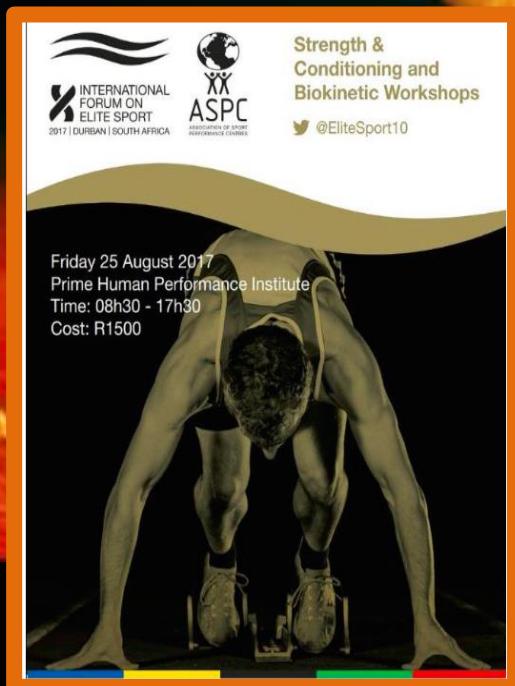


CNS  
READINESS



INTERNATIONAL FORUM ON  
ELITE SPORT  
2017 | DURBAN | SOUTH AFRICA

ASPC  
ASSOCIATION OF SPORT  
PRACTITIONERS & COACHES

Strength &  
Conditioning and  
Biokinetic Workshops

[@EliteSport10](#)

Friday 25 August 2017  
Prime Human Performance Institute  
Time: 08h30 - 17h30  
Cost: R1500

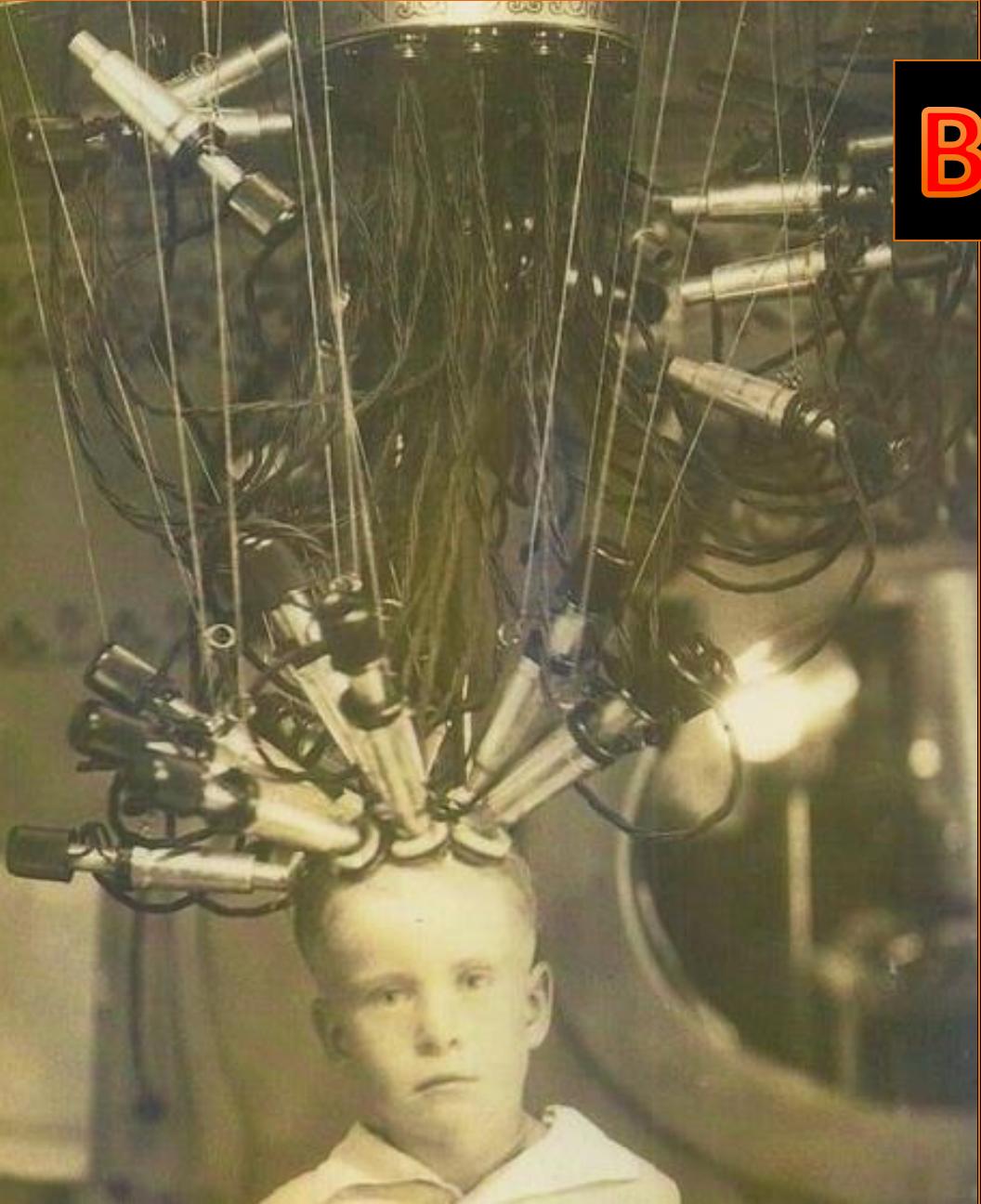


John Underwood  
HUMAN PERFORMANCE PROJECT

# CNS READINESS

The single largest factor in athlete performance is CNS readiness



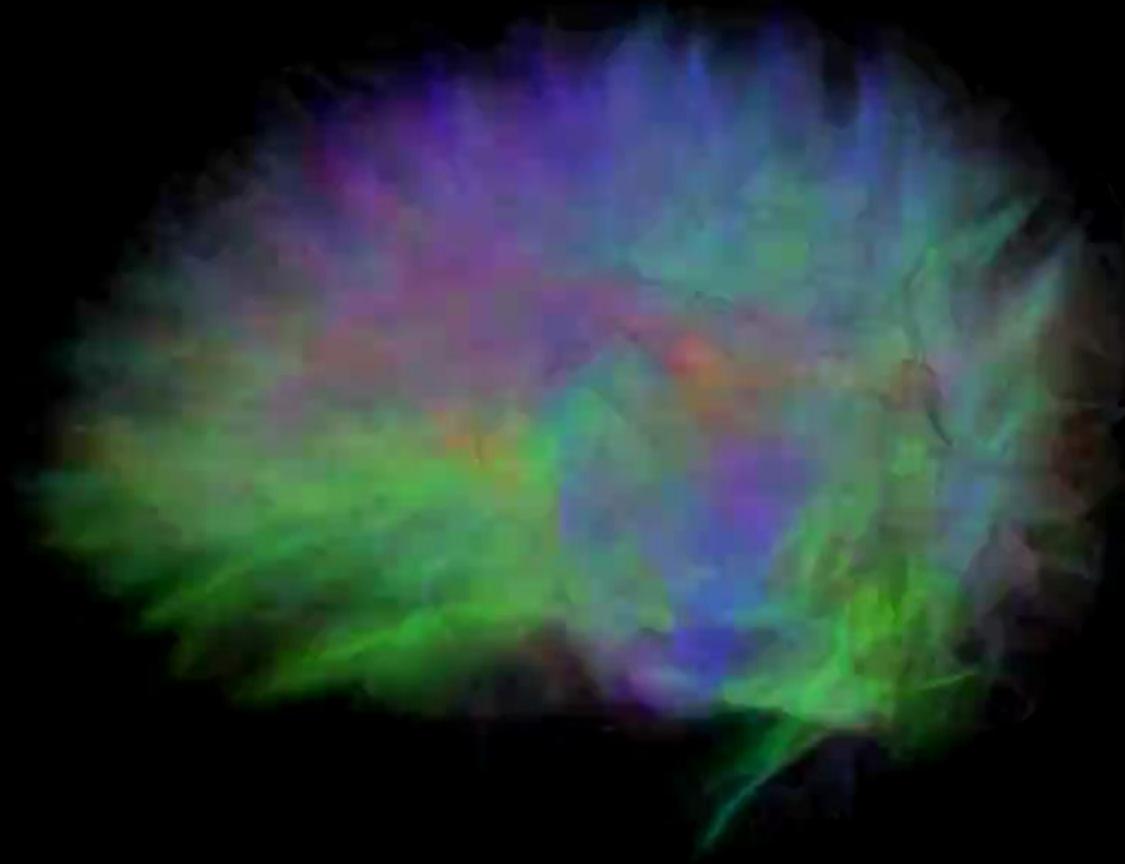


# Brain Science

We have  
come a  
long way!

8388608 Neurons with 144727653F Synapses  
Simulation time: 138.9 ms (Real time factor: 0.0004x simout; 0.0005x avg.)  
0.49 PPS (Avg: 0.40) ; Frame render time: 7732.24 Mcycles (avg: 7706.00 Mcycles)

fMRI BOLD (Coronal View):



# BRAIN SCIENCE

CNS  
READINESS

BRAIN BODY  
CONNECTION

NEURAL  
FATIGUE



# *“CNS – a New Challenge and Possibility in High Performance Sports”*

*John Underwood USA*



**Life of an Athlete  
Human Performance Project**



Optimal Athletic Performance

It starts with your brain!



Life of an Athlete  
Human Performance Project

**Performance begins  
and ends in brain**



## Many Factors in Fatigue

### Highest Levels of Fatigue

- Research shows that motor recruitment and fatigue during exercise will be affected by a huge variety of factors, including emotional state, mental fatigue, recovery from previous exercise, motivation, self belief, prior knowledge of the duration of exercise, cerebral and arterial oxygenation, muscle glycogen storage, fluid loss, thirst, heat, and more. In fact, “the prediction of this model is that potentially everything ... can potentially affect athletic performance. But that the most important of these effects begin and end in the brain.”

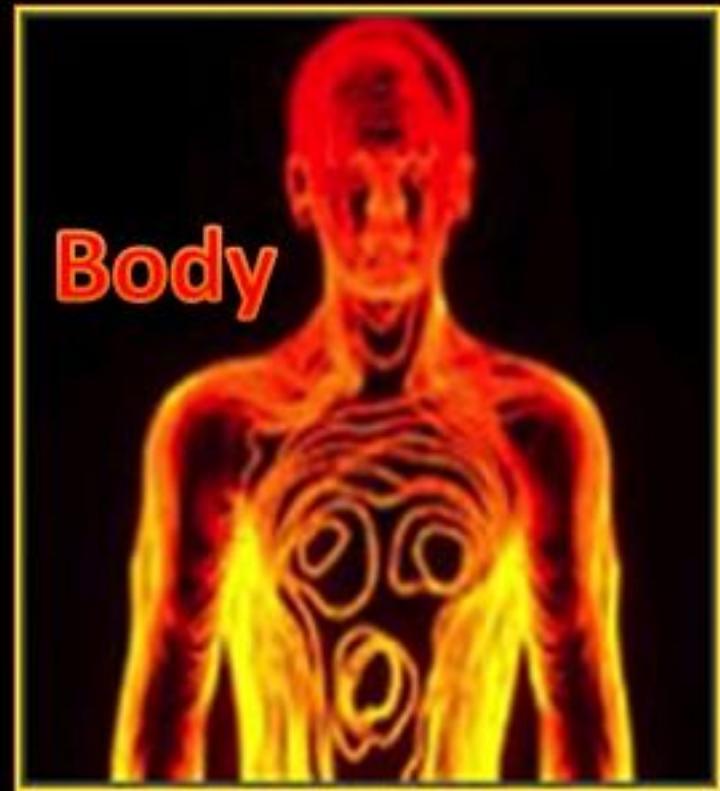
# Many Factors in Fatigue

## Highest Levels of Fatigue

- Research shows that motor recruitment and fatigue during exercise will be affected by a huge variety of factors, including emotional state, mental fatigue, recovery from previous exercise, sleep, bloodglucose levels, motivation, self belief, prior knowledge of the duration of exercise, cerebral and arterial oxygenation, muscle glycogen storage, fluid loss, thirst, heat, and more. In fact, “the prediction of this model is that potentially everything ... can potentially affect athletic performance. But that the most important of these effects begin and end in the brain.”

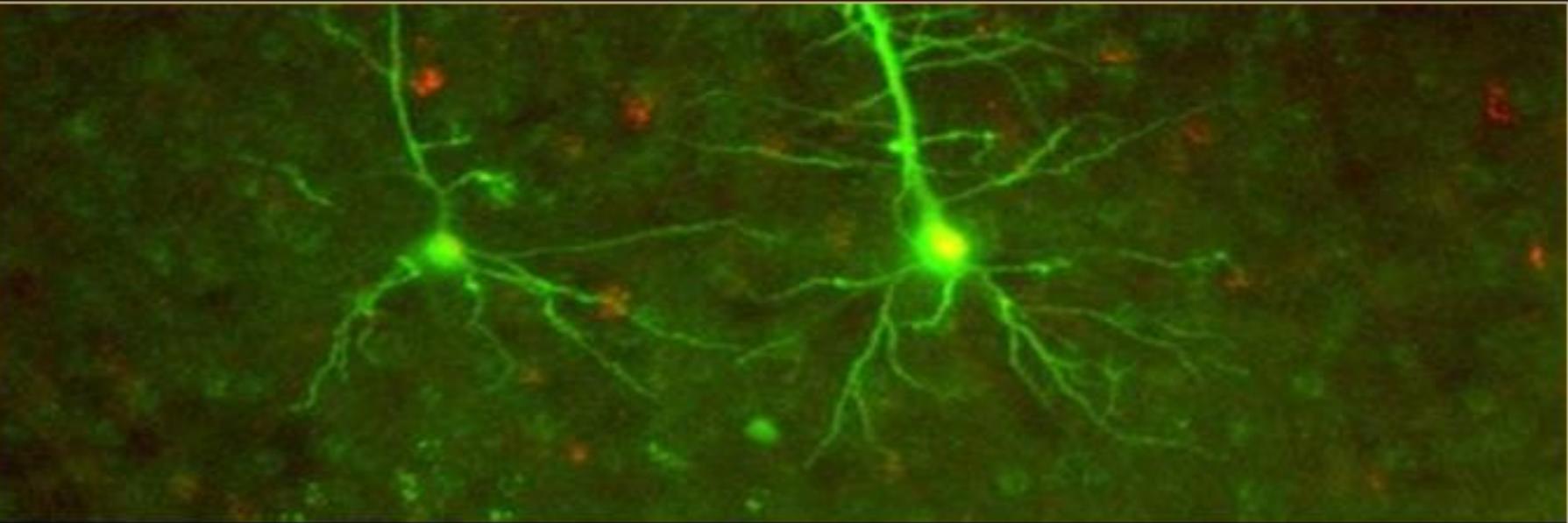


**Brain CNS**



**Brain is incredibly complicated  
Body is simple**

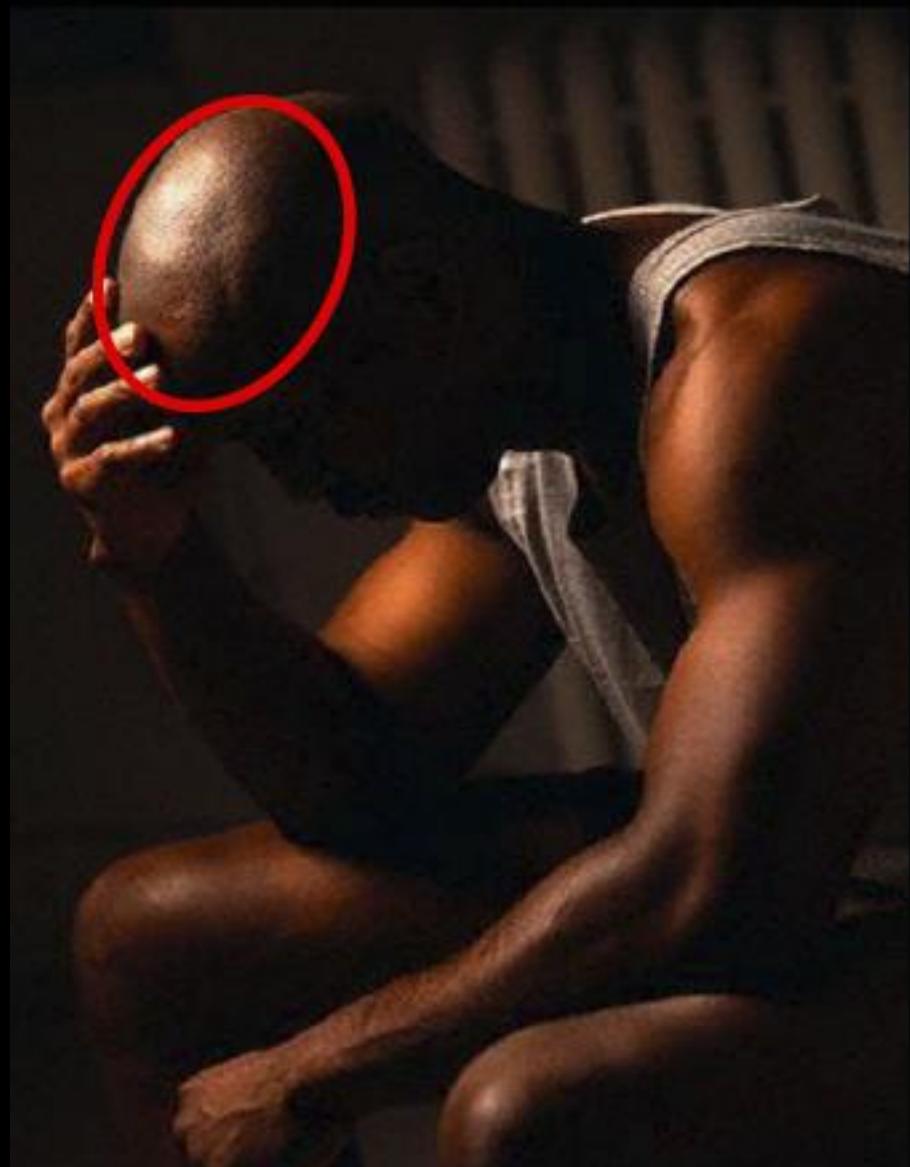




100,000 Chemical reactions per second during athletic competition



- The conscious mind processes 40 bits of data per second
- The unconscious mind operates at 40 million bits of data per second
- Thinking - delivers thoughts to 90 trillion cells
- For every positive thought – You have 16 negative thoughts.

