

# Building a Better Athlete:

A group of USA basketball players and coaches are huddled on a court during a game. The players are wearing white jerseys with "USA" and their numbers. One player in the foreground has "HOWARD" and "13" on his jersey. Another player has "BRISANTO" and "10" on his jersey. A coach in a dark blue shirt is talking to the players. The background shows a basketball court with a wooden floor and a green wall.

**How Great Coaches  
Game the Nervous System  
for Optimal Performance**

By Mark Lang

**“It’s ok. It’s ok.  
It’s ok. It’s ok.  
It’s ok.”**

These are words swimmer Emmie Mirus whispered to herself behind the starting blocks before her 100 yard freestyle at the 2022 NCAA Championships. This was Mirus’ last individual race of her collegiate career, and a lot was on the line – Her team was headed into the final night of competition 12 points down on the defending national champions, and she knew she needed to do her part to help her team accomplish their dream. But, as Mirus explains, she was terrified:

“I was pretty cool and collected throughout the meet, except before the last session. Before the last session, I was truly and visibly FREAKING OUT... I went to one of those little door alcoves at the pool before warming up to cry and Fernando [Rodriguez, my coach] found me. I was crying and explaining to him how nervous I was, because I had realized we totally *could* win but also how amazing of performances it would take... and Fernando hugged me and said “it’s going to be okay if we lose. And it’s going to be really okay if we win.””

Mirus would go on to take the field by storm, picking up a surprise win and the first individual national title of her career. More importantly, she helped to power her team to victory that evening. She gave a rousing post-race interview where she spoke about how her team came into the competition that night with a singular goal in mind, and how she knew she had to do everything within her ability to accomplish that goal. And while Mirus did much to lead and motivate the team that night, she credits her coach for helping



*Mirus after winning the 100 yard freestyle at the 2022 NCAA Championship (Photo by AJ Mast).*

to get her to the place where she could do the nearly impossible: “Something about the simplicity of that idea — that win or lose, the outcome would be essentially the same — really hit me. It totally calmed me down.”

Like the coach Mirus describes here, good coaches know not just the right words to say to an athlete to help them reach their full potential, but also when to utilize specific language, adapting what they’re saying depending on the person, context and competition. And while, at the surface level, it might appear that the words being used just soothe a worried mind, they actually accomplish far more. Recent research linking the fields of neuroscience, sports psychology, kinesiology, and physiology suggests that, when it comes to developing high level performances, coaches can convince an individual (and their body) to do far more than they ever thought possible, all through a few specific

words and approaches. And, in the end, can build a better athlete using these techniques which can be applied beyond just athletics.

## **Language Matters: Threats vs. Challenges**

One of the most important skills a coach can provide their athlete revolves around how an athlete approaches a competition. It has been well known since the 1990s that individuals respond to an obstacle (or in this case a competition/performance/event) in one of two ways: by feeling threatened or feeling challenged [1]. Individuals typically respond as if under threat when they feel their self-identity is under attack.. When this occurs, the body, sensing a



threatening event, goes into fight, flight, or freeze, a state caused by the activation of the hypothalamo-pituitary-adrenocortical (HPA) axis [2].

Mechanistically, this is caused by the release of corticotropin releasing hormone (CRH) from neurons located within the hypothalamus [2]. CRH then tells the pituitary gland to begin to release adrenocorticotropin hormone (ACTH), another intermediary hormone that travels out of the brain and down to the kidneys and the adrenal glands [2]. Once there,

