

# Cognitive Assessment and Profiling for increased understanding of Individual and Team Game Intelligence and Performance in Ice hockey

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**Abstract.** Game intelligence, the ability to be in the right place at the right time and make optimal decisions, is crucial for athletic performance. This whitepaper explores how neurocognitive testing and profiling can deepen our understanding of game intelligence, which includes elements such as situational awareness, decision-making, problem-solving, and flexibility.

The whitepaper targets sports professionals aiming to enhance their understanding of game intelligence through neurocognitive assessments. The assessments mentioned in the paper provide insights into athletes' cognitive strengths and weaknesses, aiding in talent identification, personalized coaching, strategic team composition, tactical adaptations, and injury prevention. Executive functions are crucial in both open sports (e.g., soccer, basketball) and closed sports (e.g., archery, golf). For example, in ice hockey, players must continuously adapt to dynamic environments, requiring quick decision-making, strategic thinking, and creativity.

Integrating neurocognitive assessments into sports practices has the potential to enhance the understanding of game intelligence, reduce subjectivity and bias, and improve individual and team performance, as well as ensure the wellbeing of athletes through tailored mental health support and coping strategies. Testing and profiling of individuals and teams can practically help enhance understanding of Game Intelligence. The process involves assessment, awareness, individual acceptance, strategic development, integration into coaching, and continuous follow-up to monitor progress and aid adjustments.

## Game Intelligence in Sports

Game intelligence, the ability to be in the right place at the right time and make the right decisions, is a critical aspect of athletic performance. This whitepaper explores how neurocognitive testing and profiling can deepen our understanding of game intelligence, encompassing elements such as situational awareness, decision-making, problem solving and adaptability.

## Understanding Game Intelligence

Game intelligence refers to the cognitive skills and processes that enable athletes to anticipate play developments, make strategic decisions, and execute actions

effectively under varying conditions. Recent scientific studies indicate that distinct aspects of game intelligence can be predicted by examining specific executive functions (EFs) such as attention, working memory, cognitive flexibility, creativity, and impulse control.

### **Defining Game Intelligence and Executive Functioning**

- **Game Intelligence:** The ability to understand and anticipate game situations, make strategic decisions, and execute appropriate actions. Or to be at the right place at the right time and do the right thing.
- **Executive Functioning :** The cognitive processes enabling individuals to focus on the right things and perform successfully in constantly changing environments. This ability varies between individual, and depend on a combined set of cognitive functions that interact.

These definitions highlight the executive functioning are central in forming game intelligence. Measuring and understanding executive functions can hence help understand distinct aspects of game intelligence, create insights, and aid us in how to coach and apply efficient strategies that support an athlete's performance and development.

### **Target Audience**

This whitepaper is intended for sports professionals seeking to enhance their understanding of game intelligence, including scouts, sports directors, coaches, general managers, mental coaches, physiotherapists, and athletes. By integrating neurocognitive assessments into their talent identification, development and coaching processes, these professionals can gain a more comprehensive understanding of an athlete's potential and performance capabilities and integrate this knowledge to better support the development of individual athletes. As well of the optimal function of a team.

### **The Role of the Brain in Game Intelligence**

The Brain and in particular Executive Functions in the frontal lobe are crucial for controlling and regulating information processing, thoughts, emotions, and performance. They include among others:

- **Attention:** Focusing on relevant information while ignoring distractions.
- **Short Term Memory:** Retaining and utilizing information over brief periods.
- **Working Memory:** Holding and manipulating information over short periods.
- **Impulse Control:** Suppressing inappropriate actions or responses.
- **Cognitive Flexibility:** Adjusting to changing situations and demands.
- **Creativity:** Generating novel ideas and solutions.

- **Conceptualization:** Forming and manipulating concepts.
- **Strategic Thinking:** Planning and executing strategies.

There are significant differences in cognitive functioning between individuals (and athletes). By assessing these differences, we can create cognitive profiles, where strengths and weaknesses of the individual can help us understand aspects of game intelligence and how to work with individual strengths and potential while finding efficient strategies to compensate for weaknesses. Based on the athletes' different cognitive profiles, it is possible to apply strategies that improve both individual and overall performance of teams. It is also possible to improve well-being among athletes by understanding and basing coaching and the athletes' roles of individuals cognitive profiles.