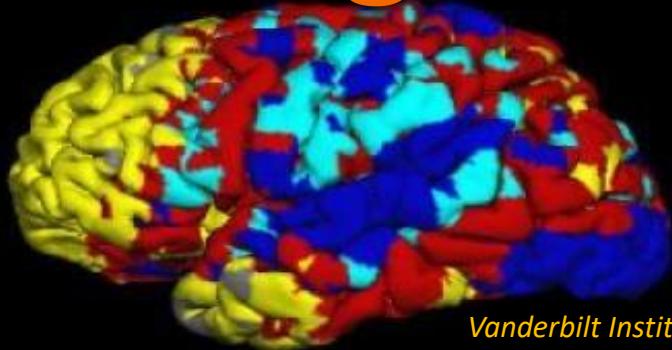


NEGATIVE COACHING DOESN'T PRODUCE POSITIVE RESULTS

An fMRI map of a resting state network that shows the connections between the sub-regions of the thalamus with other parts of the brain. The different colors represent the overall functional association of the sub-regions with other areas of the brain.

What neuroscientists call its resting state. What the brain is doing when an individual is not focused on the outside world has become the focus

## Resting State



*Vanderbilt Institute of Imaging Science*

Even when at rest brain  
regions remain connected



# It is all in your Head...

What makes awesome happen?

# BRAIN SCIENCE

- ◆ Impact of Sleep on performance
- ◆ Impact of Alcohol and Marijuana on performance
- ◆ Impact of Technology Use on performance
- ◆ Impact of Neural Fatigue on performance
- ◆ Impact of Blood Glucose on performance
- ◆ Impact of Hydration of performance
- ◆ Impact of Stress on performance
- ◆ Impact of Mood on performance
- ◆ Impact of Energy Drinks on performance
- ◆ Impact of Diet on performance



# CNS READINESS

Brain function during performance is being studied world wide. Whether you are an athlete, musician, actor, dancer, or student Central Nervous System (CNS) Readiness is the single biggest factor in performance.



Human Performance Project

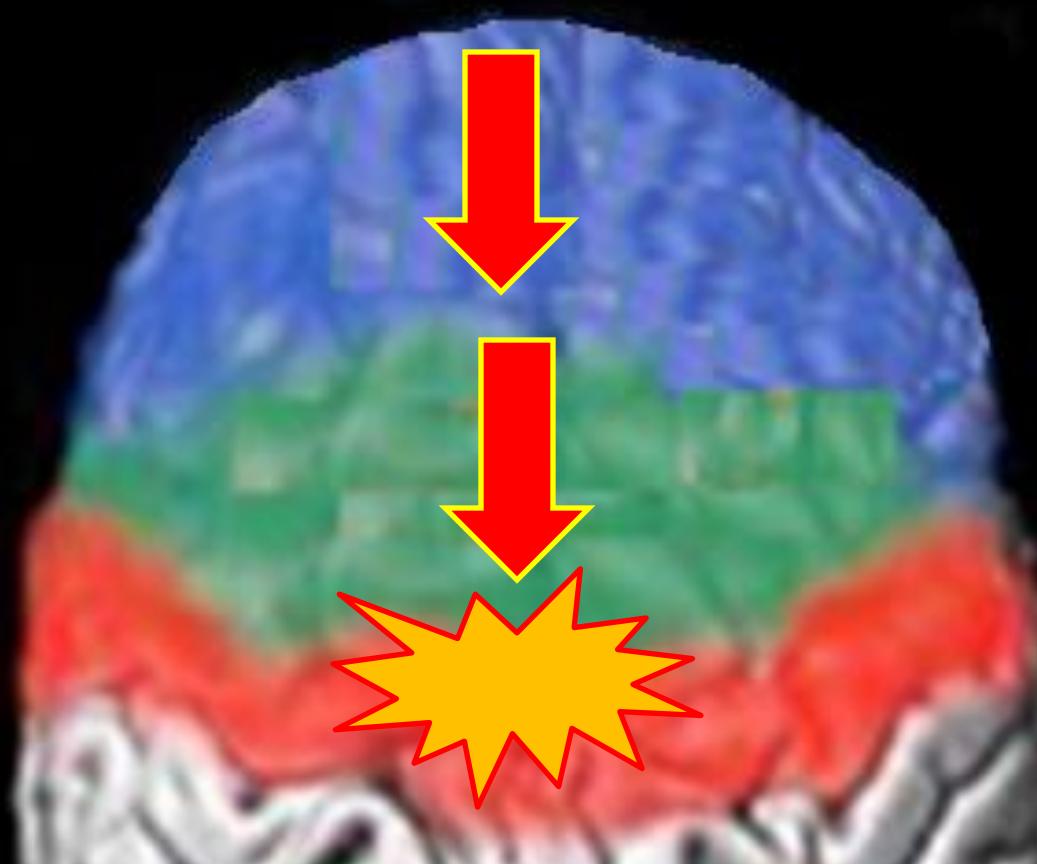
# Neural Drive

The brain provides what is known as neural drive to the body. This is the electrical signal sent  
f  
g **BRAIN MUST BE HIGHLY RESTED** <sup>r</sup>  
<sup>h</sup>

recruitment. Young athletes do not yet command this process but by training over time this activation develops. Eventually the recruitment increases force development and outputs.



## MUSCLES MUST BE HIGHLY RESTED



Fatigue levels in the frontal cortex decrease functions in pre-movement and movement regions of the brain





## Glucose makes you shine!

Glucose is the form of sugar that travels in your bloodstream to fuel the mitochondrial furnaces responsible for your brain power. Glucose is the only fuel normally used by brain cells. Because neurons cannot store glucose, they depend on the bloodstream to deliver a constant supply of this precious fuel. This means you must keep your blood glucose levels up during a long day in order to function at a high level for mental performance. This is just as important in practice as it is in a competition. A few sips of Gatorade or Powerade or some simple carbs or even non-acidic fruit will release glucose into your bloodstream and you will perform! You can find info on this topic in the Power Back Diet!



**Life of an Athlete  
Human Performance Project**

# NO GLUCOSE NO WAY



What your BRAIN runs on?

Even at 50mL levels of blood glucose, mental decline is in process. Focus, processing, attention, alertness, reaction, are affected. An athlete who eats lunch at 11:30 A.M. daily has potential 50mL levels which impair quality of training in the late afternoon or upon waking in the morning.

## EFFECTS OF GLUCOSE DEPRIVATION ON THE BRAIN



In the healthy normal functioning brain, glucose is the only substrate utilized for energy metabolism. Thus hypoglycemia (Low Blood Sugar) presents the brain with a very serious problem. Brain glucose consumption is normally about 10 mg per 100 mL., accounting for almost 75 percent of the liver's production of glucose and further attesting to the brain's heavy reliance and dependence on glucose. While most other tissues can shift to utilizing free fatty acids (FFA) as an alternative energy source when glucose is lacking, the brain cannot because they are excluded by the blood-brain barrier. While there is some evidence that the brain can utilize  $\beta$ -hydroxybutyric acid for energy metabolism when glucose levels are low or when fats are being mobilized for energy metabolism throughout the rest of the body, the brain could never supply its high energy demands by this method alone in the absence of glucose. Thus the brain is dependent on an uninterrupted supply of blood-borne glucose to energize its cells.

Decreases in blood glucose bring on disturbances in cerebral function. Depending on the level of hypoglycemia, these changes range from mild sensory disturbances to coma. At blood glucose levels of 19 mg per 100 mL or below (normal is 60 to 120 mg per 100 mL), a mentally confused state occurs. Brain O<sub>2</sub> utilization falls to 2.6 mL per 100 g per minute (normal, 3.5 mL per 100 g per minute) and glucose utilization drops as well. Coma commences when glucose levels fall to 8 mg per 100 mL.

Life of an Athlete

# REFUELING

1.

## BRAIN

2.

## MUSCLE

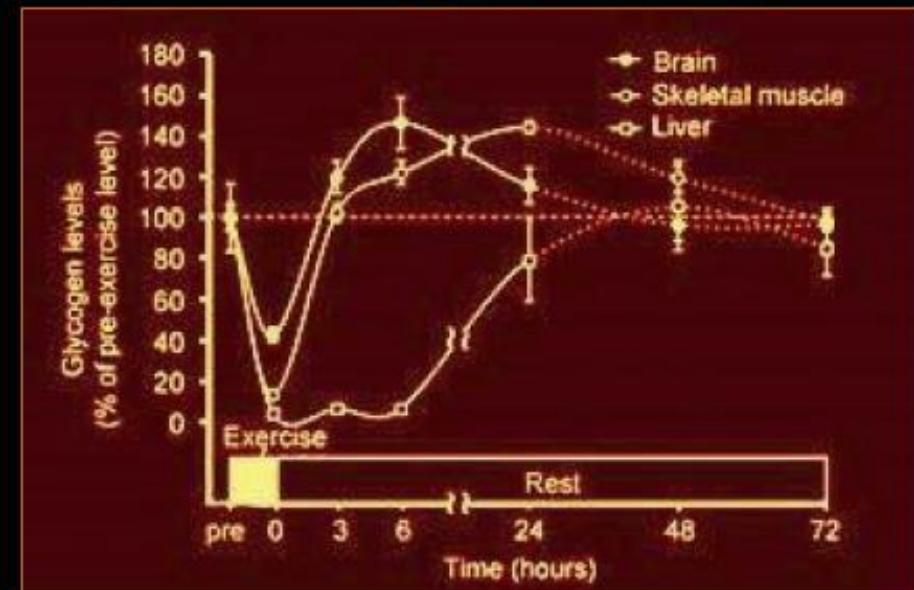
3.

## LIVER



# Glycogen Back

Order and rate of glycogen refueling



Life of an Athlete  
Human Performance Project

Life of an Athlete Human Performance Project

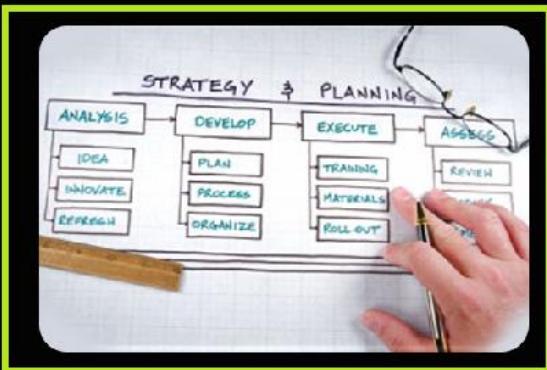
# PERFORMANCE



TRAIN  
RECOVER  
ADAPT



# SLEEP AND COGNITION



## Cognitive Output and Sleep

Restriction of sleep produces a neural sleep wave pattern that is sometimes observed in depression. A reduction in sleep reduces higher levels of cognition such as problem solving, high speed decision making, processing and reaction. Much of your sport depends on how you think and quickly react. Sleep and you will see more functional mental performance.

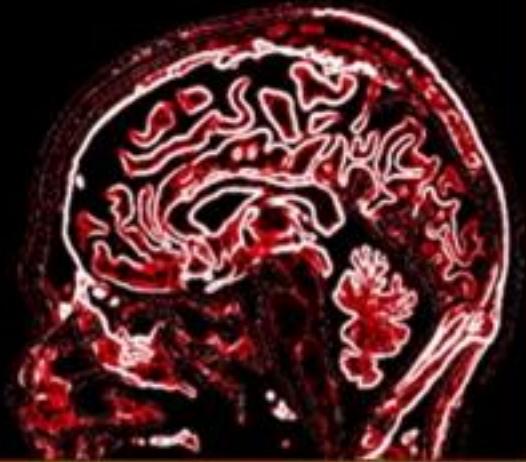


**LIFE OF AN  
ATHLETE**  
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The brain  
processes  
400 billion  
points of data  
every second.

Is your brain ready to play?





**A human brain  
produces as many as  
12,000 to 50,000  
thoughts per day  
depending on how deep  
a thinker a person is.**

[WEFACTYOU.COM](http://WEFACTYOU.COM)

# Duration of limits of performance



MENTAL  
14 HOURS



PHYSICAL  
2-3 HOURS



OPTIMAL PERFORMANCE

If the body and CNS is rested it can perform for long periods of time at high output capacities. Mental outputs of up to 14 hours and physical outputs up to 2-3 hours are possible. There are many factors that influence these time durations. Sleep, glucose levels, stress, fatigue, alcohol, marijuana... Studies indicate that CNS function clearly impact physical function. The CNS builds up energy reserves or deficits over one to three days and will function at those levels. Take into consideration every possible option to recover and recharge. You will increase the quality at which you train and compete.



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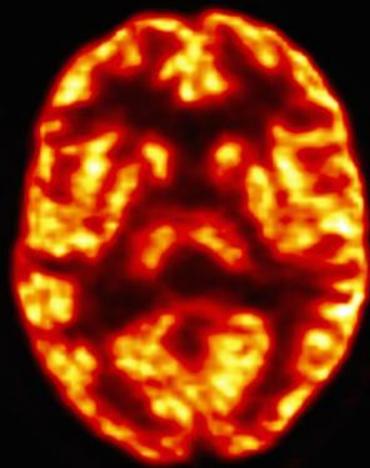
The human body was meant to be up for 16 hours and down for eight... The body can adapt to less sleep but mental and physical performance is degraded.