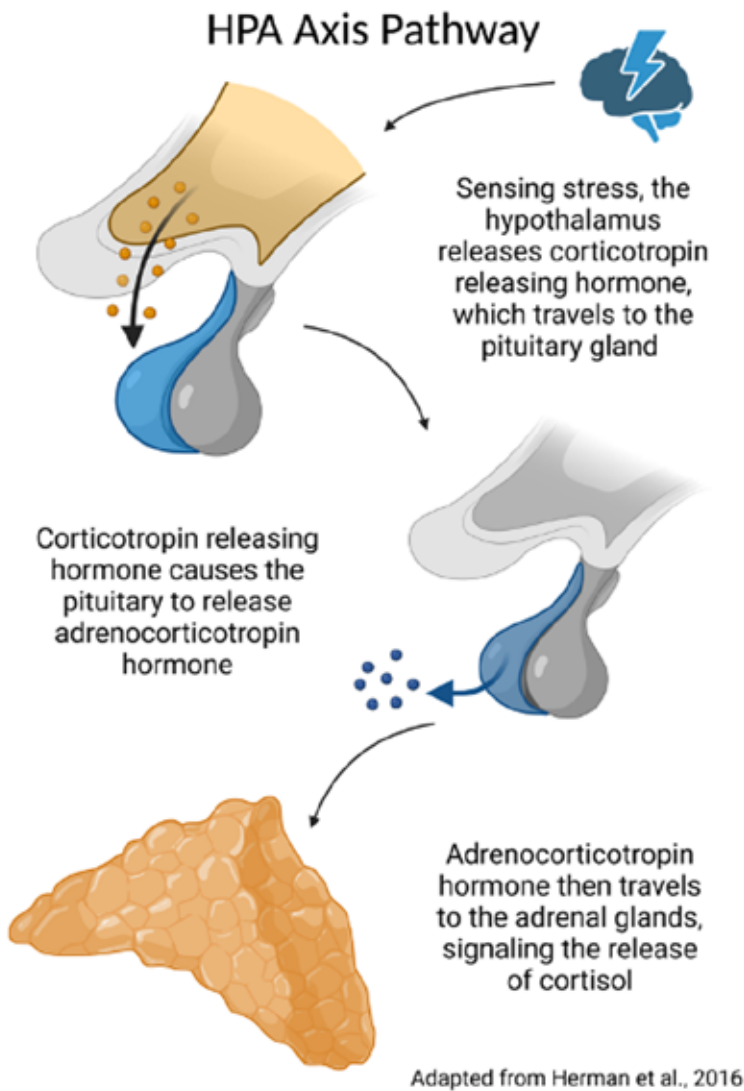
ACTH tells the adrenal glands to begin to produce and release cortisol, the main stress hormone of the body [2]. Cortisol then diffuses throughout the body, where it forces the body into overdrive, releasing large quantities of stored energy – but taking time and energy to do so [2]. Thus, while adaptive in nature, the HPA axis can be detrimental when it is triggered in moments where an individual's life is not on the line, such as during athletic competitions.

Additionally, the HPA axis can become locked in an “on”

state. Normally, once the body begins to release cortisol, some of the cortisol travels back into the brain and inhibits the release of CRH - this is known as a negative feedback loop (negative in the sense that it halts the function of the pathway) [2]. Sometimes, however, the neuronal circuitry of an individual malfunctions, and cortisol does not inhibit CRH in the way that it should, leading to the body continuing to follow the pathway and release cortisol [2]. This is quite common with athletes who have a fear of failure in their competitions due to viewing their outcome in the sport as part of their self-identity – they are so stressed about failing that it becomes a self-fulfilling prophecy as their body shuts down (the freeze) [3]. Since they are so consumed with how competent they look, they are chronically stressed about failing, and chronic stress is one of the ways the HPA axis gets locked on [2], [3].