### **Measuring Cognition and Executive Functioning**

Cognitive neuroscience has existed as a science for more than 80 years with the purpose of better understanding individuals based on their inherent abilities and help optimize function. The last couple of decades research has spread from focusing on function deficit to also study talent and top performance, particularly in sports.

Neurocognitive tests have been developed to measure these abilities and can be used to provide a detailed profile of an athlete's cognitive strengths and weaknesses. Cognitive capacities in executive functions are intricately linked to an individual's executive performance, which refers to their ability to function effectively in dynamic and demanding environments. Research constantly indicates that the validity of these measurements is high, ranging from 70-90% when it comes to measuring the capacity of these functions, on both general and athletic populations.

### **Application in Sports - Talent Identification and Development**

By using neurocognitive profiling, sports organizations can better understand an athlete's cognitive capacities, which are crucial for game intelligence. These insights can facilitate better decisions related to scouting, team composition, and both personalized and situational tactics and coaching strategies for individuals and teams. An increased self-awareness and understanding of others can also improve team dynamics and collaboration.

### **Open and Closed Sports**

Open sports are activities where the environment is unpredictable, and athletes must respond to changing conditions and the actions of opponents. Characteristics:

- **Unpredictable Environment:** Conditions change constantly, requiring quick adjustments.

- **Reactive:** Athletes must react to opponents, teammates, and environmental factors.
- **Examples:** Soccer, basketball, tennis, rugby, hockey.

Closed sports are activities performed in a stable, predictable environment where the athlete initiates the action. Characteristics:

- **Predictable Environment:** Conditions remain stable, allowing for consistent execution.
- **Self-Paced:** Athletes control the timing and pace of their actions.
- **Examples:** Archery, golf, bowling, gymnastics routines, diving, target shooting.

Key Differences between Open and Closed Sports:

- **Environment:** Open sports have dynamic and unpredictable environments, while closed sports have stable and predictable ones.
- **Action:** Open sports require reactive skills, while closed sports rely on pre-planned, self-paced actions.

#### **General examples of Executive Functions in Open Sports**

- **Attention in High-Pressure Situations:** Studies show that high-level attention is critical in sports where multiple events occur simultaneously, such as basketball soccer, hockey etc. Enhanced situational awareness allows athletes to perceive and respond to dynamic play developments effectively.
- **Working Memory in Complex Play:** In sports like soccer, handball, football, basket, baseball etc, athletes need to hold information, such as instructions, online, and act on rapidly on them. Working memory facilitates the retention and application of these instructions during fast-paced games, for example adaption and integration of the instructions with the ongoing game.
- **Cognitive Flexibility and Creativity in Soccer:** Midfielders and forwards, especially in soccer and ice hockey, require elevated levels of creativity and cognitive flexibility to switch between offensive and defensive roles seamlessly and generate novel multi-step solutions to emerging challenges.
- **Speed vs. Accuracy in Decision-Making:** The balance between speed and accuracy varies across sports. For instance, in football and ice hockey, quick decision-making often takes precedence over precision due to the fast-paced nature of the games. Hence the focus on ball possession and retaking the ball. In contrast, handball emphasizes accuracy, as the sport involves more structured play, and the consequences of mistakes are magnified. Hence the focus on not losing the ball.
- **Impulse Control in Timing Actions:** An athlete's ability to regulate and time their actions precisely under pressure is vital. For example, a soccer player may need to control their impulse to shoot immediately and instead

wait for the optimal moment, ensuring a higher success rate. Especially defenders or goal keepers benefit from a strong impulse control not to be lured by an opponent, a process that requires behavioural inhibition. The timing is crucial and missing the action may result in a goal and a lost match.

- **Strategic Thinking in Pre-Planned Plays:** Sports like American football, basketball, and handball often involve complex, pre-planned plays. Athletes must learn and execute these plays accurately, which requires strong strategic thinking and memory skills combined.
- **Variability in Performance:** An athlete's executive functioning can fluctuate based on conditions such as fatigue and stress. For example, a player's impulse control might be high in calm situations but diminish under pressure, affecting their timing and emotional regulation. Understanding individual sensitivity to changes within and around may allow athletes to optimize in a decisive way to be at their best when it matters.

### **Importance of Executive Functions in Ice Hockey**

Ice hockey is a fast-paced, high-stakes sport where players must continuously adapt to the dynamic environment. The role of executive functions in ice hockey is critical due to the need for quick decision-making, strategic thinking, and effective communication.