*John Underwood Human Performance Project*



2-3 Hours

14 Hours

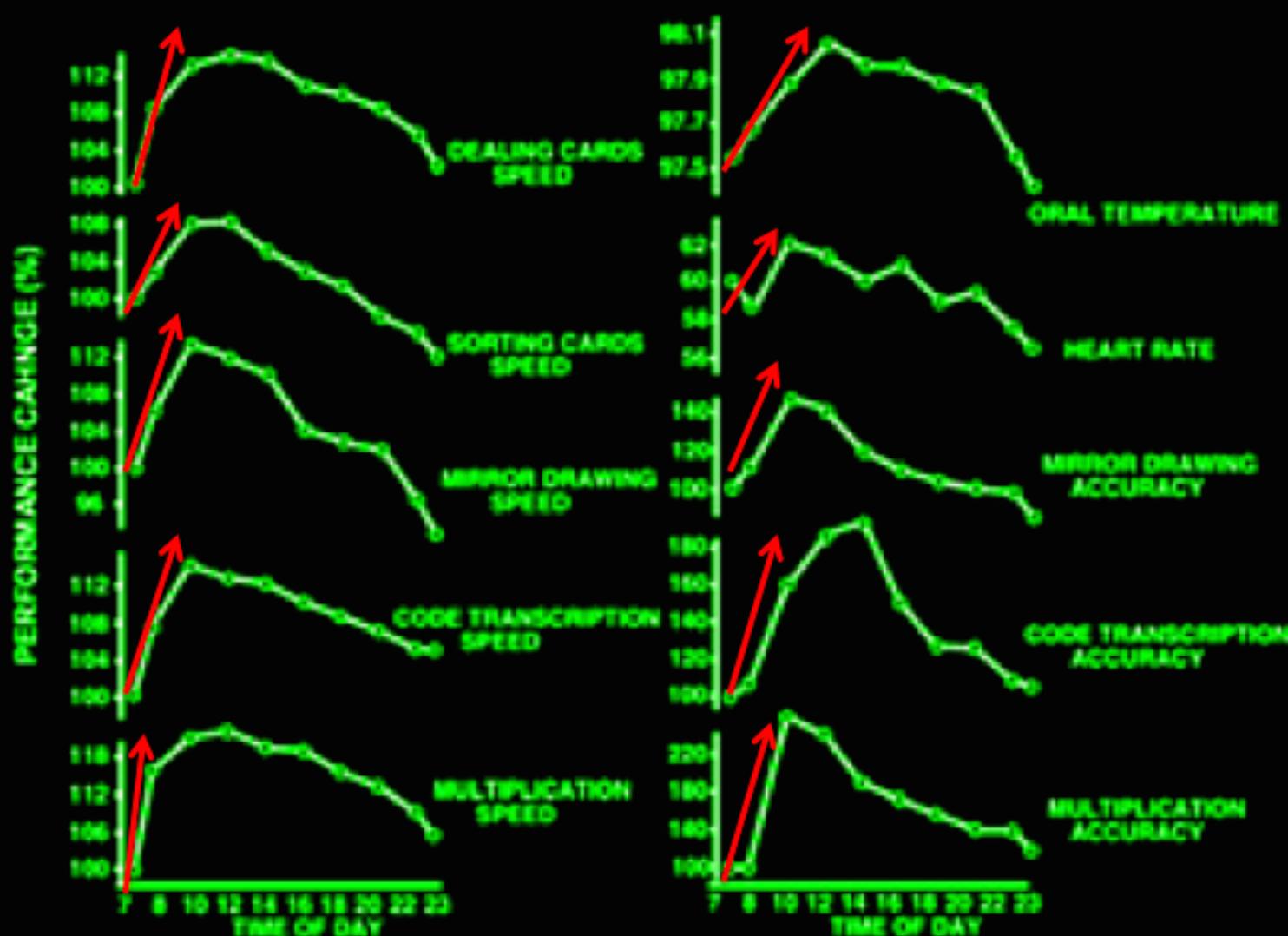


Once in a state of fatigue the more you struggle to close the gap between what you can do and what you think you can do, the further down the performance curve you move and the more compromised you are!

*John Underwood Human Performance Project*



# Circadian rhythm of performance





# Signals



# CNS as a PREDICTOR

- *“Soviet coaches knew for decades that the condition of the athlete’s nervous system is the most important variable in posting an elite performance and breakthrough neuroscience research by their fellow countrymen had given them an undeniable advantage over the rest of the world. Simple and effective tests of the CNS tonus were developed: the grip, the standing vertical jump, the critical blinking frequency, the latent reaction time, tapping with a pencil and hitting a maximal number of dots in 5sec, etc.”*

**USSR 1940's- 1980's**





Blink rates vary quite a bit depending on emotional and mental states. Stress and anxiety tend to increase a person's blink rate (**SLOWER**). Intense concentration tends to reduce the blink rate(**FASTER**), and if you're in a situation that implies some **STRESS**, your blinking rate can go way down (**RAPID**) -- presumably to **INCREASE HYPERVIGILANCE**.



# HOW STRONG IS THE SIGNAL?

Signal Amplitude



If our CNS is rested and ready we increase performance potential

CNS Readiness & Neural Connection

Increases in explosive muscle strength (contractile RFD and impulse) were observed after heavy-resistance strength training. These findings could be explained by an enhanced neural drive, as evidenced by marked increases in EMG signal amplitude and rate of EMG rise in the early phase of muscle contraction.

Increased rate of force development and neural drive of human skeletal muscle following resistance training  
Per Aagaard , Erik B. Simonsen , Jesper L. Andersen , Peter Magnusson , Poul Dyrhe-Poulsen  
*Journal of Applied Physiology* Published 1 October 2002 Vol. 93 no. 4 1318-1326 DOI: 10.1152/japplphysiol.00283.2002



Life of an Athlete  
Human Performance Project





Nicolay Onokin WR PoleVault Olympic Champion  
USSR Master Coach and Scientist

## Listen to the following recommendations on CNS by Prof. Nikolay Ozolin.

Buy a hand grip dynamometer of the kind used in physical therapy clinics and test yourself daily. Never change the testing protocol: do it at the same time of the day, with the same hand, in the same posture, with the same warm-up or lack of thereof, etc. Make only one attempt.

The number itself does not reflect the level of your CNS excitability; it is the pattern charted over time that matters. When your training load is appropriate, there will be little daily variance: 1-2kg or 2.2-4.4 pounds. A greater decrease indicates an excessive training load, an insufficient recovery, a nervous fatigue, an early phase of overtraining, or some disturbance in your regimen or your life. A slight drop for one to three days following a competition is normal however.

"Analysis of daily values of grip strength gives the opportunity not only to objectively control changes in the nervous system excitability, but also to direct it into the right direction with the help of the daily regimen, massage, training, and pharmacology," continues Ozolin. "A reminder: a calm and long cross country run through the woods lowers excitability and brief but intense work, including strength work, increases it. Training in the pre-competition days and a warm-up the day before the competition restrains an increase in excitability while passive rest filled with thoughts about the upcoming competition sharply increases it."

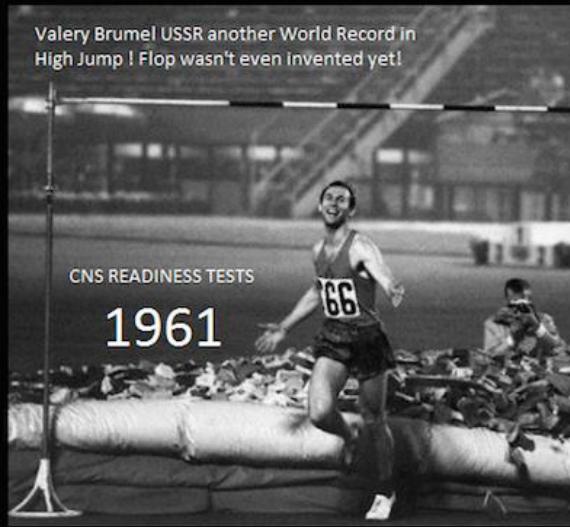
The Soviet champion, scientist, coach offers more advice on fine-tuning your CNS condition in the days before the competition:

- Don't rest longer than 24 hours before the event.
- Perform a warm-up specific to your event 24 hours before the competition.
- Do a light workout if nervous on the days leading up to the competition.
- Skip the workout if don't feel like training after the warm-up.
- Don't push it in the days after an unsuccessful competition. No point in punishing yourself... train light and do exercises that are not specific to your sport.



**Life of an Athlete  
Human Performance Project**

# 7' 4 1/4"



Brumel straddled this height, a jump of 2.23 metres (7 feet 4 inches)!

## CNS Tests Used by Russians in 1961 to Show Performance Readiness

It was 1961 and Russians were flying high. Yuri Gagarin was the first man in space. Valery Brumel was breaking world records in the high jump. Every day the latter's coach would test his grip strength. He knew that this test was the simplest way to gage the work capacity and excitability of the athlete's CNS—the single most important variable in posting great results. That day the chart showed that the sportsman's grip had suddenly spiked up. The coach shook his head; he knew that this indicated premature peaking. He did not want his star jumper to leave his best performance in the gym—to get "discharged", as Russian athletes would say. So Brumel took a harder than planned workout and the excitation came down but several days later started climbing up again. Another workout, a light one this time, brought it down once more. The coach's adjustments worked like a charm. On the day of the championship Valery Brumel's grip strength was off the charts, his nervous system in peak form, another record fell...The Soviets knew in 1961 that the CNS was the most indicative measurable factor in performance and we are just getting on this page in 2015. Much of our Human Performance Project has been associated with this CNS readiness phenomenon. We have utilized simple phone apps to measure on a day to day basis athlete readiness to train and compete. That is the power of science that can make you a champion!

Soviet coaches knew for decades that the condition of the athlete's nervous system is the most important variable in posting an elite performance and breakthrough neuroscience research by their fellow countrymen had given them an undeniable advantage over the rest of the world. Simple and effective tests of the CNS tonus were developed: the grip, the standing vertical jump, the critical blinking frequency, the latent reaction time, tapping with a pencil and hitting a maximal number of dots in 5sec, etc.



**Life of an Athlete  
Human Performance Project**

6 World Records and each one predicted prior to competition!





7' 4  $\frac{1}{4}$ "





Brunel Had A Serious Case Of The B  
Could touch the rim with



Every performance  
predicted by his coach prior!

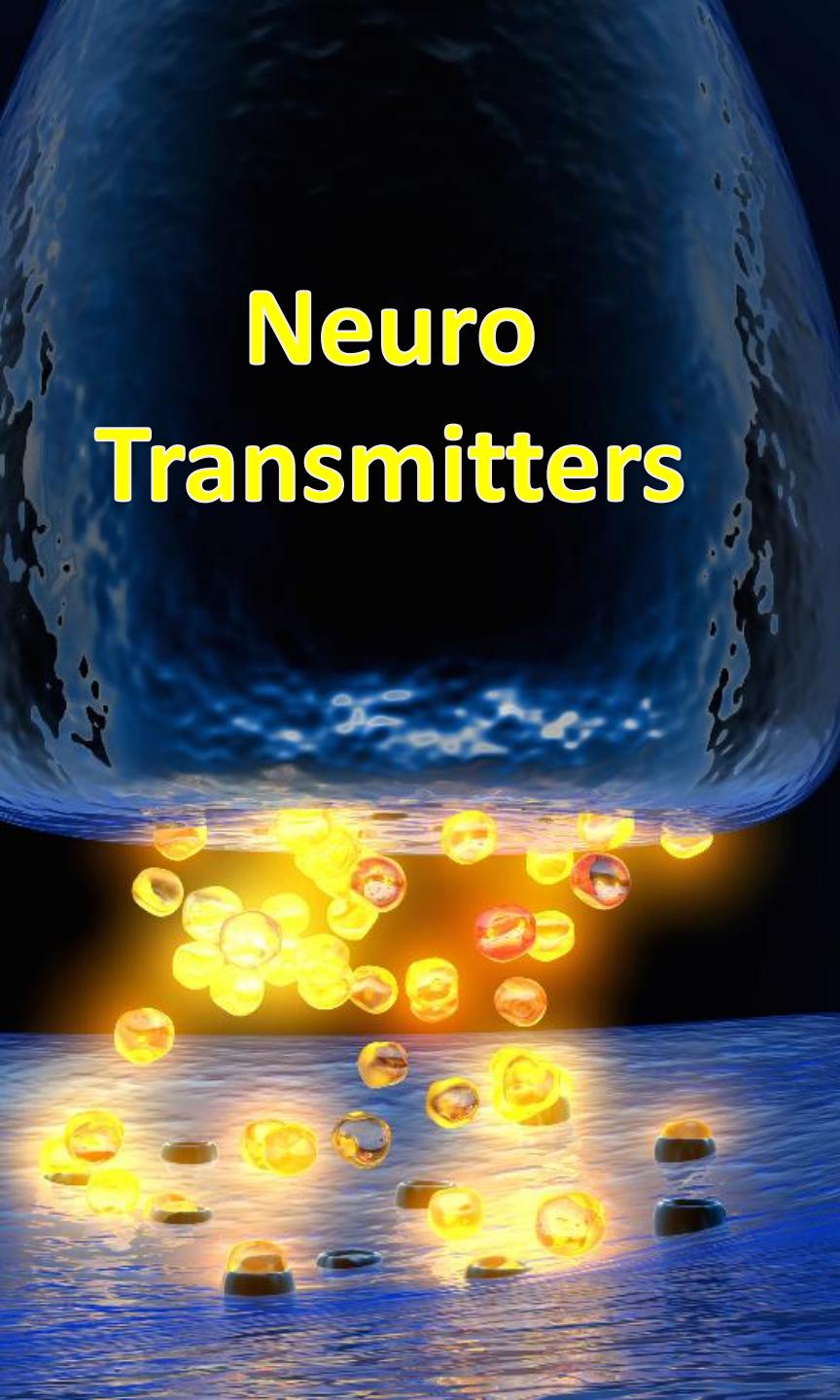
humel dominated the high  
a decade 1961-1971

the modern "flop" technique



5X





# Neuro Transmitters



Initiation of movement  
Power Outputs  
Force Development  
Neural Drive  
Reaction



