

ENTEM[®]

Emotions in Sports

Overview

Based on academic and our proprietary research, there is a strong consensus from sports coaches and performance directors that emotions are the primary driver behind game performance.

"Emotions are the driving force. They drive your attitude."

Nicholas Potter

*Director of High Performance
and Sports Science for
Basketball, Duke University*



Why Do Coaches Care About Emotions in Sports?

Oftentimes on the playing field, coaches are in high pressure situations where they need to intuitively make a decision quickly that fosters positive outcomes. Seasoned coaches are able to efficiently know what to focus on and what went wrong during game performance. However, a common barrier is that coaches do not have concrete evidence or data to back up their intuition or gut feelings. Not having data to drive decisions that affect individual athletes can prompt conversations that make them feel awkward or under-valued.

Having certain statistics to support coaches' decision-making can back up conversations with athletes, empowering both parties and making them feel confident during game time, thus further enhancing performance and outcomes. This is why sports analytics solutions are popular, as they can provide the insights that coaches could not have had. While most solutions out there measure physical factors, many coaches will agree that emotions are indeed the driving force behind game performance. Research in sports psychology strongly supports this notion of emotions having a critical role in sport and exercise (Hanin, 2000) and being the primary motivational system (Izard, 1993). Since emotions can affect athlete performance, using these insights can support and accelerate coaches' strategic decisions, ultimately strengthening outcomes.

The Solution

To bridge the gap between making efficient, robust decisions in a fast-paced context and ensuring positive game impact, ENTEM has researched and developed a solution that utilizes the primary driver behind game performance as the key variable: emotions. This revolutionary approach is different from existing solutions in that we measure the predictor and antecedent variable of game engagement and performance, rather than the outcomes. For instance, common sports analytics solutions will measure physical factors such as speed or distance. Emotions play a vital role in these factors. Components of emotion include: physiological changes, action tendencies, and subjective experience (Deci, 1980; Young, 1973).



Impact of Emotions in Sports

Supporting research demonstrates that emotions during game performance can impact athletes' thought processing and winning outcomes (Uphill et al. 2012; Stanger et al., 2018). Based on an analysis of emotions from 4,318 images of soccer players from 304 teams, display of certain emotions can be a sign of higher team performance (Hopfensitz and Mantilla, 2018). The analysis revealed that emotions such as anger and happiness greatly impacted team performance in the World Cup. Teams with players that had more anger, had fewer goals whereas teams with players who expressed more happiness, scored more goals. Another research also examined the role of passion in sports, where it represents motivational force. The research consisted of 184 basketball players (Vallerland, et al. 2007). Prior to a game, players reported how they felt using the Passion Scale, which has high levels of validity and reliability. Shortly after the game, coaches rated and assessed the performance of the athletes using a validated measure. The research concluded passion is a significantly positive predictor of objective performance in sports. Consistent with the other studies, another research proved positive and negative emotions significantly predict performance through influencing basketball players' game behaviors (Uphill et al., 2012). The game was videotaped and digitized, using a behavioral analysis computer package. Players completed an "emotional recall guide" within 5 minutes of the game ending to report emotions. Players performance behaviors (ie: pass, foul) were coded by the second to yield analyses performance. Overall, the players reported 106 experiences of emotions across 6 games: 23 anger, 14 anxiety, 19 embarrassment, 25 excitement, 25 happiness, and 7 mixed emotions.

Understanding emotions during game performance can help coaches facilitate tactical decision-making during high pressure game context and development of game strategy. For example, if you know your team is emotionally high, you can adjust defensively versus offensively. Coaches can also use emotional analytics to understand team dynamics and how to improve team culture for optimal performance. For instance, player energy and emotions from the sidelines can affect game performance and those who see it. Insights from emotional analytics can also assist the team in understanding

where they need to be emotionally during the game and adjust coaching accordingly. Additionally, coaches can identify the drivers and impact of fan engagement on game performance. The insights drawn from the emotional analytics can also assist individual players and facilitate player development and growth for the long-term, especially since every player deals with emotions differently.

From the athletes' end, emotional insights can help them be aware of their emotions for individual player development and its impact on team dynamics and culture. For example, overall team emotions were low because individual players had negative emotions that permeated and affected other players. Furthermore, players can also understand the role of their emotions on game performance, such as better managing emotions on the field, such as not losing temper. Measuring both individual and team emotions are crucial so that coaches can understand overall team dynamics as well as how to cultivate player development on the individual level. In essence, the ENTEM model is based on the framework that emotions affect behavioral dimensions such as engagement, which ultimately impacts performance. While measuring athlete emotions is key, coaches play a vital role in influencing athlete behavior and performance as well given their leadership role. ENTEM's solution also measures coaches' emotions as well since coaches have a role as a transmitter, where their expressions and behavior can affect the individual athletes.