- **Focus and Attention:** During a power play, a player must maintain focus on the puck while being aware of the positions of teammates and opponents. This requires sustained attention and the ability to filter out irrelevant stimuli.
- **Cognitive Flexibility:** A defenseman might initially plan to pass the puck to a teammate on the left, but if an opponent intercepts that path, they need to quickly switch strategies and find an alternative passing route or decide to clear the puck.
- **Creativity:** Players must employ creative thinking to devise unexpected plays and manoeuvres, such as innovative passing sequences, deceptive shots, and creative dekes to outmanoeuvre opponents and create scoring opportunities.
- **Inhibition Control:** Controlling impulses is vital during face-offs and when checking opponents. A player must avoid unnecessary penalties by restraining from actions like high-sticking or tripping, which could harm the team.
- **Working Memory:** Players need to remember and execute complex play formations, such as a breakout strategy from the defensive zone. They must also recall the tendencies and strategies of the opposing team from pre-game analysis.
- **Planning and Strategic Thinking:** For a forward breaking into the offensive zone, planning involves deciding whether to pass, shoot, or deke based on the positions of the defenders and the goalie. They must anticipate the possible reactions of their opponents and teammates.

- **Team Dynamics and Communication:** Effective communication and understanding of team dynamics are crucial. Players must quickly interpret and respond to verbal and non-verbal cues from teammates to execute plays successfully, such as a quick pass during a fast break or coordinating a defensive strategy to counter an opponent's attack.

### **Examples of Executive Functions in Closed Sports**

Closed sports, also known as self-paced sports, are activities where the athlete initiates the action and performs in a stable and predictable environment. Understanding and controlling executive functions in these sports is crucial due to the need for precision, concentration, and strategic planning. Here are some examples of closed sports along with the challenges where executive functions are essential:

#### **Archery**

- **Focus and Attention:** Archers need to maintain intense concentration for extended periods to aim and release the arrow accurately.
- **Inhibition Control:** The ability to suppress distracting thoughts and external noises is crucial to maintain a steady hand and precise aim.
- **Cognitive Flexibility:** Adjusting to varying wind conditions or slight changes in lighting without losing focus.

#### **Golf**

- **Planning and Strategy:** Golfers must plan their shots carefully, considering factors like wind, terrain, and distance.
- **Working Memory:** Remembering previous shots, course layout, and adjusting technique accordingly.
- **Inhibition Control:** Managing frustration and maintaining composure after a poor shot to avoid affecting subsequent shots.

#### **Bowling**

- **Attention to Detail:** Bowlers need to focus on their approach, timing, and release to ensure accuracy and consistency.
- **Cognitive Flexibility:** Adjusting technique based on lane conditions and performance of previous frames.
- **Inhibition Control:** Controlling emotions and staying calm under pressure, especially in competitive settings.

#### **Gymnastics (certain routines)**

- **Inhibition Control:** Suppressing nervousness and distractions to perform complex sequences accurately.

- **Focus and Attention:** Maintaining attention on precise execution of movements while ignoring external stimuli.

#### **Target Shooting (e.g., rifle or pistol shooting)**

- **Focus and Attention:** Shooters need to maintain elevated levels of concentration to aim and fire accurately.
- **Inhibition Control:** Suppressing physical and mental distractions, such as muscle tremors or anxiety.
- **Cognitive Flexibility:** Making minute adjustments to aim based on changing environmental conditions.

#### **Diving**

- **Planning and Strategy:** Divers need to plan their dives meticulously, considering the sequence of movements and entry into the water.
- **Working Memory:** Remembering and executing complex routines.
- **Inhibition Control:** Managing stress and maintaining composure before and during the dive to ensure precise execution.

#### **Billiards/Pool**

- **Strategic Thinking:** Planning shots several moves ahead to control the table.
- **Attention to Detail:** Precise control over cue ball and object balls requires intense focus.
- **Inhibition Control:** Maintaining calmness and control, especially in high-pressure situations.