Focus  
Concentration  
Processing  
Reaction

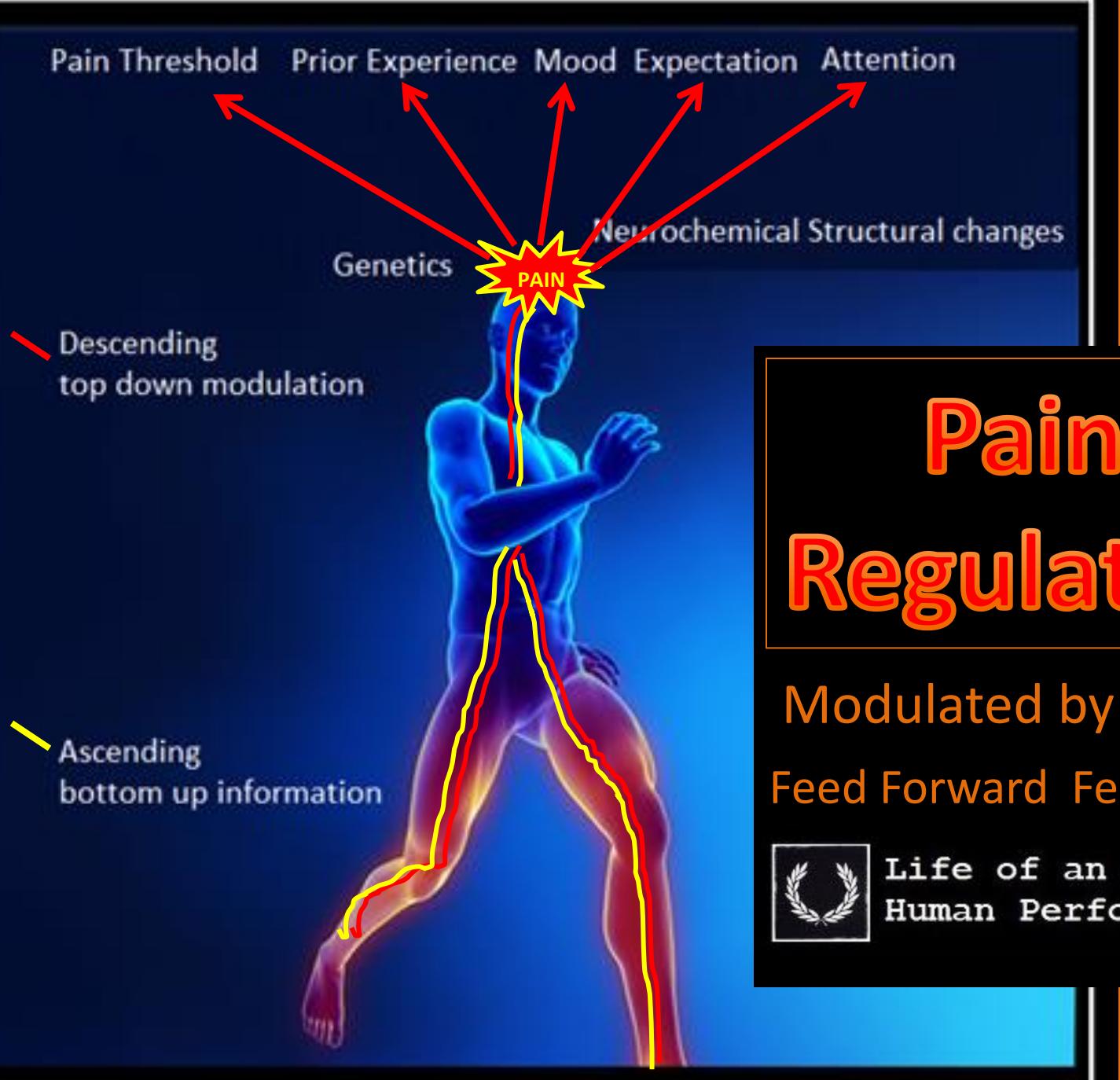
# Cognitive function

Initiation of human movement



NEUROTRANSMITTER REGULATED





# Pain Regulation

Modulated by Brain CNS  
Feed Forward Feed Back System



Life of an Athlete  
Human Performance Project

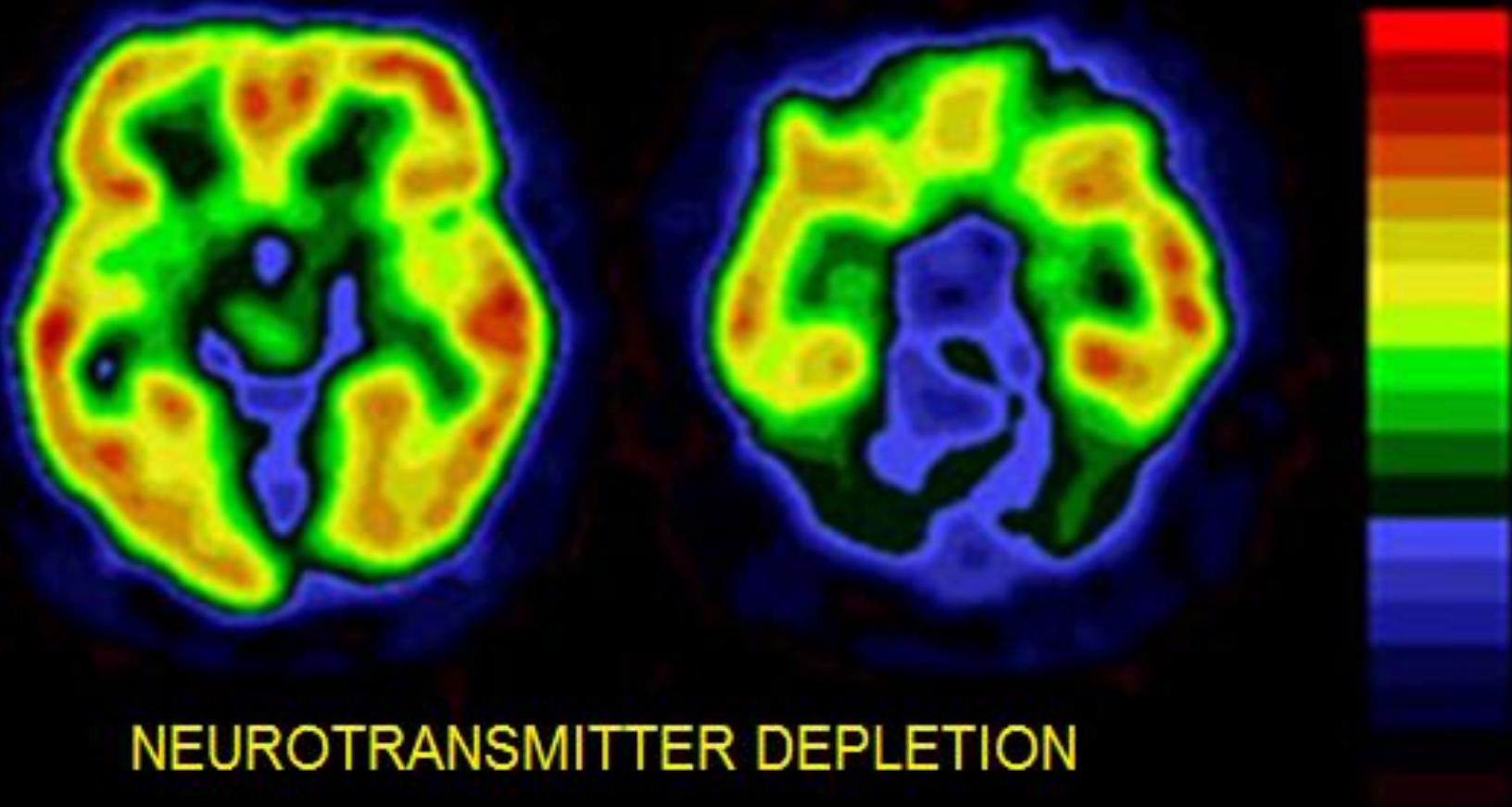


NEUROTRANSMITTER MODULATED

Five ascending  
pain-conducting  
neuronal pathways

**LOADED**

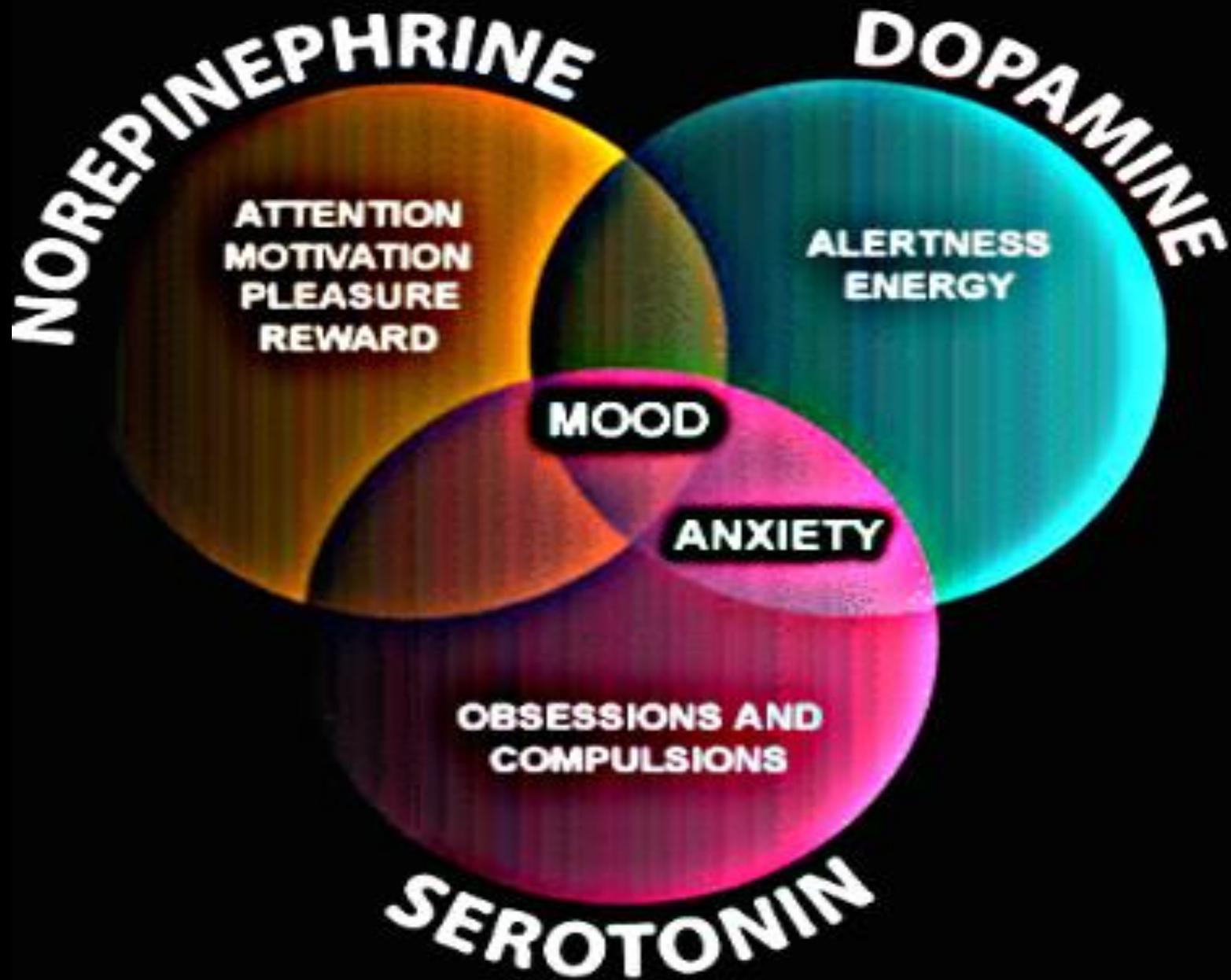
**DEPLETED**



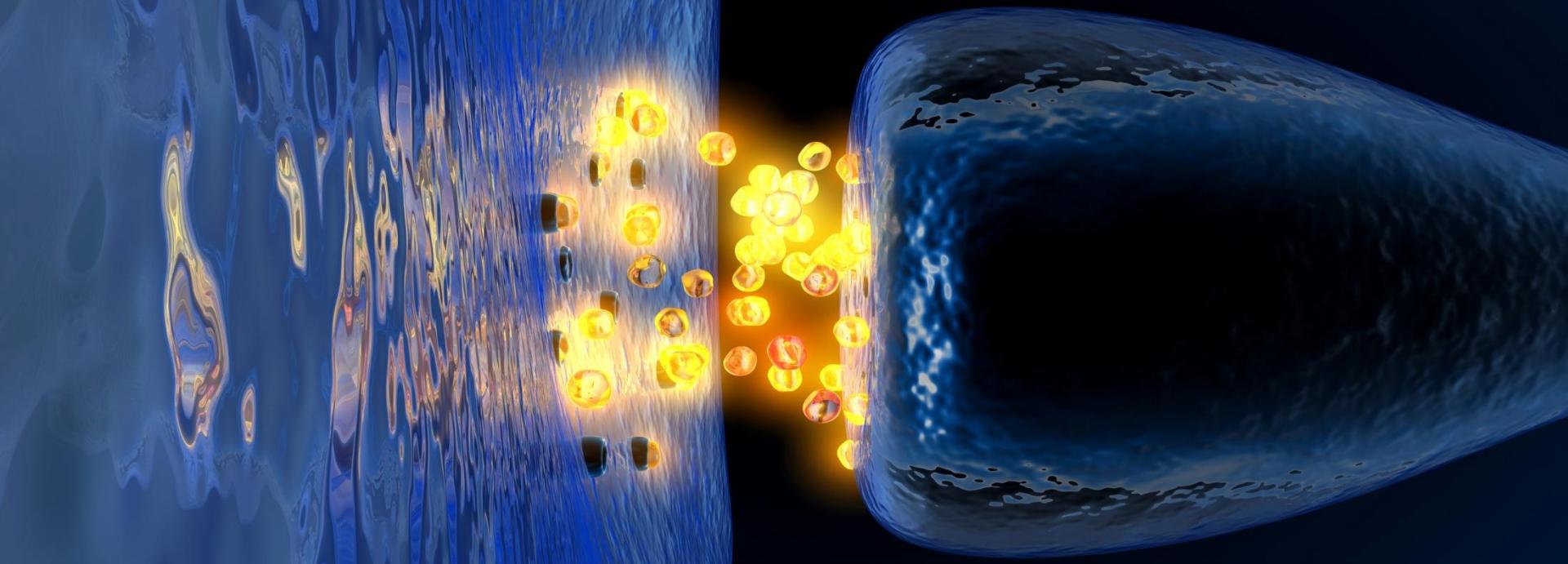
## **NEUROTRANSMITTER DEPLETION**

The importance of the connection between serotonin and dopamine stems from the balance that must be maintained within the body for brain /body function

**RELOADED DURING SLEEP**



# ACCELERATOR FOR MOVEMENT



> MOTOR NEURON ACTIVITY

NEUROTRANSMITTERS



# Serotonin

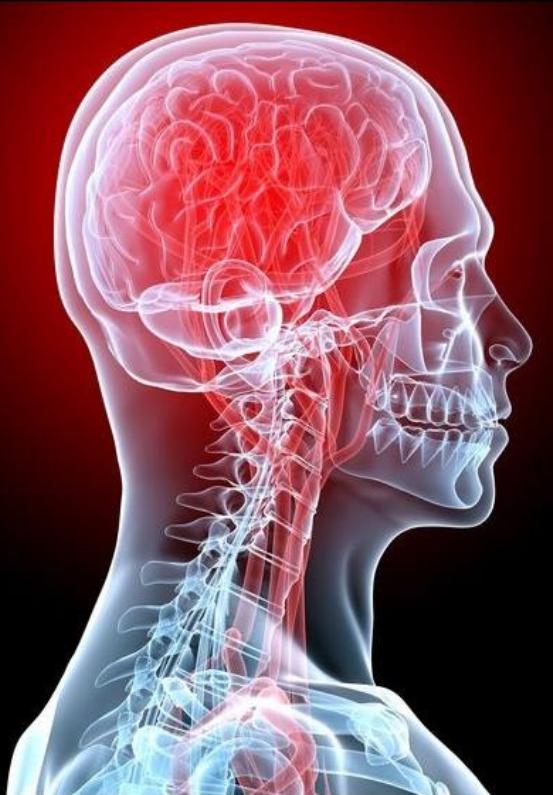


# Dopamine

## CNS Fatigue Serotonin and Dopamine

CNS Fatigue is that there are not one, but two points from which our muscles can become fatigued: 1) in the muscle itself; and 2) at the point of origin of the muscular contraction (the central nervous system). Fatigue in the muscle itself is referred to as peripheral fatigue while fatigue at the point of origin is known as central fatigue.

Much of the research into CNS fatigue has focused on Serotonin (5-HT) and Dopamine due to their roles in regulating functions such as sensory perception, mood and perceived exertion. Research suggests that an imbalance in these neurotransmitters- Particularly, a spike in Serotonin and a drop in Dopamine levels- is associated with the onset of CNS fatigue. The theory is the high 5-HT/low Dopamine brings on CNS fatigue with low 5-HT/high Dopamine resulting in enhanced performance.



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Human Performance Project

# Results in CNS Fatigue

As soon as the body starts moving, serotonin is released. It functions as an accelerator for movement and makes motor neurons more active.

It is actually a surplus of serotonin that triggers a braking mechanism in the brain. In other words, serotonin functions as an accelerator but also as a brake when the strain becomes excessive.

Jean-François Perrier from the Department of Neuroscience and Pharmacology

Serotonin spillover onto the axon initial segment of motor neurons induces central fatigue by inhibiting action potential initiation.

Florence Cotela, Richard Exley<sup>b</sup>, Stephanie J. Craggb, and Jean-François Perriera,<sup>1</sup>  
<sup>a</sup>Department of Neuroscience and Pharmacology, University of Copenhagen, 2200 Copenhagen, Denmark; and <sup>b</sup>Department of Physiology, Anatomy and Genetics, University of Oxford, Oxford OX1 3PT, United Kingdom

# Serotonin Surplus Triggers Breaking Mechanism



Can't run any further because your legs have turned to jelly? You're not exhausted - it's your brain that's tired, say scientists!

The University of Copenhagen, in Denmark, think that they can now explain why our brains feel tired when we exercise. They mapped the mechanisms behind so-called central fatigue – the braking mechanism in the brain that swings into effect to make us too tired to continue exercising.

Associate Professor Jean-Francois Perrier, from the Department of Neuroscience and Pharmacology, explained: 'We have always known that the neurotransmitter serotonin is released when you exercise, and indeed, it helps us to keep going.'

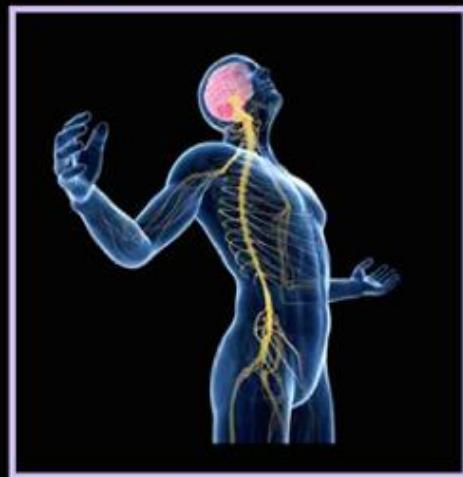
'However, the answer to what role the substance plays in relation to the fact that we also feel so exhausted we have to stop, has been eluding us for years.'

'We can now see it is actually a surplus of serotonin that triggers a braking mechanism in the brain.'



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# Psycho-Physiological Preparation



The brain isn't just a finely tuned control center, but also a sensor that can detect and react to self-doubt and hesitation. It interprets doubt as a signal that the body isn't up to the task. If you worry about completing a race before it begins you've already lost - your legs will feel tired from the start even if you're fit.

If you really believe you can win - not just think it but deeply believe it because you're fit, at the peak of physical preparation and know you're capable - your brain takes this confidence and programmes your body for optimal performance. If you visualise your victory, 'taste' it before the race begins and train with victory foremost in your mind, chances are excellent you'll produce your best possible performance.