Based on the IZOF (Individual, Zones, Optimal, Functioning) model, there are key dimensions we take into account as part of measuring emotions: form, content, intensity, time, and context (Hanin, 2000). Sports coaches emphasize the importance of emotions and its impact on game performance. The relationship between emotions and engagement can be defined as engagement being the "emotional dimension of the athlete's attitude" regarding their actions, where it denotes identification with the task being performed, satisfaction level, and emotional attachment feeling (Mikicin, 2013). According to the IZOF Model, it aims to predict performances based on emotional states and standard individualized criteria, such as the optimal and dysfunctional zones (Hanin, 2000). The model centers on explaining how individual and team performance are affected by psychosocial states (Hanin, 2000). With regards to the core of ENTEM analytics, we can explore the "functioning" component of the IZOF model, where it highlights the "role of optimal functions of emotions in performance quality" (Hanin, 2000, p. 85). This can be explained as "optimal task involvement" that can be observed in one's readiness to engage in the task through effort that is sustained and active (Hanin, 2000, p. 85). This becomes viable through 1) assuring adequate effort when initiating and maintaining tasks and 2) having efficient use of resources that are available until the task is completed (Hanin, 2000).

While emotions play a pivotal role in athlete performance, not all emotions are conducive to optimal game performance. The emotional content, or “qualitative characteristic of the performance state”, can either enhance or impair game performance (Hanin, 2000). Furthermore, a positive emotion does not necessarily enhance game performance. For instance, “excited” is a positive emotion but rated as a “predominantly dysfunctional emotion” whereas a positive emotion such as “energetic” a “predominantly optimal emotion” that facilitates game performance (Hanin, 2000). Similarly, “tense” is another negative emotion but has been classified as being optimal for enhancing performance. When measuring the impact of the emotions on performance and other players, we also consider the intensity and context. These are critical factors for assessing the value an emotion has on engagement and impact, and ultimately performance. The basic emotions we will use are: sadness, anger, happiness, fear, and surprise. The various aspects of emotions and behavior we will detect and measure of active players in-game include: face and body detection, face and body identification, facial emotion expression recognition, body posture recognition, player tracking, player behavior and engagement recognition, player impact recognition, and player performance prediction. In addition to active players, we also plan to detect expressions of players on the sidelines, fans and spectators, and coaches as well since these individuals are all relevant in influencing the emotions of the athletes. ENTEM considers the various contexts and role of these emotions and behaviors, ensuring that coaches can draw the most relevant insights for improving game performance.

Artificial Intelligence

Recent advances in artificial intelligence, from deep neural networks applied to computer vision, and dedicated inference chips with ultra-low power consumption to work in emotional analytics for web5 applications are the foundation for this project. We utilize dedicated ultra-zoom cameras with automated tracking for pro teams as well as standard broadcast video for D2/D3 schools along with neural inference chips for edge processing along with cloud compute power for deep analysis and off-line training. Utilizing deep computer vision, we identify players based on their jerseys and face, but also tattoos and signature shoes. Tracking players along the court, we read facial emotions and body language from video sequences. We feed these raw emotions into the ENTEM model. Trained with our unique and proprietary data set, we calculate the values along the Entem dimensions from the raw emotions.