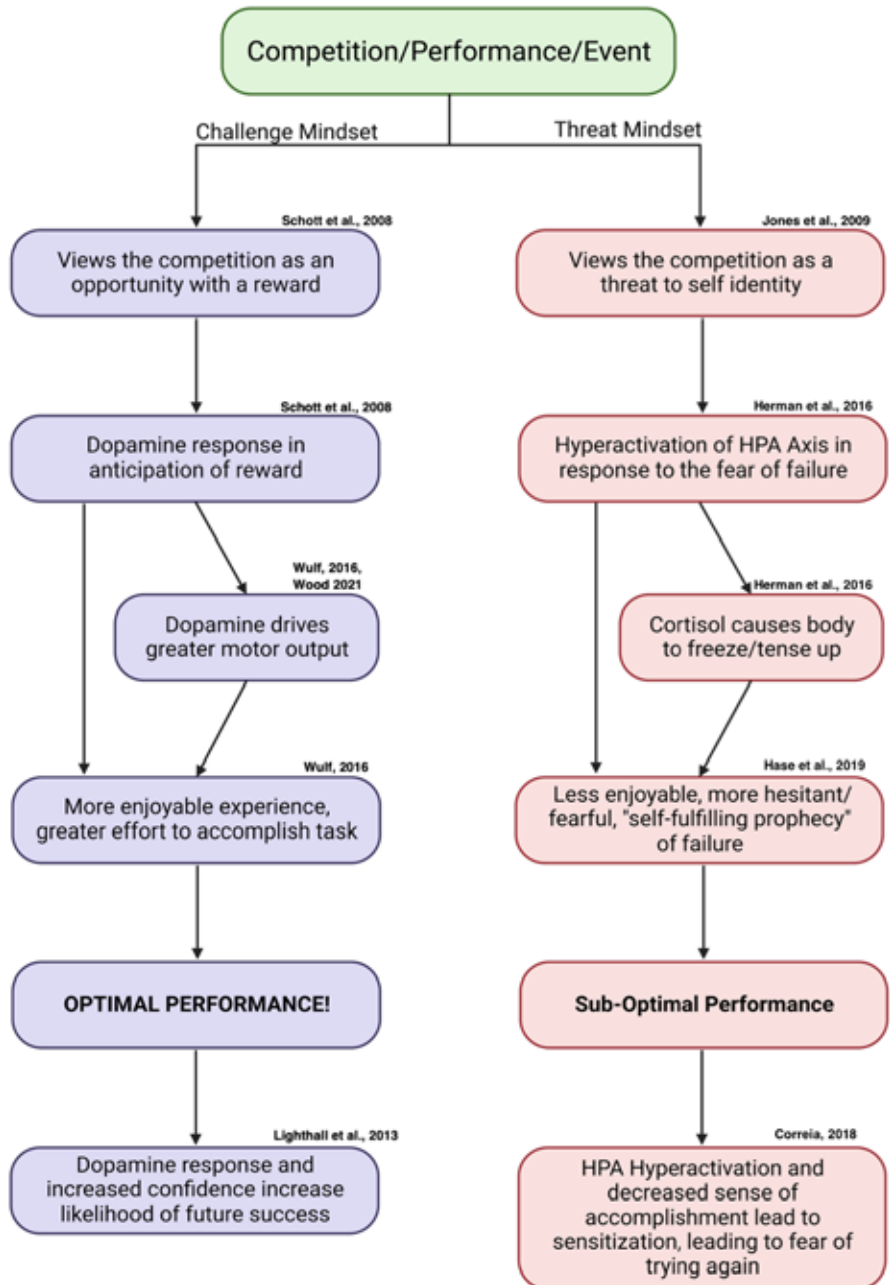
In contrast, individuals who view an obstacle as a challenge which they can conquer have a very different neurological response. While they still do, to some degree, have a stress response brought about by the HPA axis, it is to a much lower degree than the threat response [3]. Put simply, the differences can be explained with the words nervous and excited. Nervousness implies a fear of a negative outcome, while excitement carries connotations of a positive outcome with some sort of reward. That is how the brain treats tasks and obstacles presented as a challenge – something that has a reward associated with it.

When the brain views a challenge as rewarding, it begins to release dopamine in anticipation from the substantia nigra, a major dopamine-releasing nucleus found deep within the brain [4].



**Figure 1.** The HPA axis responds to stress by releasing cortisol through a pathway involving the hypothalamus, pituitary gland, and adrenal gland. Chronic stress or feedback loop malfunctions cause the axis to become “locked on,” leading to negative consequences for an individual’s health and performance.