Your Brain and  
Your Expectations



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Human Performance Project

Tim Noakes

Mental Preparation  
Psychological Preparation  
Physiological Function



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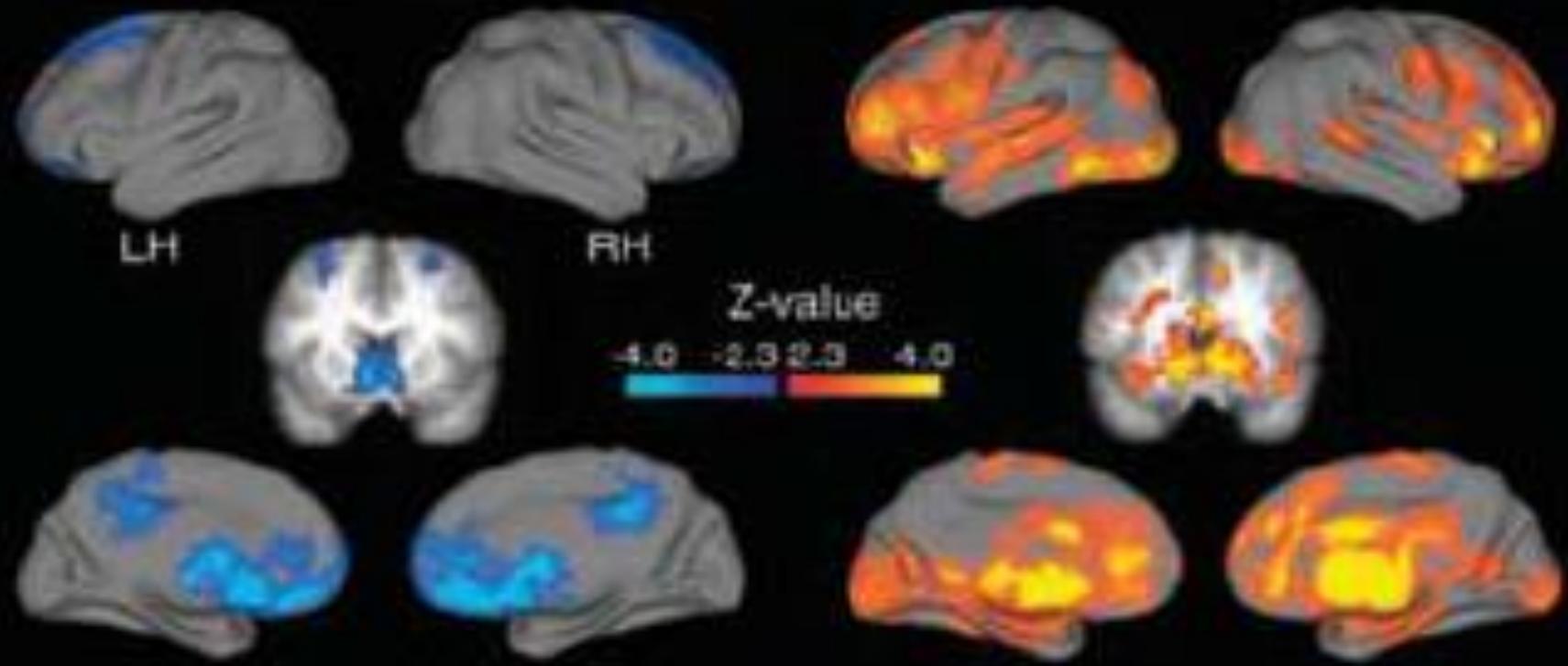
The brain interprets doubt as a signal that the body  
is not ready for high level physical performance

I have no DOUBTS



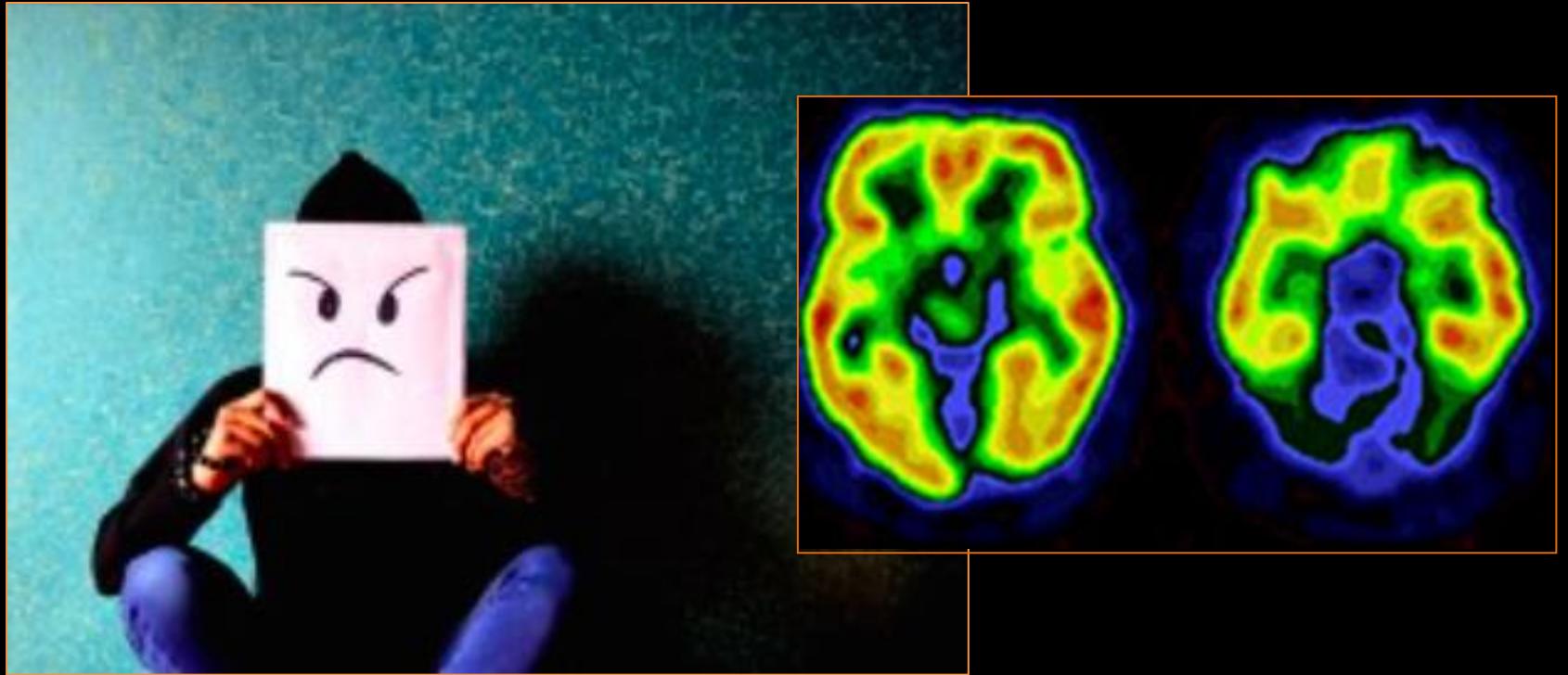
man will never fly the  
summit of mt. everest  
will never be conquered  
the second barrier will

**LOSE** **WIN**



**negative thoughts**

# DEPLETED DOPAMINE



# DECREASED MOTIVATION

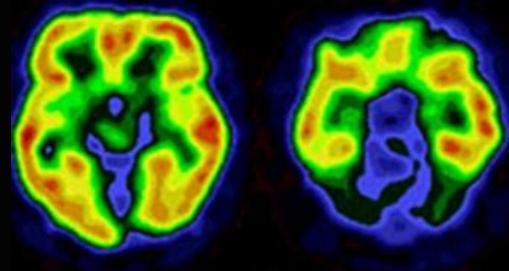
# The ratio of serotonin and dopamine determines

## MOOD REGULATION

INSTABILITY

IMPULSIVITY

REACTIVITY



# DEPLETED SEROTONIN



Decreased Brain/Body Function

# DEPLETED DOPAMINE

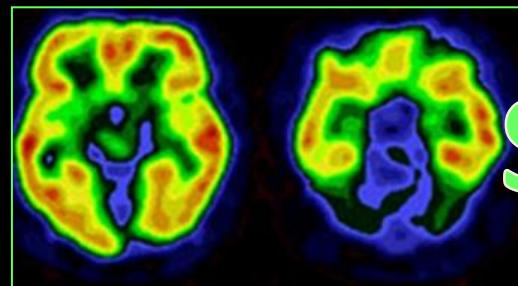


# DECREASED MOTIVATION



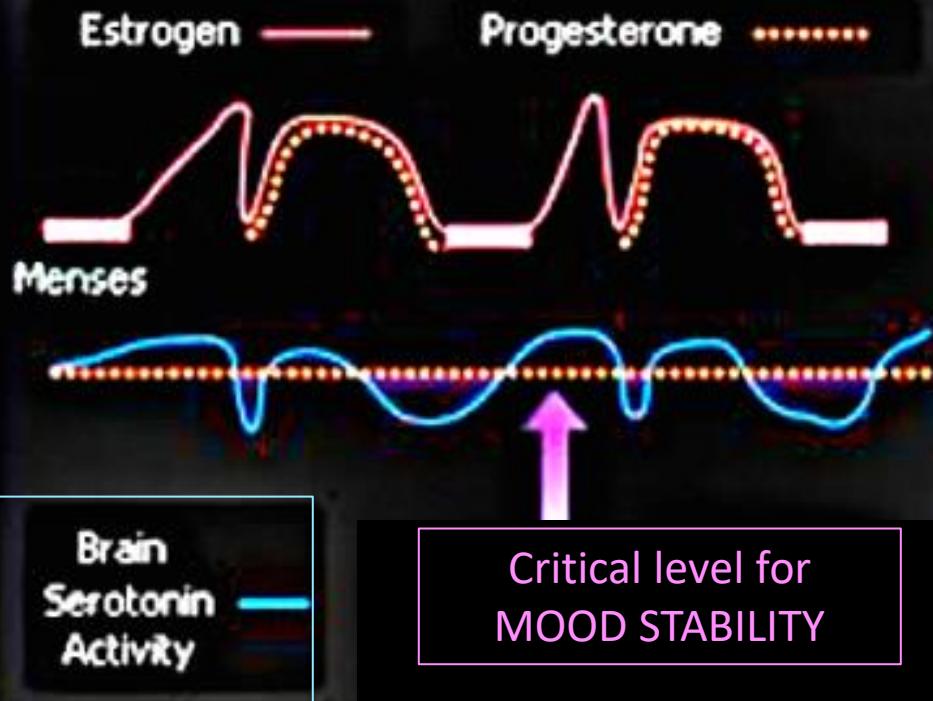
Mood Stability and NT Ratios of SEROTONIN AND DOPAMINE

MOOD



STABILITY

## Hormone Imbalance Affects Production of Serotonin in the Brain

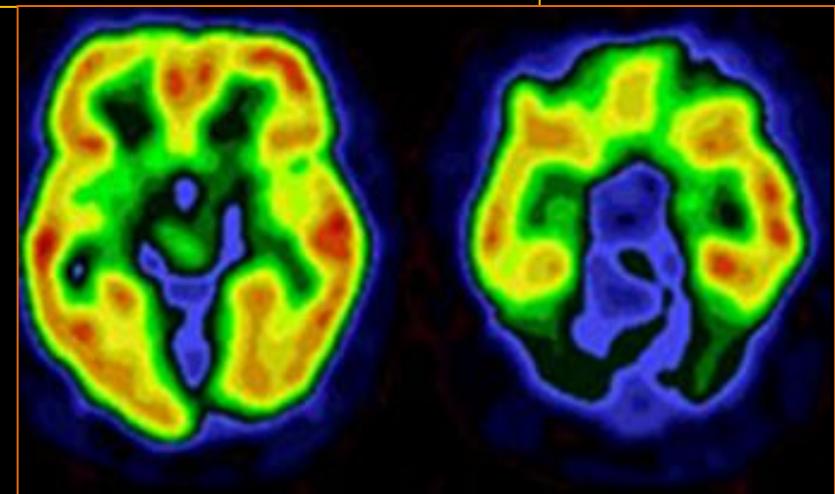


PMS symptoms, including mood issues, occur during the last (luteal) phase of the menstrual cycle, which starts after ovulation — typically day 14 to 28 of a woman's monthly cycle.  
Once menstruation starts, mood swings usually disappear.

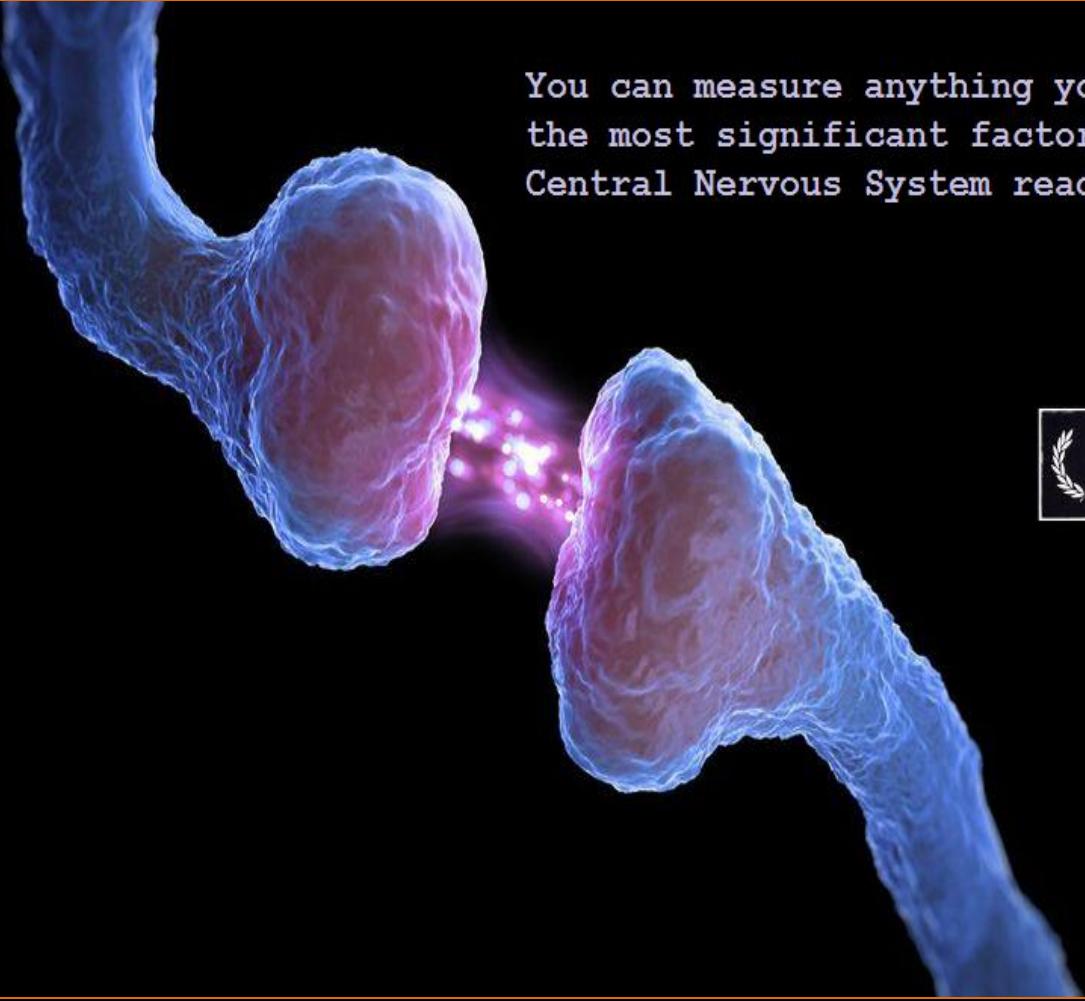
# FEMALE COMPLICATIONS

# DEPLETED SEROTONIN

## DECREASED MOOD



# How fast \* How long\* How strong\*



You can measure anything you want in a laboratory... but the most significant factor in human performance is CNS Central Nervous System readiness!

John Underwood  
Human Performance Project

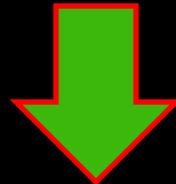


Life of an Athlete  
Human Performance Project

# REACTION for 100 Years

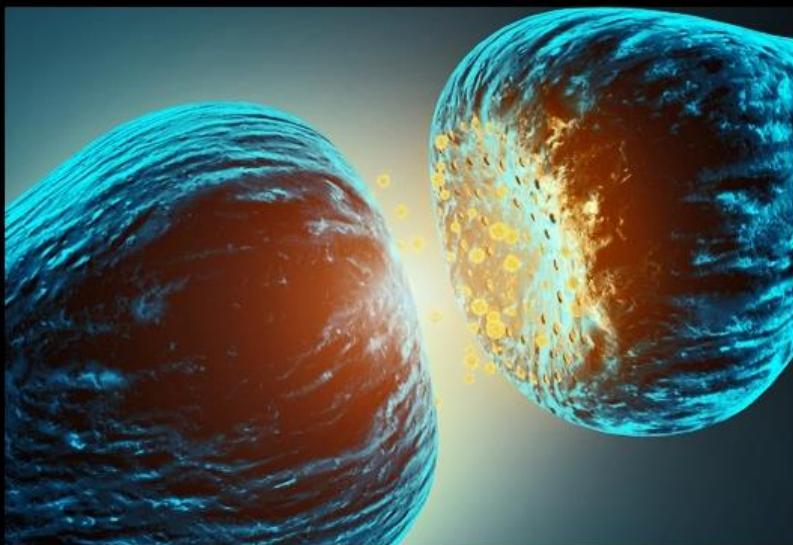
For more than a century, the accepted figures for mean simple reaction times for college-age individuals have been about 190 ms (0.19 sec) for light stimuli and about 160 ms for sound stimuli (Galton, 1899; Fieandt *et al.*, 1956; Welford, 1980; Brebner and Welford, 1980).

NOW .186



Fastest Gamer 0.191 slowest is .246.  
Fastest Non-Gamer is .209 slowest is .318.