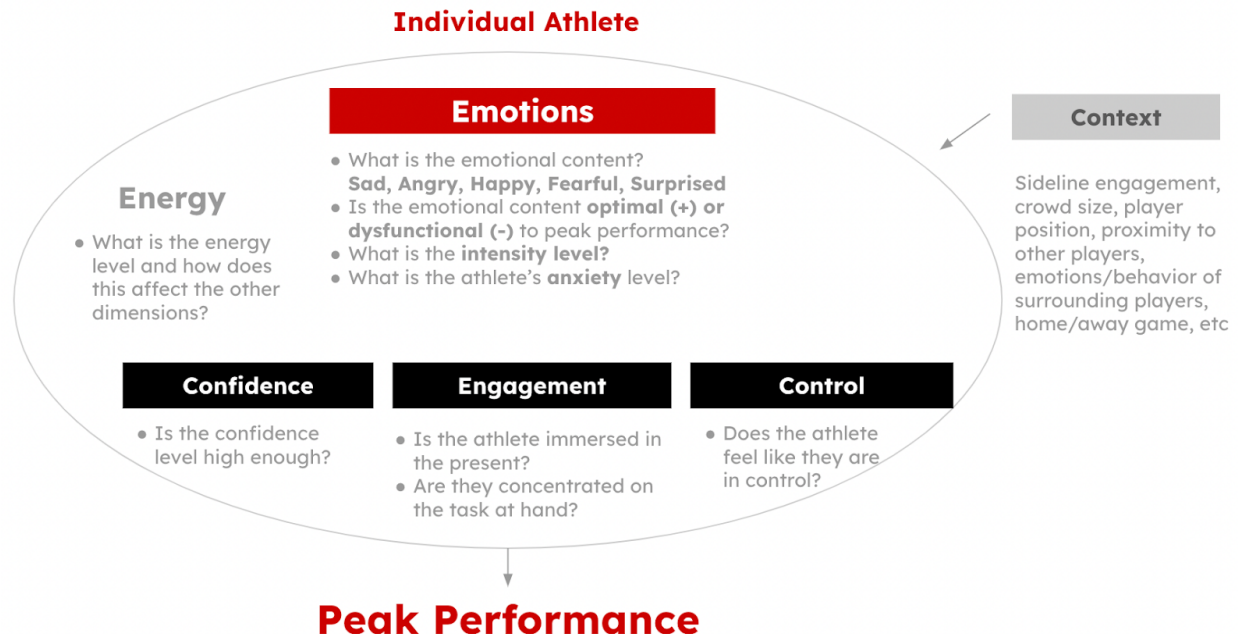
Peak Performance

As discussed, emotions are a key factor in impacting performance. When assessing emotions, we want to measure what the emotional content is, such as sad,

angry, happy, fearful, or surprised. Then, we want to determine if the emotional content is optimal or dysfunctional to peak performance. Finally, it is essential to measure how intense the emotion is, which includes measuring the range of emotional expression and its impact on surrounding individuals.

As a sports analytics solution, we aim to not only provide coaches with relevant insights to improve game outcomes, but to also facilitate understanding on what leads to peak performance. Peak performance is defined as optimal functioning, where one utilizes their full potential in a given activity (Privette, 1981). ENTEM focuses on these primary variables that can predict optimal performance: confidence, engagement, and control. These factors parallel with various scientific research on attributes of peak performance (Hanin, 2000). Confidence reflects the individual's belief in their ability to execute the task successfully. Research shows that those who display emotions associated with confidence end up scoring more (Hopfensitz and Mantilla, 2018). It can include measuring perceived likelihood of success and emotions. Anxiety is relevant to detect because it is the most critical explanation for negative performance (Lazarus, 2000). One study for a badminton game examined that players' in-game anxiety positively predicted cognitive interference and performance during a competitive match (Stanger et al., 2018). The research suggested confidence has a role in affecting how anxiety is interpreted for game performance. Many studies examining emotions in competitive sports have a strong emphasis on anxiety (Lazarus, 2000). We can measure the emotional expressions of athletes. And how having varying levels of anxiety with confidence can affect performance. This can relate to the challenge-skill balance often discussed as being one of the elements conducive to peak performance. Engagement is defined as the emotional aspect of an athlete's attitude toward their performance (Mikicin, 2013), and includes measuring motivation and effort. In the sports context, team engagement is defined as "psychological functions that influence competitive performance" (Lazarus, 2000, p. 240). It can encompass motivation, which can be assessed based on perceived benefit of the emotions, perceived likelihood of success, and perceived ability for the task at hand. We can measure engagement based on the athlete's visual attention. Lastly, control is the tendency to inhibit emotional expression, which our technology will measure using variables such as intensity and impact. Emotional control and regulation can affect how players interact with others and game outcomes (Tamminen and Crocker, 2013). Emotions can affect decision-making. We would measure the emotions and assess how intense and how much it varies from the athlete's baseline - how much they have emotional control. We also want to consider the athletes' energy levels as well since it can impact their capabilities and performance. Context is another key element we seek to measure in providing insights. We will take into consideration the contextual variables, using computer vision to measure sideline

engagement, crowd size, player position, proximity to other players, emotions and behavior of surrounding players, and so forth to measure and assess the impact on the individual athlete. These variables affect the players' emotions, behaviors, and ultimately their game performance.



All these dimensions will be assessed on both an individual and collective level, where individual athletes can impact other athletes due to their emotions and behaviors, consequently impacting overall team performance.

While these are the elements that can affect or lead to optimal performance, our framework considers other emotional content that can either enhance or debilitate performance, such as a dysfunctional or optimal emotion. Our solution draws on the relevant attributes for peak performance so coaches can see at a glance how their team is doing, both at the individual and collective level. With supporting research, a robust framework, and cutting-edge technology, our team is confident in generating the necessary meaningful insights coaches seek to guide their athletes to optimal game performance.

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