This dopamine release makes the challenging task more enjoyable, as dopamine activates several regions of the brain associated with pleasure [5]. Dopamine has a dual role, however, one that often goes unnoticed: It plays a huge role in regulation motor movement and skill acquisition [6]. While much of the research on the role of dopamine in muscle control comes from research on Parkinson's disease (a disorder characterized by a lack of dopamine in the pleasure centers of the brain and a progressive loss of motor control), recent research has focused on the role of dopamine in motor neuron learning and execution of various forms of movement [6]. In particular, there is evidence that the presence of dopamine enhances the long-term potentiation of motor neurons as well as likely increasing the firing rate of neurons in singular events [6], [7]. Long term potentiation is the increase in the connections between neurons, often accomplished with either the presynaptic neuron (the one sharing information) releasing more neurotransmitter or the postsynaptic neuron (the one receiving information) creating more receptor sites. The brain seeks to create more opportunities to release dopamine because it's pleasurable. This results in the strengthening of regions in the brain which lead to dopamine release. In this case, the athlete gets pleasure from completing the challenge and obtaining achievement within their sport, leading to the brain strengthening the motor neuron patterns that led to conquering the challenge. So, framing something as a challenge has a short-term benefit; the athlete enjoys the challenge due to dopamine being released in anticipation of a reward and works harder to reach their goal. There is also a long-term benefit; the presence of



**Figure 2.** Dopamine release during challenging tasks enhances pleasure centers in the brain and plays a dual role in regulating motor movement and skill acquisition. This results in stronger synapses of specific motor patterns that increase the likelihood of the behavior occurring in the future.

dopamine strengthens the synapses of the specific motor patterns that lead to the accomplishment of the goal. This means that the behavior is more likely to occur in the future [7], creating a better athlete.

This is all great in theory, but how can coaches utilize this challenge framework to benefit their athletes and avoid a threat response? To begin with, coaches

can utilize language that promotes a challenge framework. Creating an aura of enhanced expectations ("I believe that you can do this, now show me that you can" or "This is challenging, but I know you can do it") develops a sense of confidence in the athlete that they can accomplish the task at hand, viewing it as an opportunity to challenge themselves to

be better than they currently are [7]. These enhanced expectations have been heavily researched and show promising results across a whole range of sports mediums, from golf to competitive kickboxing to soccer, and all rely on the dopaminergic reward system to facilitate greater performance [7]. Coaches can also work with their athletes to help them to separate their individual identity from that of their athletic performances, working to eliminate the fear of failure that comes from viewing their performance outcomes as a representation of their own self-worth [8]. This should reduce some of the hyperactivation of the HPA axis, leading to better performances even without incorporating a challenge approach into training and competition. Finally, coaches should be careful when presenting difficult tasks/obstacles in practice to make sure that they come across as challenges which can be accomplished (although they might immediately be very difficult and take multiple tries) rather than scary and daunting tasks that determine some characteristic about the athlete. Too much of the latter runs the risk of becoming sensitized, where if the individual repeatedly fails, any attempt at trying again leads to hyperactivation of the HPA axis and even more unfavorable outcomes [9]. Thus, it is imperative that a coach recognizes when an athlete is responding to a task as a threat instead of a challenge, and works closely with them to readjust their approach to view the task not as a measure of their self-worth, but rather as something rewarding yet challenging.

