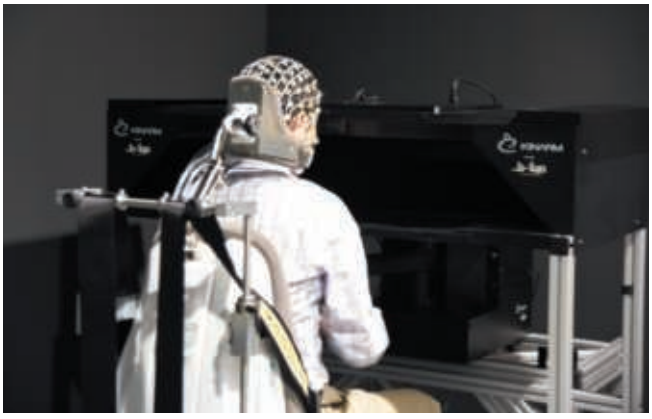
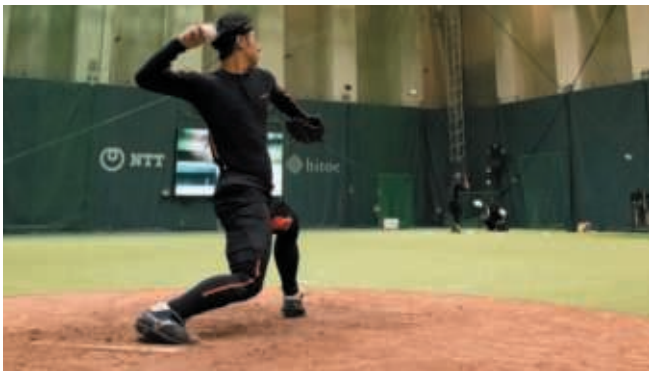
Split seconds matter — the brain and sport

The SPORTS BRAIN SCIENCE (SBS) project harnesses information technology for its data-intensive brain research. Launched in January 2017 by one of Japan's biggest telecommunications companies, NIPPON TELEGRAPH AND TELEPHONE CORPORATION (NTT), it's using cognitive neuroscience to change training as we know it.





In baseball, every millisecond counts. From the moment, the ball leaves the pitcher's hand, the best batters in the world can read the spin and speed, adjust to the trajectory and swing their whole body with optimal coordination — all within 0.5 seconds. By studying what goes on in the brain during such sophisticated decision-making, the Sports Brain Science (SBS) project is helping athletes to raise their game.

Based at the NTT Communication Science Laboratories in Atsugi in the Kanagawa Prefecture of eastern Japan, the SBS project group uses innovative information technology (IT) tools to probe deeply into the unconscious capabilities — or the so-called implicit cognitive functions — of athletes' brains.

"What sets our project apart from other sports training facilities is our focus on investigating implicit brain activity," says SBS project manager and senior distinguished scientist Makio Kashino.

Using a device called the 'smart bullpen', for example, Kashino's team is able to monitor biometric data such as muscle activity and heart-rate during both pitching and batting, and analyse the cognitive performance of each player to an unprecedented degree.

The new evaluation methods made possible by the smart bullpen, combined with NTT's state-of-the-art eye-tracking technology (enabling analysis of tiny, involuntary eye movements known as microsaccades), are attracting the attention of top athletes and coaches in Japan.

DECISION-MAKING OCCURRED... IN LESS THAN 0.1 SECONDS

Softball player Eri Yamada, a gold medalist at the 2008 summer Olympics in Beijing, recently visited the SBS labs and underwent biometric analysis. In contrast to rookie players, Yamada's data from the smart bullpen revealed her superlative ability to detect and adjust her body positioning prior to hitting a changeup (slower-speed) ball, as opposed to a straight ball. Time-motion analysis showed that her decision-making occurred — as with the best baseball players — in less than 0.1 seconds.

A wearable sensor named hitoe®, developed by NTT in collaboration with Toray Industries, is also being used to collect data on the heart's electrical activity, which can be further analysed to help athletes train more effectively. Consisting of light, flexible nanofibers (with a diameter of 0.7 μm), hitoe® offers a non-invasive, non-restrictive approach to studying athletes in real-world settings.