#### **Cycling**

- **Focus and Attention:** Cyclists need to maintain focus on their pace, breathing, and positioning on the bike for extended periods. Any lapse in concentration can lead to decreased performance or accidents.
- **Cognitive Flexibility and quick decision making:** During a race, a cyclist may need to adjust their strategy based on changing weather conditions or the behaviour of other competitors. If a rider breaks away from the pack, the cyclist must quickly decide whether to follow or stick to their planned pace.
- **Inhibition Control:** Cyclists must manage their energy output and resist the urge to push too hard too early in the race, which could lead to burnout. They need to stick to their planned strategy and pacing.
- **Working Memory:** Remembering the course layout, including the locations of steep climbs, sharp turns, and aid stations, is crucial for effective race management. This allows for strategic energy conservation and optimal performance.
- **Planning and Strategic Thinking:** Effective race planning involves setting a pace strategy that considers the cyclist's strengths and the course profile. For example, knowing when to conserve energy on flats and when to push hard on climbs can make a significant difference in overall performance.

### **Importance of Executive Functions**

In all sports, the ability to control executive functions directly impacts performance. To control we need to understand and therefore we need to measure. When measuring it is also important to examine and related capacity to awareness and existing coping strategies that might already be in place.

Based on enhanced awareness, effective adaption of training and coaching can help athletes enhance their performance by improving their mental control, decision-making, and overall strategic approach to their sport. As always in performance-intense environments slight changes may have a significant impact on the result.

### **Practical Implications**

Integrating neurocognitive assessments into sports practices provides a robust basis for:

- **Enhanced Understanding of Game Intelligence:** Improving overall game intelligence by understanding how cognitive functions influence decision-making and situational awareness.
- **Reduce Subjectivity and Bias:** Providing objective data to minimize biases in talent identification, training, and team selection decisions.
- **Enhanced Understanding of Individual Functioning:** Gaining deeper insights into how each athlete's cognitive abilities impact their performance and tailoring support accordingly.
- **Enhanced Talent Identification:** Identifying athletes with high potential based on cognitive profiles.
- **Personalized Coaching:** Developing tailored training programs to, based on cognitive profile, strengths and weaknesses, support development of optimizing and compensating strategies as well as adapt physical, technical, tactical, and mental training.
- **Strategic Team Composition:** Forming teams with complementary cognitive strengths.
- **Tactical and Strategic Adaptations:** Adapting tactics and strategies to leverage cognitive strengths and address weaknesses, both at individual and team levels.
- **Matching Players:** Pairing or grouping players based on compatible cognitive profiles to enhance on-field synergy and effectiveness.
- **Co-Play and Team Dynamics:** Fostering better teamwork and communication by understanding and leveraging cognitive dynamics within the team.
- **Time Efficiency:** Saving time by quickly understanding athletes' cognitive profiles, allowing for faster and more effective training adaptations and decision-making processes.
- **Stress resilience and Well-being:** Enhancing athlete well-being by recognizing cognitive stressors, providing appropriate mental health support, and coping strategies.



- **Injury Prevention and Assessment:** Utilizing cognitive assessments to prevent injuries, including concussions, by identifying risk factors and monitoring cognitive health, and assessing cognitive impact post-injury to guide rehabilitation and return-to-play decisions.

### **Implementing Understanding of Executive Functioning**

- **Assessment and Profiling:** In just 45 minutes, an athlete's cognitive profile can be assessed, providing a robust evidence base for their development. This quick yet comprehensive assessment ensures timely and accurate understanding of cognitive strengths and weaknesses. And can save weeks, months or even years of struggling to coaching and development. Thus supporting a quick transition from Good to Great.
- **Understanding and Awareness:** Fill the gap by understanding the "how" and "why" behind observed performance and behaviour. Engage all relevant stakeholders to ensure an integrated approach, enhancing cooperation and minimizing misunderstandings.
- **Acceptance and Commitment:** Ensure the individual athlete's acceptance of the test results and foster their commitment to working with the insights gained. This step is crucial for effective application and long-term success. Make sure all stakeholders are involved and have a sufficient level of understanding.
- **Optimizing and Compensating Strategies:** Leverage the cognitive profile to identify effective coping strategies not just cognitively, but also across the tactical, physical, technical, and mental domains. This multi-faceted approach ensures comprehensive development and performance optimization.
- **Integration into Existing Coaching and Training Schemes:** Seamlessly integrate the cognitive insights into daily coaching and training routines. This ensures that all involved actors, including coaches and support staff, are aligned and can work synergistically towards the athlete's development.
- **Follow-Up and Adjustment:** Establish a continuous follow-up mechanism to monitor progress and make necessary adjustments. This ensures sustained understanding, reinforcement of strategies, and ongoing development.

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