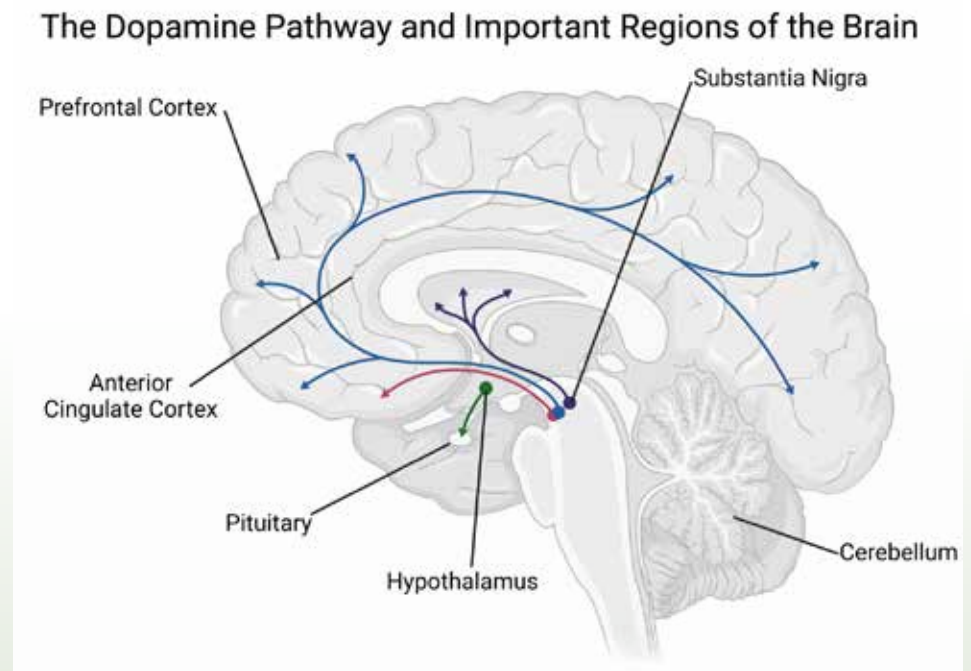
## Building a Better Mindset:

# Growth, Growth, Growth

Even though we have not yet used the word mindset, that is, without a doubt, the topic of this entire article: How can coaches coach specific mindsets into their athletes that lead to enhanced performance outcomes? One of the many issues that plague coaches is that, while they can be very selective about the language they use in conversation with their athletes (like we saw above in presenting tasks as challenges), they cannot control the language that the athlete uses to speak to themselves in their mind. Or can they? Of the many potential tools a coach has in the arsenal, perhaps the most important is the ability to shape how an athlete approaches their training or a competition. Ideally, coaches can do this by

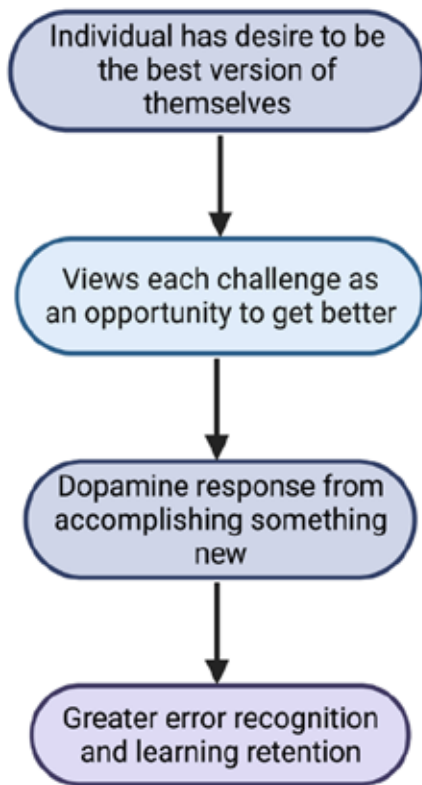
incorporating some form of mindset development into their training regimen.

Much of sports psychology approaches mindset using development psychologist and researcher Carol Dweck's paradigm of "Fixed" vs "Growth" mindset [10]. A fixed mindset is characterized by the belief that specific qualities about oneself are fixed and cannot be altered, while growth mindset individuals typically display a belief that traits are adaptable and can be developed over time [10]. Having a growth mindset has been linked to greater success in both academic and athletic pursuits, work-based challenges, and even cultural confrontations.. Additionally, growth mindset individuals tend to view mistakes as learning opportunities, while fixed mindset individuals tend to view mistakes as a reflection of their own intelligence or skill [12]. Clearly, the traits associated with a growth mindset are beneficial in all aspects of life! But these traits are



**Figure 3.** Dopamine pathway and key brain regions involved in motivation and growth mindset. Growth mindset individuals have higher dopamine levels in the anterior cingulate cortex, leading to increased motivation and a greater likelihood of seeking self-improvement."