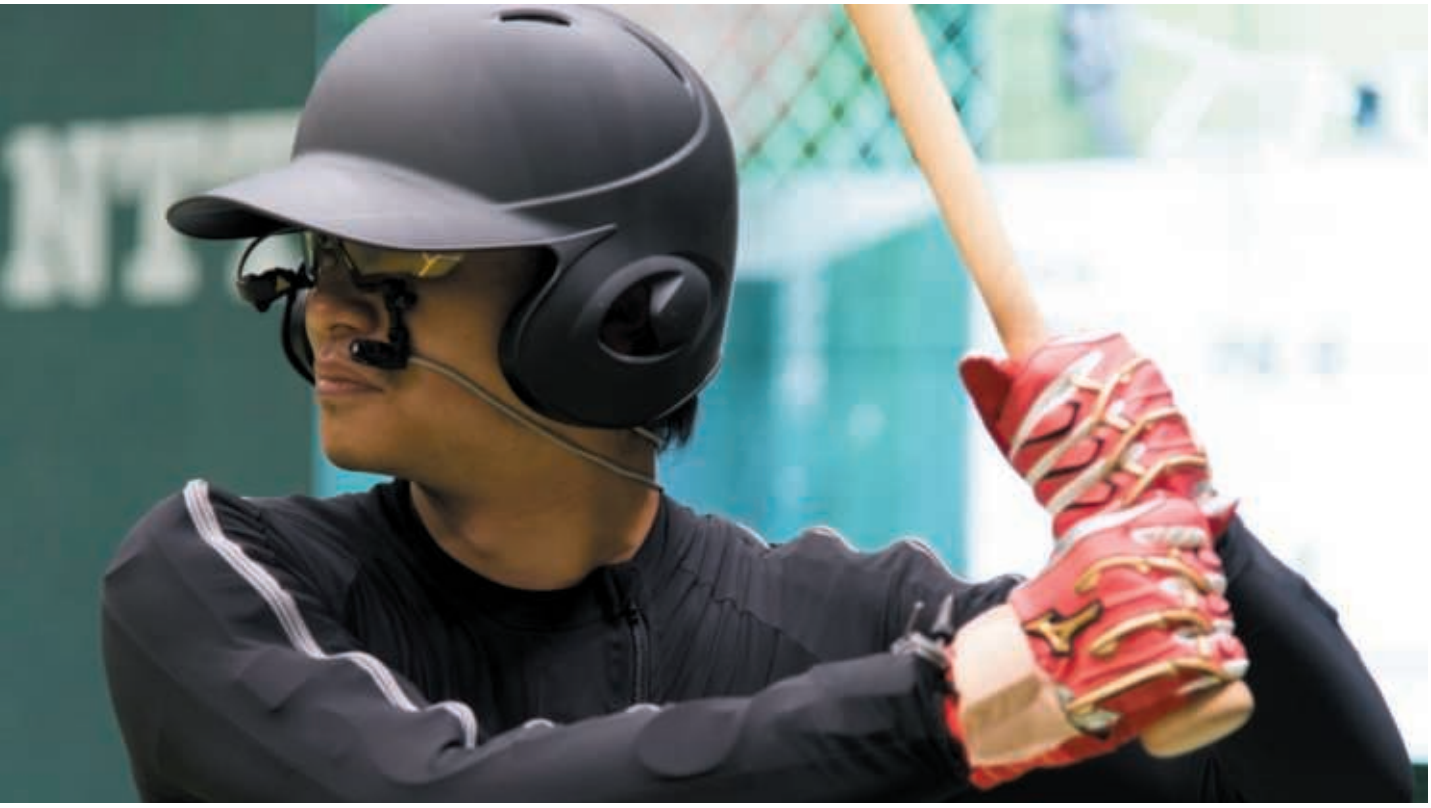
While noting that the project is still in its initial phase, Kashino says: "We felt it was the right time to pursue the SBS project primarily due to the advancement of technologies such as wearable sensors."

"Our aim is to support athletes by bridging our expertise in cognitive science with the latest technologies in order to design new high-performance training methods."

Honing athletic instincts

Identifying the cognitive elements of top athletic performance is the first step towards further developing new training techniques. For example, Kashino says that one characteristic shared by top baseball players is their ability to look at the big picture instead of a single focal point. "This is what we call 'distributed view' or *enzan no metsuke*," he says, referring to a Japanese phrase used in the martial art kendo that means 'gazing at distant mountains'. Cultivating this perspective may enable players to see subtle signals (from the environment or opponent) that might otherwise be missed.

"What's interesting is that top players are often unaware of these implicit brain functions," Kashino continues. "This makes it extremely difficult to verbalise, let alone teach, such masterly skills. Our



project seeks to overcome this difficulty by uncovering the nature of the brain's 'internal model'. Based on an IT method we developed called 'body-mind reading technology', we can use biometric data to infer processing mechanisms within the brain, and then develop methods to reinforce or enhance this unconscious ability."

The SBS project team includes specialists in auditory perception, and experts in visual perception and motor control. The former are developing ways to convert actions (such as the specific timing or amount of force used by an athlete) into sound signals instead of verbal instructions — these sounds may help athletes to train more intuitively. The latter, Kashino says, are "finding new ways to predict batting performance and potential through visuomotor experiments, for example, by analysing involuntary arm responses based on dynamic visual information."

The ultimate goal of the project is to develop more efficient ways of training athletes of all levels (junior, amateur, semi-professional and professional), to assist coaches and sports analysts and promote early detection of talent.

IT, AI and big data

The SBS project is partly funded by the Japan Science and Technology Agency's CREST programme, with an eye to accelerating innovations in the lead-up to the Tokyo 2020 Olympic and Paralympic Games.

Baseball and softball will be included in the 2020 Olympics, and Kashino adds that information gleaned from the SBS project will undoubtedly also be relevant to other sports involving similar split-second reactions, such as tennis, badminton and martial arts.

As a leading global IT innovator, the NTT Group has already collaborated with tennis star Kei Nishikori to develop a unique virtual reality system enabling users to experience facing Nishikori's serve.

Findings from the SBS project may also impact other fields including rehabilitation, education and entertainment. Tapping into the potential of artificial intelligence (AI) technologies and the Internet of Things (IoT) will also be critical.

"Currently, we know that AI technologies work well in restricted domains, such as chess and *shogi*," says Kashino. "The challenge will be how to make AI more tailored towards athletes. There are many unknown factors in sports, such as varying stadium conditions and noise from fans. Top athletes are able to process these complicated factors and adjust their performance accordingly. Our task is not simply to fine-tune existing models, but to invent brand new paradigms for AI and utilise IoT to collect big data."

Highlighting the importance of collaborating with top international teams, Kashino says: "We welcome enquiries from athletes, coaches and sports analysts interested in partnering with the SBS project. Researchers interested in working with us on areas such as cognitive neuroscience, virtual reality, machine learning and media technology are also encouraged to contact us." ■

NTT