# Diminishing Speed of Transmission



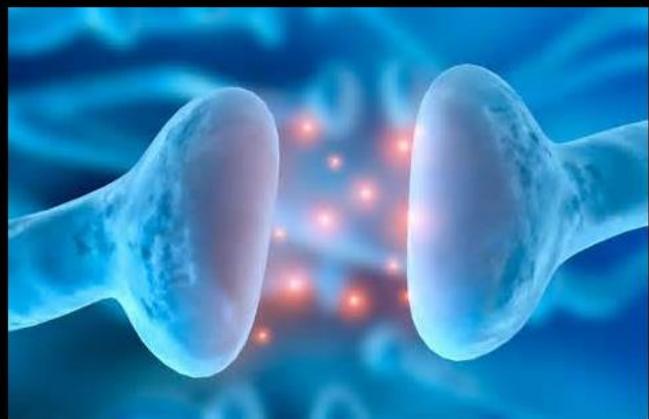
## The need for speed

Reaction time in training athletes is .186 msec. for sight reaction and .160 msec. to sound. Many variables effect these speeds as signals travel from brain, down the spinal pathways to nerve junctions at the site of neuro-muscular connection. Our projects have examined blood glucose levels, sleep, stress, metabolic fatigue, neural fatigue, muscular fatigue, alcohol, marijuana, and many other negative issues related to decreased mental and physical performance.



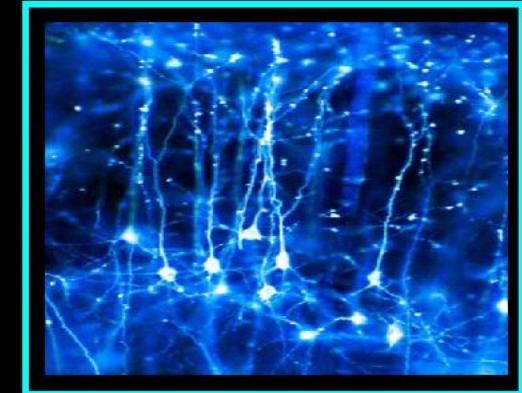
**Life of an Athlete  
Human Performance Project**

**400 km / hr**



**Nerve Impulses  
travel at over  
400 km/hr (250 mi/hr)**

*Don't slow down  
your performance!*



**Life of an Athlete  
Human Performance Project**

**Reaction for training athletes**

**.186 msec**

# .186 Optimal

.231

Neural Fatigue

.246

No sleep

.248

Low blood glucose

.305

Alcohol

.300 .312 .450

1x/ week

3-4x/week

Daily

Marijuana



# BRAIN Nerve Nerve Junction CNS



*Under the highest levels of fatigue*

*The decline in ability of a muscle to generate force.*

*There are two main causes of muscle fatigue - limitations of nerve's ability to generate a sustained signal and the reduced ability of calcium ( $\text{Ca}^{2+}$ ) to stimulate contraction.*

*Muscle cells work by detecting a flow of electrical impulses from the brain which signals them to contract through the release of calcium.*

*The muscle's ability to generate force is most strongly limited by nerve's ability to sustain a high-frequency signal.*

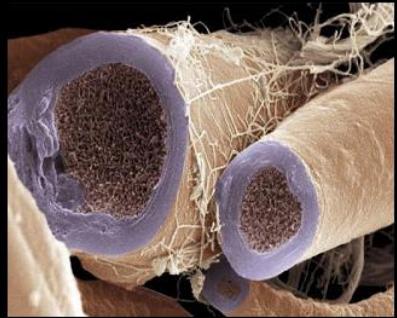
*Part of the process of training is increasing the nerve's ability to generate sustained, high frequency signals which allow a muscle to contract with its greatest force for longer time duration.*



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# SIGNAL?

# Myelin Thickness > Speed



## Myelin Thickness

Myelin is an insulating layer, or sheath, that forms around nerves, including those in the brain and spinal cord. It is made up of protein and fatty substances. The purpose of the myelin sheath is to allow electrical impulses to transmit quickly and efficiently along the nerve cells. If myelin is damaged, the impulses slow down. Myelin thickness is an indicator of fast nerve transmission pathways. An athlete that practices a skill movement over and over and over will develop such pathways.



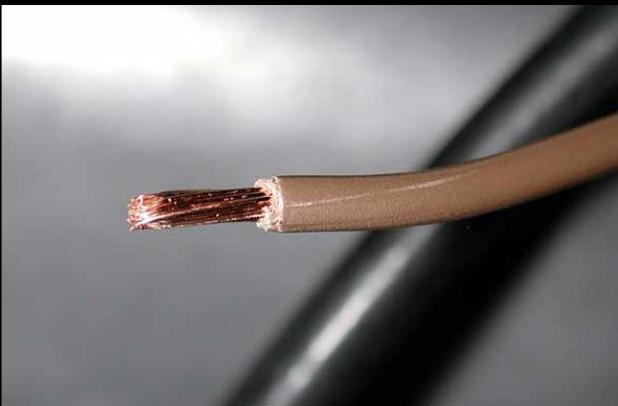
**LIFE OF AN  
ATHLETE**  
Human Performance Project

# Myelin is Speed



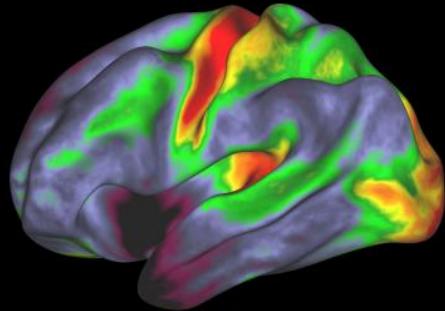
Just like the insulation on wires, myelin has much to do with the transduction of nerve impulses to your muscles. More importantly the speed of those impulses. Myelin is a dielectric (electrically insulating) material that forms a layer, the myelin sheath, usually around only the axon of a neuron. It is essential for the proper functioning of the nervous system. The production of the myelin sheath is called myelination. In humans, myelination begins in the 14th week of fetal development, although little myelin exists in the brain at the time of birth. During infancy, myelination occurs quickly and continues through the adolescent stages of life.

Alcohol downregulates the expression of genes that form myelin.



The main purpose of a myelin layer (or sheath) is to increase the speed at which nerve impulses propagate along the myelinated nerves.

## Myelin in Motor

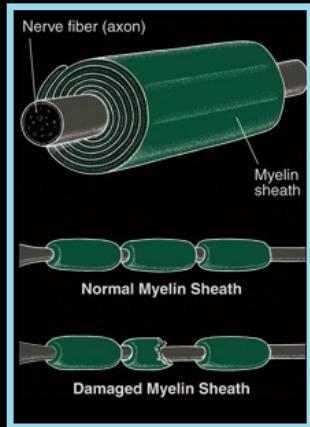


Myelin map of the human brain created by magnetic resonance imaging. David Van Essen/ Washington University School of Medicine. See: Mapping Human Cortical Areas *in vivo* Based on Myelin Content as Revealed by T1- and T2-weighted MRI

## Myelin Density in Brain



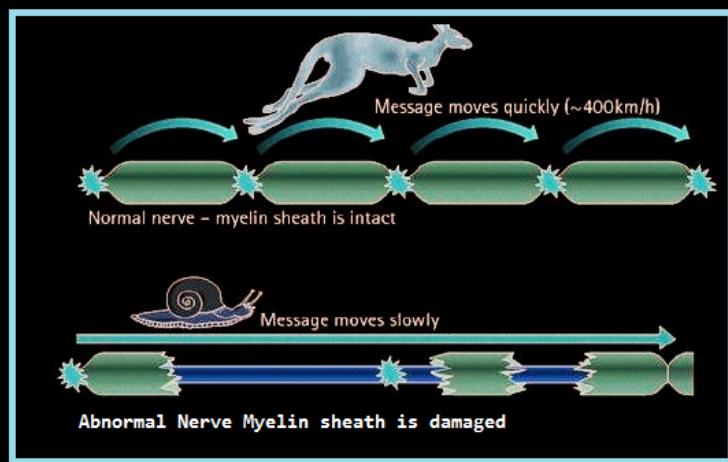
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## Myelin =Speed

Myelin is a sausage-shaped layer of dense fat that wraps around the nerve fibers – and that its seeming dullness is, in fact, exactly the point. Myelin works the same way that rubber insulation works on a wire, keeping the signal strong by preventing electrical impulses from leaking out. This myelin sheath is, basically, electrical tape, which is one reason that myelin, along with its associated cells, was classified as glia (Greek for "glue"). Its very inertness is why the first brain researchers named their new science after the neuron instead of its insulation. They were correct to do so: neurons can indeed explain almost every class of mental phenomenon—memory, emotion, muscle control, sensory perception and so on. But there's one question neurons can't explain: why does it take so long to learn complex skills? Myelin gets thicker when the nerve is repeatedly stimulated. The thicker the myelin gets, the better it insulates and the faster and more accurately the signals travel. As Fields puts it, "The signals have to travel at the right speed, arrive at the right time, and myelination is the brain's way of controlling that speed."

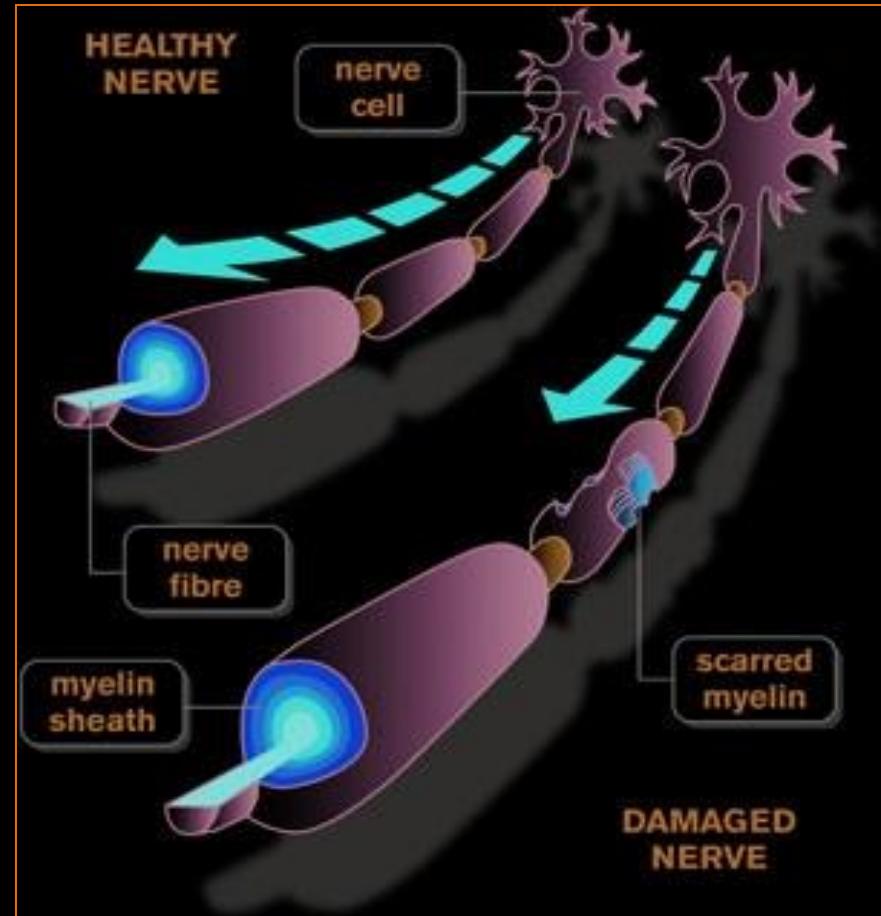
In children, myelin arrives in a series of waves, some of them determined by biological code, some of them dependent on activity. These waves last into young adulthood. Until this time, the brain is extraordinarily receptive to learning new physical skills.





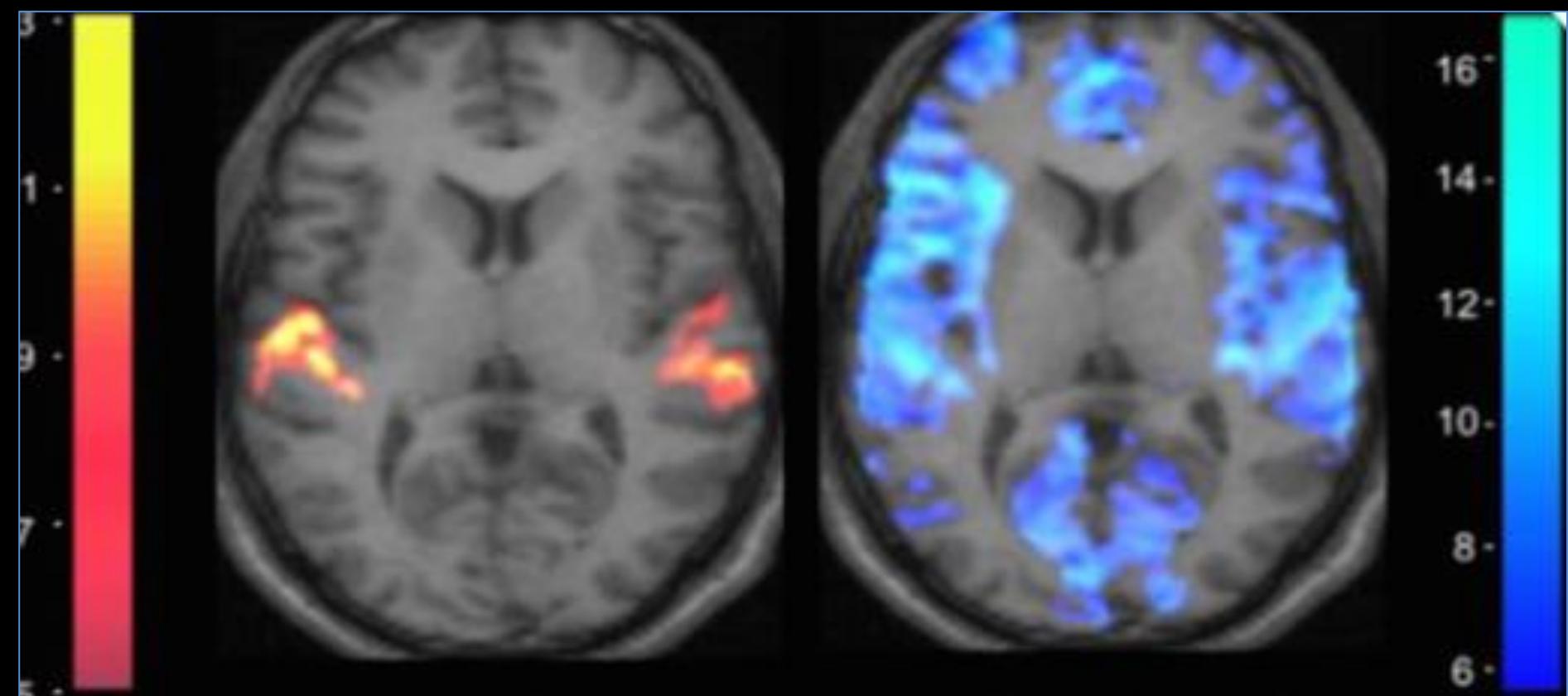
- The inflammation process may lead to various degrees axonal injury
- This signals poorer recovery

