

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