Adapted from Ng, 2018

**Figure 3.** *The growth mindset cycle.*

more than just mindset. Fixed and growth mindset individuals actually display different brain circuitry patterns. In fact, growth mindset individuals display greater neuronal connectivity in areas of the brain associated with error determination, such as the medial and dorsolateral prefrontal cortex and the cerebellum, an exciting finding given that these individuals tend to see errors as opportunities to improve [11].

Much of the research with the growth mindset also points back to the role of dopamine as a mechanism for driving motivation in individuals. Dopamine levels in the anterior cingulate cortex (the region of the brain responsible for controlling automated motor function!) is higher in growth mindset individuals than in individuals who score as having a fixed mindset [12]. Individuals receive a release of dopamine any time they accomplish a goal, so growth mindset

individuals are priming themselves for seeking improvements by tricking their brain into rewarding them for doing tasks that benefit them as a person [12]. Additionally, an EEG study (where neuroscientists record the electrical impulses of the brains of individuals while they complete various tasks) of the growth mindset showed that individuals with a growth mindset had greater electrical activity when they make a mistake on a task in the midline parietal, an area of the brain associated with learning and memory retention [12]. These individuals, when retested later on the same tasks where they previously made mistakes, do better than individuals who score as having a fixed mindset. These results imply that individuals with a growth mindset are more aware of their mistakes and actually learn to correct them, rather than feel fear and shame over making a mistake like fixed mindset individuals do.

Not only does the mindset of the athletes matter for their individual improvement, the mindset of their coach also has an influence on obtaining success. Recent research shows that athletes who are coached by individuals who have a growth mindset actually perform better (and score higher themselves on the growth mindset questionnaire) than athletes who are coached by individuals with a fixed mindset [13]. This evidence fits with the idea that the growth mindset is focused on the adaptability of traits and skills, as coaches who believe their athletes are capable of learning and growing are going to encourage their athletes to explore these ideas more, resulting in greater adoption of the mindset.

## **How Gritty Are You?**

A separate but related idea to that of the growth mindset is a trait known as grit. Grit is a topic of intense academic study, in part because every coach wants individuals with grit on their team. According to psychology researcher Angela Duckworth, grit is the long term sustainment of effort combined with a passion for the task at hand [14]. Gritty individuals have a relentless determination to achieve the task at hand – the ideal athlete for any coach to work with. Just like the growth mindset, however, grit is not a fixed trait that an individual is born with; it can be molded and strengthened both through practice and circumstance [14]. Grit is more than just a state of mind, however: individuals with more grit actually show greater electrical signaling in the dorsomedial prefrontal cortex, a region of the brain associated with self-regulation, goal setting and attainment. Be careful not to conflate this fact as an example of an inherent trait of individuals. The wiring of the brain is extremely plastic, or flexible, and wiring differences in gritty individuals are likely a result of repeated opportunities to practice grittiness, rather than something they are born with. But how do individuals become more gritty?

As a coach, working with your athletes to develop a gritty growth mindset is very important to both their long-term development as an athlete and as a person. There is no doubt that athletes will hit bouts of setbacks, illness, injuries, and just plain boredom as they move through their athletic and life careers. However, a strong growth mindset and high levels of grit will lead these individuals to conquer these challenges and ultimately prevail. One way to promote a growth mindset within your athletes is to make it clear that failure in the pursuit of learning is perfectly acceptable

and actually encouraged! Individuals who fear failure are less likely to take risks, meaning they are also less likely to learn something new and branch outside of their circle of safety. By encouraging supportive environments where individuals can authentically try and fail, coaches increase the likelihood that individuals will eventually try and succeed in what they are trying to accomplish. And this is where grit comes into play: by encouraging their athletes to continue to put their best effort forth each time they try something new or challenging (even though the athlete might fail), coaches are fostering the development of grit, especially with regards to developing a long-term passion for learning. Remember, grit is both a passion and perseverance for a task – therefore, working with individuals to attempt to embrace challenges as a chance to learn something new develops a passion for learning and the perseverance to keep striving to master something new. Together, grit and the growth mindset work to fundamentally rewire both mindset and makeup of the brain, creating individuals with skills to help them succeed at the highest level both as individuals and as athletes.