## Inflammation Myelin Damage





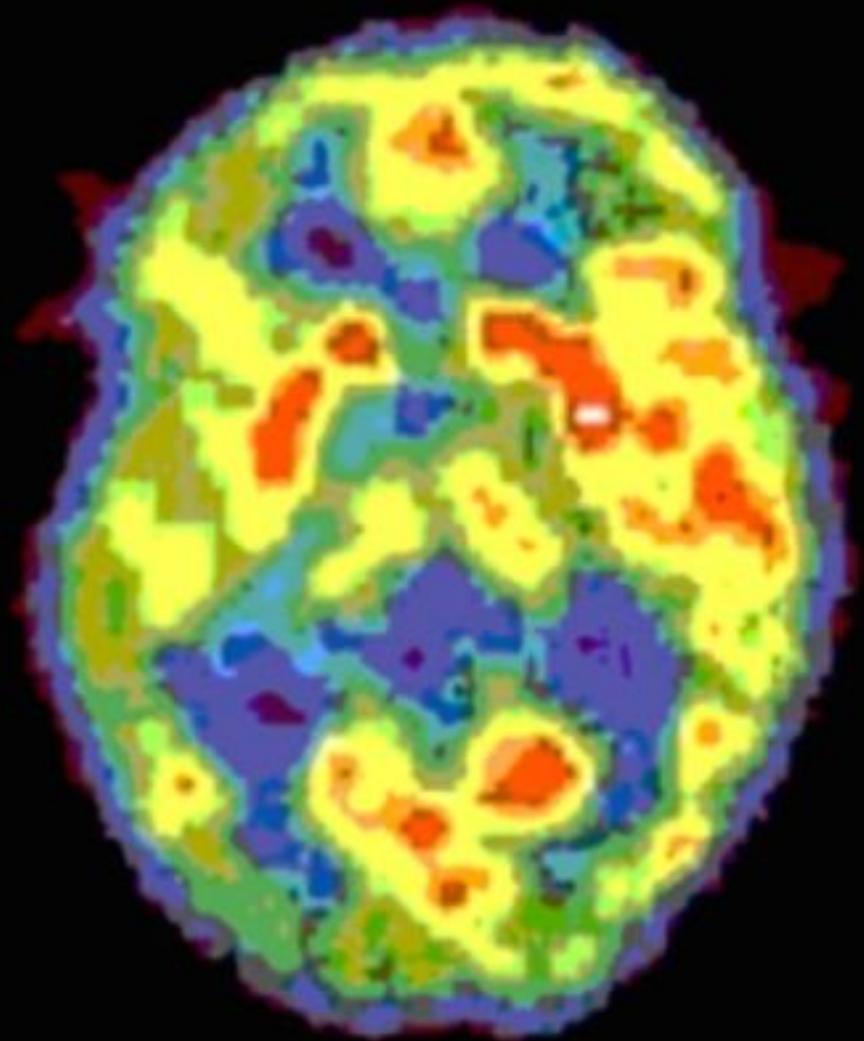
**Damaged Myelin  
Slow Signals**



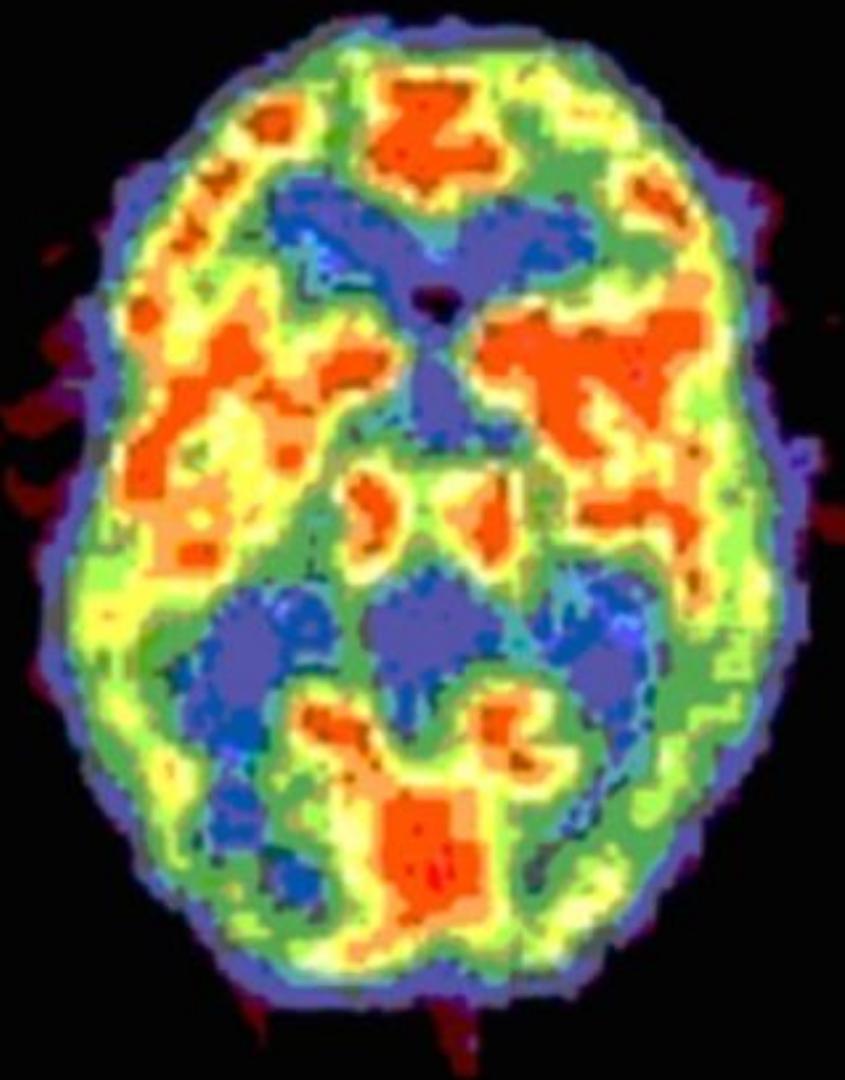
AWAKE

REM

NON REM



REM





**90%**  
**SPEED**

# 90% OF MAX





# Cumulative Damage

After 16 stages and day  
after day damage repair  
functions fail!



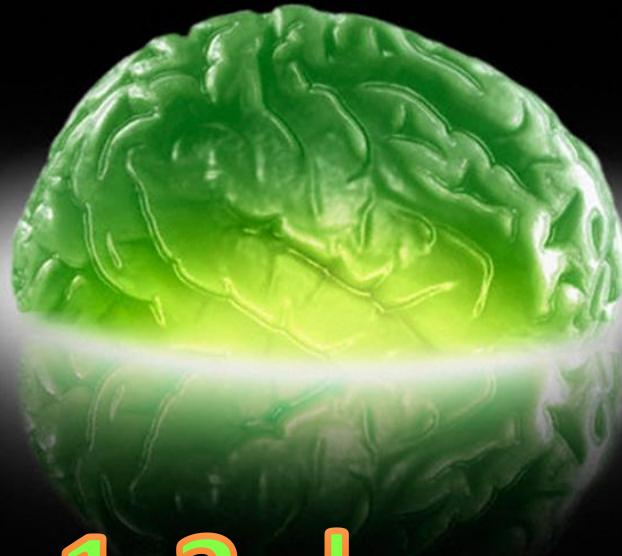
When the brain is fatigued it makes mistakes



# Neural Drive

The brain provides what is known as neural drive to the body. This is the electrical signal sent from the brain to the muscular system, which activates muscle fibers that are responsible for generating power. After heavy stress from high impact training or loads above 90% or speeds above 90% this connection is impaired.





**1-3 days**

The brain builds up energy deficits or energy reserves over several days and will function at that level.

**CNS READINESS**

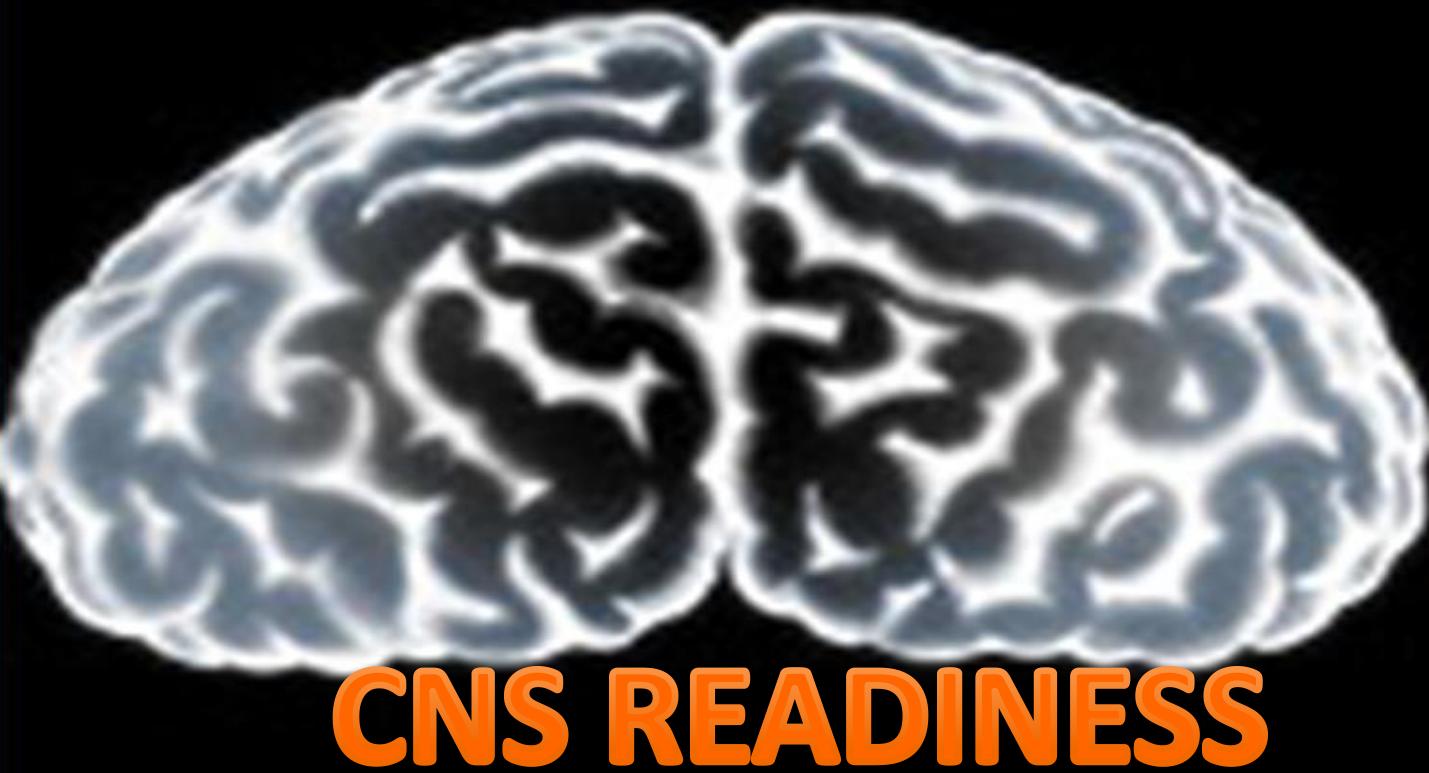


**REST NAPS DOWN TIME SLEEP**

**NON WEIGHT BEARING  
MENTAL REST**



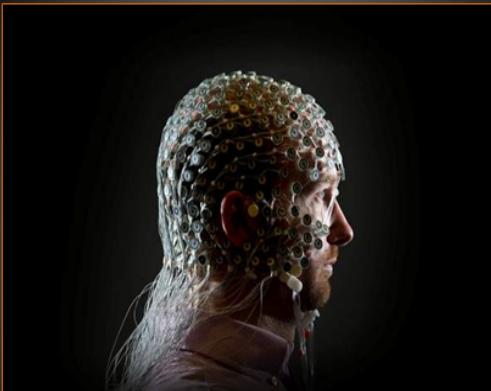
**30 MINUTE NAPS**



**CNS READINESS**

# WHY BRAIN FATIGUES

## Neural Fatigue



LIFE OF AN  
ATHLETE

Brain function under the highest levels of fatigue is a contributing factor in performance levels being maintained or reduced. Connections to muscle function have been documented which disprove the previous theories that depleted oxygen levels led to increases in lactic acid levels, which in turn led to muscle dysfunction. This is clearly not the case. When you examine the splits in a 10,000m race and discover that often the last kilometer is the fastest of all, with closing speeds just over 50 seconds for the final 400m it is clear that muscle function is not decreased. This is the new focal point of studies on fatigue and performance. Much of these studies will be centered on the brain and CNS.

## What brings it back!



# RECHARGING THE BRAIN



*Don't waste your CNS readiness  
on mindless neural processes!!!*

*Save your energy for a chance to show  
what you are capable of. The CNS  
builds up energy reserves or deficits  
over 1-3 days. Overuse of technology  
has been linked to neural fatigue and  
decreased performance. Go out today  
and set a new personal best !*

# Neural Fatigue OVERSTIMULATION





# Techno-Neural

# POTENTIAL ORIGINS OF FATIGUE: MENTAL FATIGUE

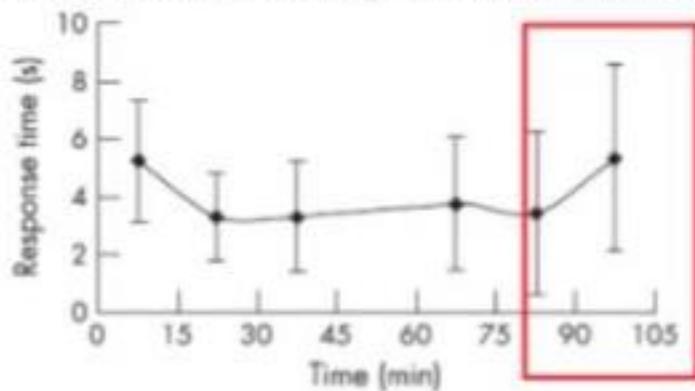
## ORIGINAL ARTICLE

A continuous mental task decreases the physiological response to soccer-specific intermittent exercise

Matt Greig, David Marchant, Richard Lovell, Peter Clough, Lars McNaughton

*Br J Sports Med* 2007;41:908–913. doi: 10.1136/bjsm.2006.030387

- 10 semi-professional soccer players completed a 90-minute laboratory-based treadmill protocol replicating the activity profile of soccer match-play.
- 2 separate trials were performed in randomised order, with and without the added stressor of a continuous grid-based vigilance task.



### ④ Facilitate mental recovery

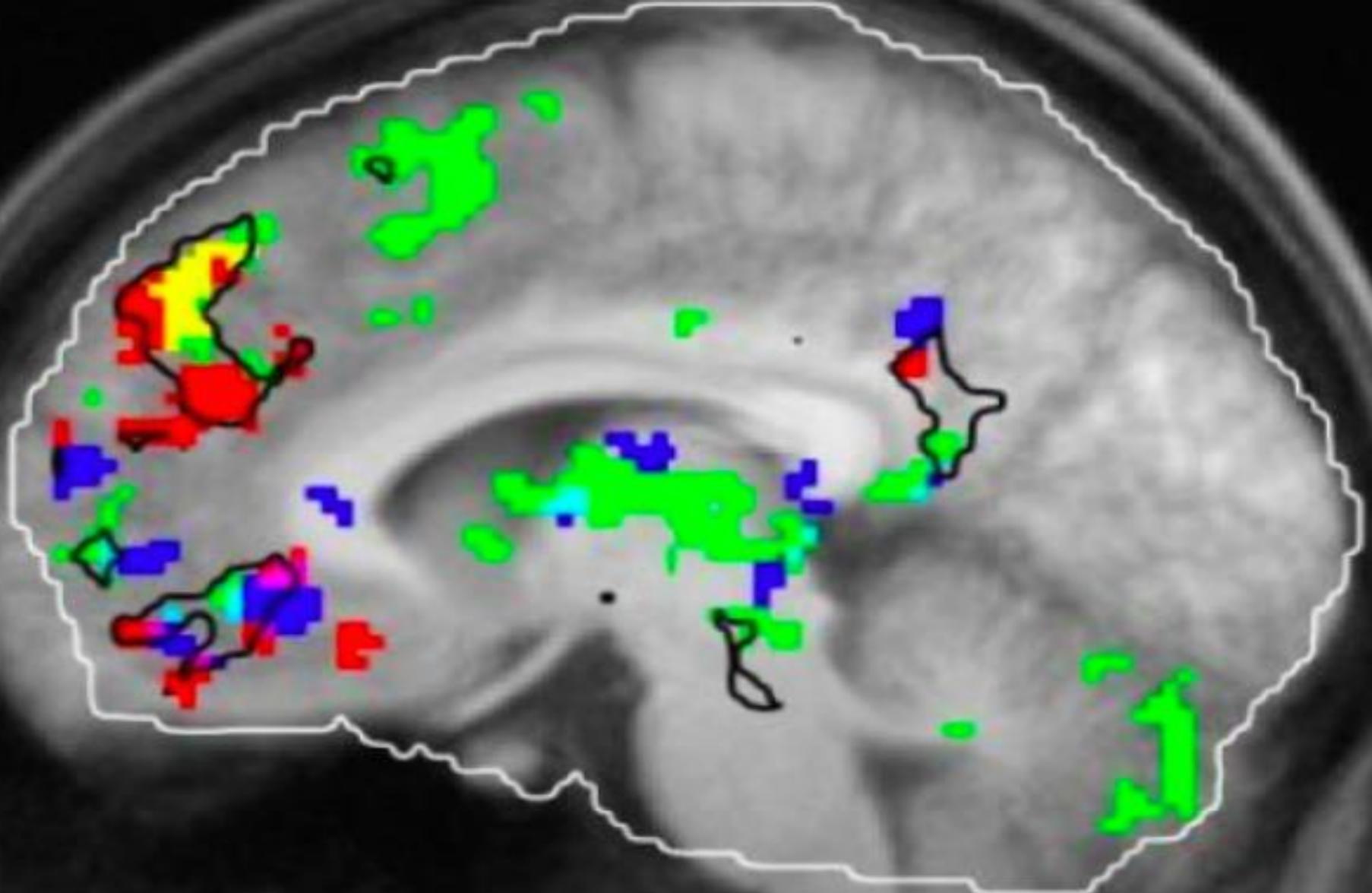


Figure 8 Mean ( $\pm$  SD) number of errors made during the vigilance task.



The amount of information we are now exposed to has increased more in the last 50 years than in the previous 5,000.