## Theories in Practice:

We've covered several different ideas on how to build a better athlete, all focused around altering an athlete's mindset. But

the question has to be asked: Is there anything else that coaches can be doing to help their athletes become their best selves? The answer is—quite obviously—yes, and it starts with the coaches themselves.

In order to build a better athlete using the growth mindset, grit, and challenges, coaches have to create an environment where athletes are willing to take risks and push themselves outside of their comfort zones, even with the potential to fail dramatically. This implies that what coaches really need to create within their teams is trust— not only between themselves and the athlete but also between the athletes and their training programs. In fact, trust is one of the most influential determinants of an individual's (and team's) athletic performance [15]. Trust is inherently neurological – the feeling of trust is driven by the neurotransmitter oxytocin, which evolved to facilitate pair bonding for offspring rearing [16]. Contrary to the expectations of many leaders, trust is not something earned just by rank and title, but rather is something that must be developed and cultivated over time. How do coaches do this? To begin with, it comes from maintaining a specific leadership style. Research shows that individuals most develop trust with leaders who are supportive and empathetic, showing genuine concern for those under their leadership [17], [18]. Groups led by individuals with this encouraging, caring personality type show more similar brain activity following a discussion than

those led by more controlling, dominating individuals [19]. While there will always be outliers, it is clear that less controlling and more supportive coaching styles lead to greater connectivity and trust, which in turn gives athletes the confidence to take risks and practice the growth mindset and challenge approach.

While we have spoken about several different topics (grit, growth mindset, challenge approach, trust), it is important to note that all of these items are interconnected, in part due to their shared origins in specific regions of the brain. Although each can be discussed and studied on their own, they truly function best in combination with each other. Working with an athlete to develop greater grittiness involves adapting both a growth mindset (“I can learn to get better at something”) and a challenge mindset (“this will challenge me but I will get it”), and requires the athlete to trust that their coach has their best intentions at heart. Working to develop the challenge approach within an athlete requires them to find a passion for what they're doing and learn to stick with it for a reward, as well as trusting in their training (and their coach) to get them to their goals. Just as no singular brain region or pathway acts in isolation, neither do any of these traits and skills. Thus, it is up to the truly great coaches to work with their athletes and develop these skills to help them to develop into the best version of themselves.



## References

- [1] Hase, A., O'Brien, J., Moore, L. J. & Freeman, P. The relationship between challenge and threat states and performance: A systematic review. *Sport Exerc. Perform. Psychol.* 8, 123–144 (2019). <https://doi.org/10.1037/spy0000132>
- [2] J. P. Herman et al., "Regulation of the hypothalamic-pituitary-adrenocortical stress response," *Compr. Physiol.*, vol. 6, no. 2, pp. 603–621, Mar. 2016, doi: 10.1002/cphy.c150015.
- [3] M. Jones, C. Meijen, P. J. McCarthy, and D. Sheffield, "A Theory of Challenge and Threat States in Athletes," *Int. Rev. Sport Exerc. Psychol.*, vol. 2, no. 2, pp. 161–180, Sep. 2009, doi: 10.1080/17509840902829331.
- [4] B. H. Schott et al., "Mesolimbic Functional Magnetic Resonance Imaging Activations during Reward Anticipation Correlate with Reward-Related Ventral Striatal Dopamine Release," *J. Neurosci.*, vol. 28, no. 52, pp. 14311–14319, Dec. 2008, doi: 10.1523/JNEUROSCI.2058-08.2008.
- [5] E. S. Bromberg-Martin, M. Matsumoto, and O. Hikosaka, "Dopamine in motivational control: rewarding, aversive, and alerting," *Neuron*, vol. 68, no. 5, pp. 815–834, Dec. 2010, doi: 10.1016/j.neuron.2010.11.022.
- [6] A. N. Wood, "New roles for dopamine in motor skill acquisition: lessons from primates, rodents, and songbirds," *J. Neurophysiol.*, vol. 125, no. 6, pp. 2361–2374, Jun. 2021, doi: 10.1152/jn.00648.2020.
- [7] G. Wulf and R. Lewthwaite, "Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning," *Psychon. Bull. Rev.*, vol. 23, no. 5, pp. 1382–1414, Oct. 2016, doi: 10.3758/s13423-015-0999-9.
- [8] M. E. Correia, "Fear of Failure and Perfectionism in Sport," *Cuad. Psicol. Deporte*, vol. 18, no. 1, Art. no. 1, Feb. 2018.
- [9] "Motivation in learning contexts: Theoretical advances and methodological implications. - PsycNET," APA PsycNET. <https://psycnet.apa.org/record/2002-01055-000> (accessed Nov. 14, 2022).
- [10] J. A. Mangels, B. Butterfield, J. Lamb, C. Good, and C. S. Dweck, "Why do beliefs about intelligence influence learning success? A social cognitive neuroscience model," *Soc. Cogn. Affect. Neurosci.*, vol. 1, no. 2, pp. 75–86, Sep. 2006, doi: 10.1093/scan/nsl013.
- [11] C. A. Myers, C. Wang, J. M. Black, N. Bugescu, and F. Hoeft, "The matter of motivation: Striatal resting-state connectivity is dissociable between grit and growth mindset," *Soc. Cogn. Affect. Neurosci.*, vol. 11, no. 10, pp. 1521–1527, Oct. 2016, doi: 10.1093/scan/nsw065.
- [12] B. Ng, "The Neuroscience of Growth Mindset and Intrinsic Motivation," *Brain Sci.*, vol. 8, no. 2, p. 20, Jan. 2018, doi: 10.3390/brainsci8020020.
- [13] J. Paden, "Getting 1% Every Day: An Exploratory Case Study about Growth Mindset in a Collegiate Athletic Setting," Master Arts High. Educ. MAHE Theses, Jan. 2020, [Online]. Available: <https://pillars.taylor.edu/mahe/168>
- [14] A. L. Duckworth, C. Peterson, M. D. Matthews, and D. R. Kelly, "Grit: Perseverance and passion for long-term goals," *J. Pers. Soc. Psychol.*, vol. 92, no. 6, p. 1087, 20070604, doi: 10.1037/0022-3514.92.6.1087.
- [15] Mach, "The differential effect of team members' trust on team performance: The mediation role of team cohesion," *Journal of Occupational and Organizational Psychology - Wiley Online Library.* 2010. <https://bpspsychub.onlinelibrary.wiley.com/doi/full/10.1348/096317909X473903> (accessed Nov. 16, 2022).
- [16] P. J. Zak, "The neuroscience of high-trust organizations," *Consult. Psychol. J. Pract. Res.*, vol. 70, no. 1, p. 45, 20180312, doi: 10.1037/cpb0000076.
- [17] W. Zhu, A. Newman, Q. Miao, and A. Hooke, "Revisiting the mediating role of trust in transformational leadership effects: Do different types of trust make a difference?," *Leadersh. Q.*, vol. 24, no. 1, pp. 94–105, Feb. 2013, doi: 10.1016/j.leaqua.2012.08.004.
- [18] A. M. Grant, F. Gino, and D. A. Hofmann, "Reversing the Extraverted Leadership Advantage: The Role of Employee Proactivity," *Acad. Manage. J.*, vol. 54, no. 3, pp. 528–550, Jun. 2011, doi: 10.5465/amj.2011.61968043.
- [19] B. Sievers, C. Welker, U. Hasson, A. M. Kleinbaum, and T. Wheatley, "How consensus-building conversation changes our minds and aligns our brains," *PsyArXiv*, Jul. 2020. Accessed: Sep. 20, 2022. [Online]. Available: <https://psyarxiv.com/56z27/>