*"Every piece of information you are consciously or unconsciously exposed to - has to be processed by your brain!"*



# WHAT IS THIS SCAN?

Every minute you spend doing this  
could have been spent recovering!



NEURAL FATIGUE  
RUINS PERFORMANCE

It is very clear that these technology issues begin at a very early age.



**This is not rest**

**This is not sleep**

**This is not recovery**

This is the difference between what  
you say you want the most and what  
will prevent it from ever happening...



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# Information Overload

## Athletes included!



How much does technology effect mental and physical performance?

More than you think!

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## PROCESSING

The problems associated with technology and CNS fatigue are real. Constant input to the processing regions of the brain result in neural fatigue which in turn creates fatigue in the pre-movement and movement regions of the brain. This affects training, training effect, recovery and competition capabilities. Video games, texting, emailing, TV, facebook and computer work time has greatly increased the total time per day we all input information, consciously or subconsciously to our brains. If you want to train and compete at your best make some choices!



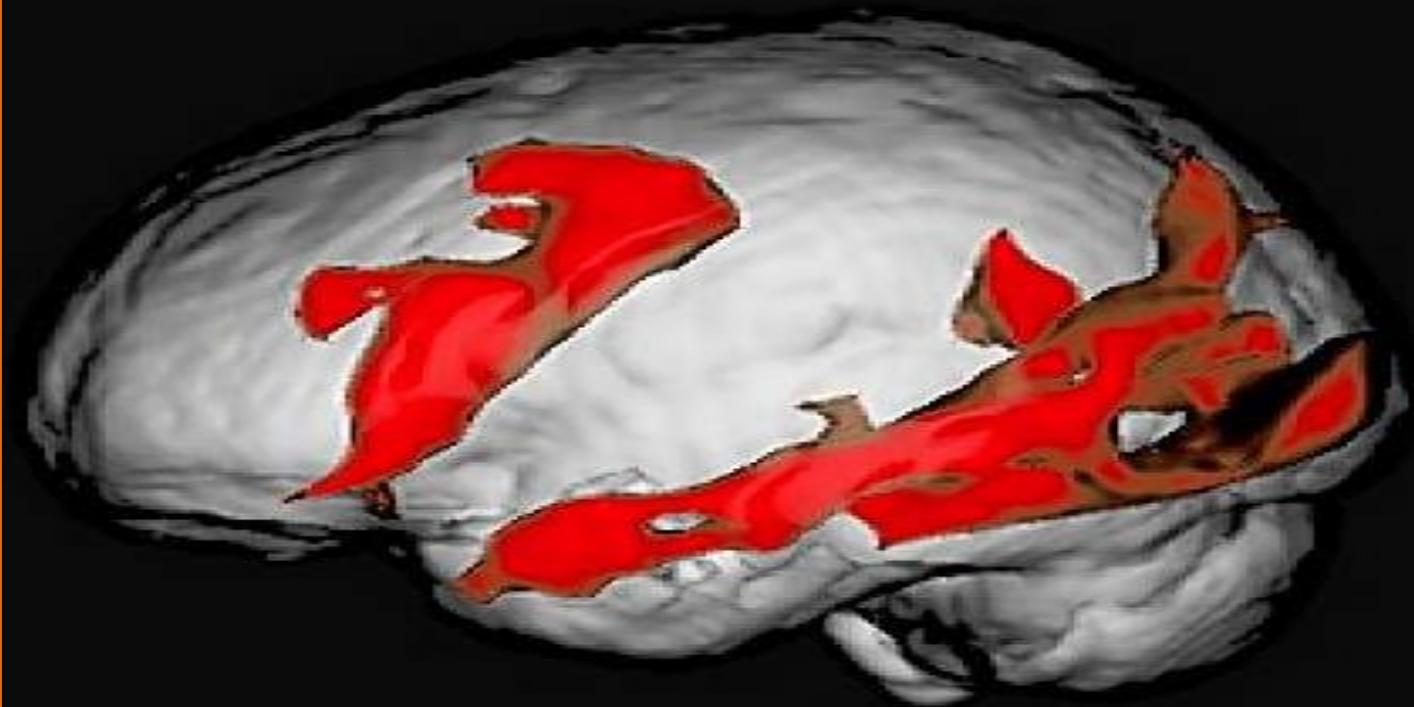
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# Unprecedented Processing

We now process more information in the last ten years than the previous 5000 years

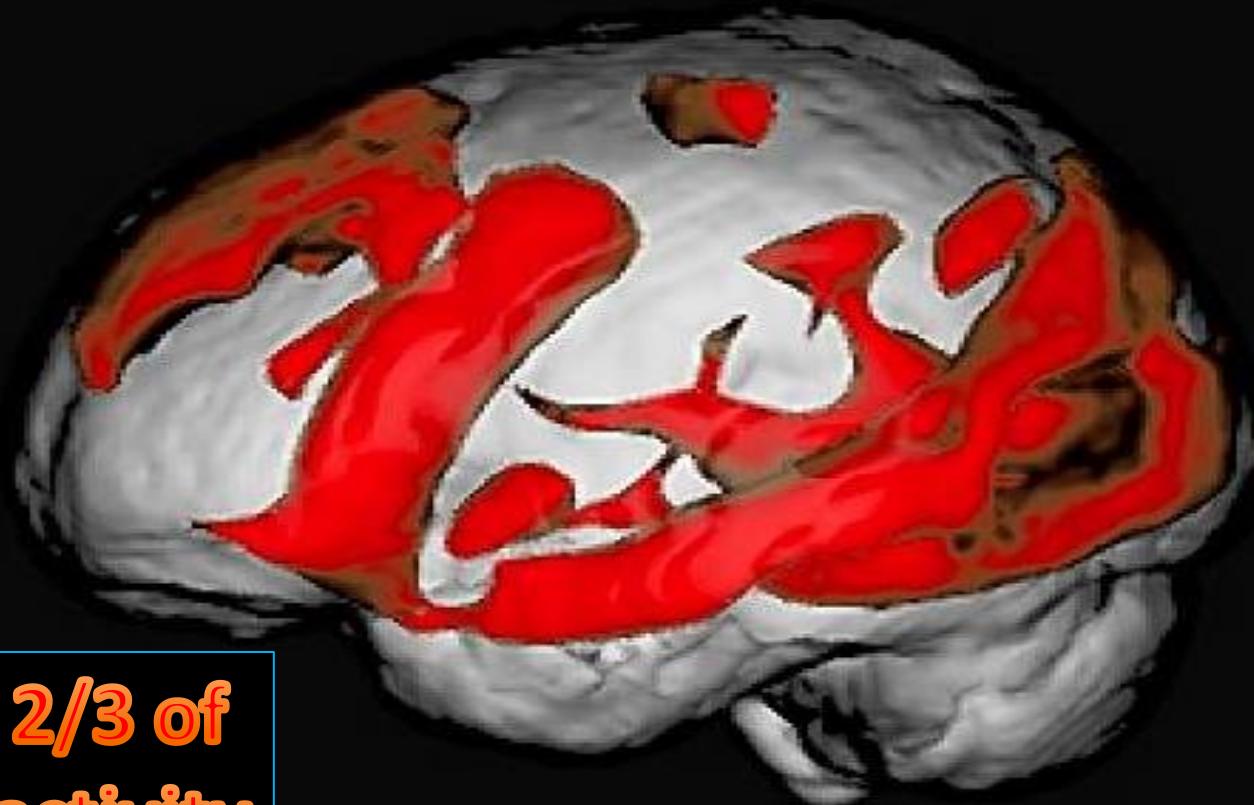
# READING

BRAIN ACTIVATED DURING READING BOOK



# ON INTERNET

BRAIN ACTIVATED WHILE ON INTERNET

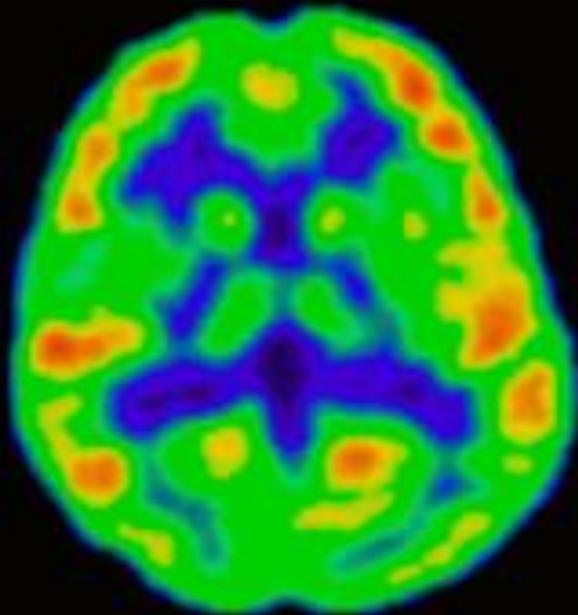


Nearly 2/3 of  
brains activity

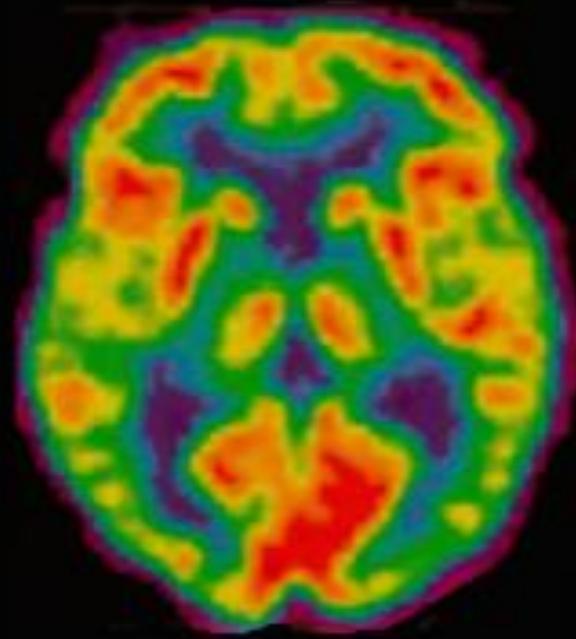
Dr. Gary Small / UCLA / Courtesy to The Chronicle

LISTENING TO YOUR TUNES IS NOT RESTING YOUR BRAIN

AT REST



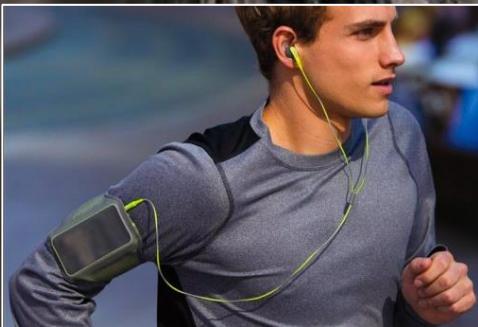
MUSIC

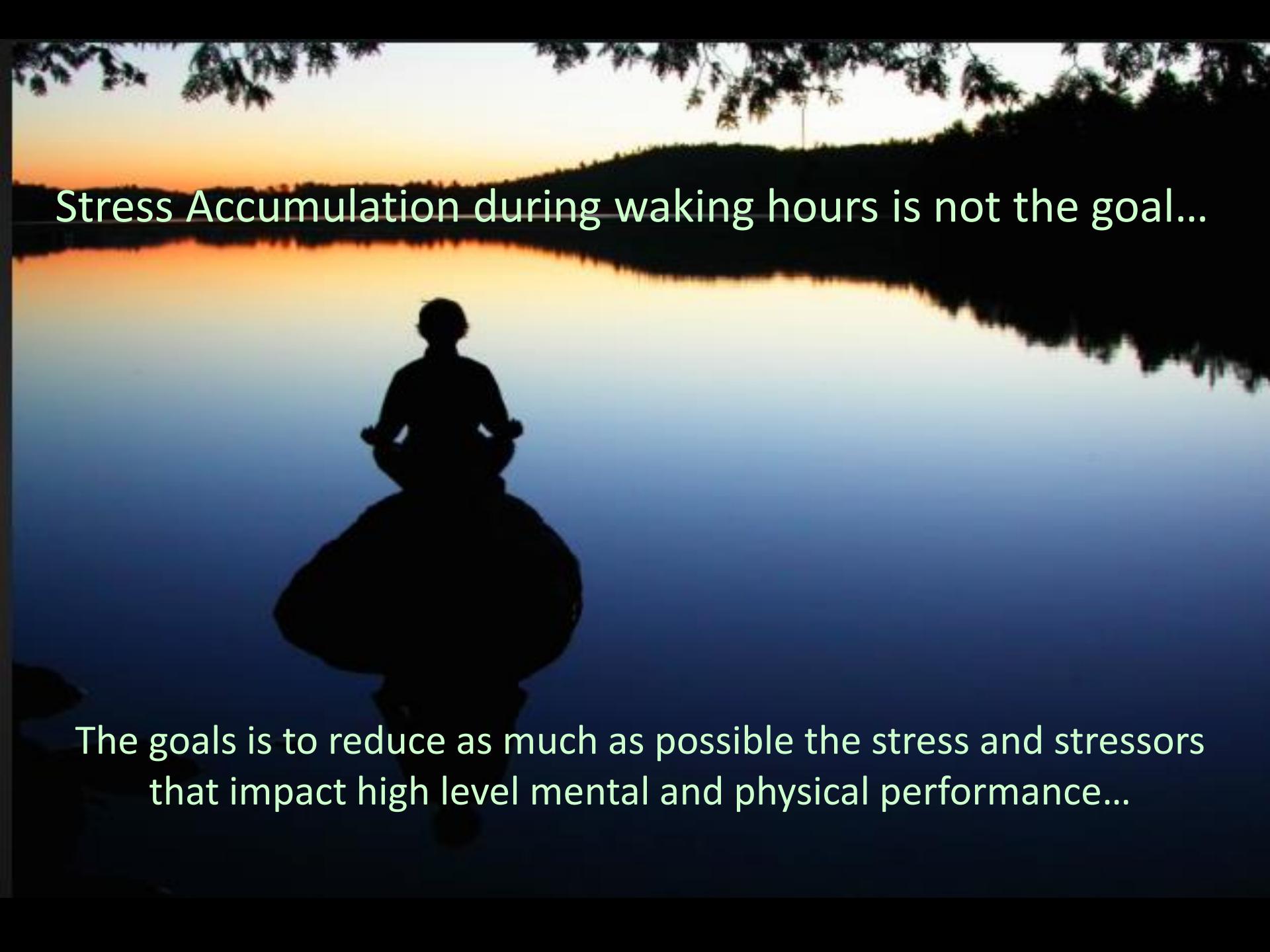


Listening to music has a global effect on brain activity...

# Learn to relax with no stimulation

Even listening to music stimulates the brain and CNS. As a matter of fact, music's effect on the brain is global. If you want to spare CNS energy learn how to simply clear your mind and relax.

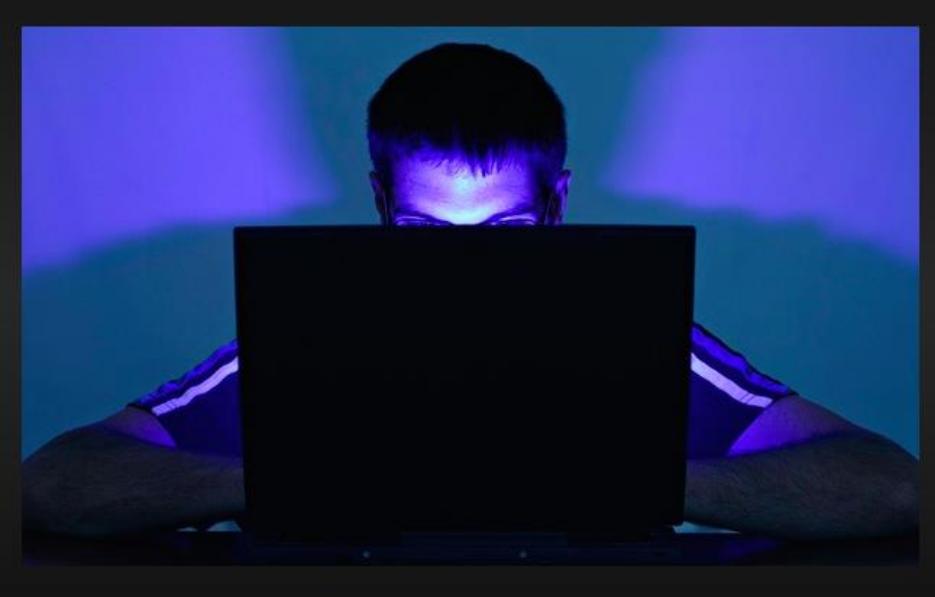


A photograph showing a silhouette of a person meditating in a lotus position against a sunset over water. The sky is a gradient from orange to blue, and the water reflects the colors. The person's hands are in a mudra, and their eyes are closed. The background features dark silhouettes of trees and hills.

Stress Accumulation during waking hours is not the goal...

The goal is to reduce as much as possible the stress and stressors that impact high level mental and physical performance...

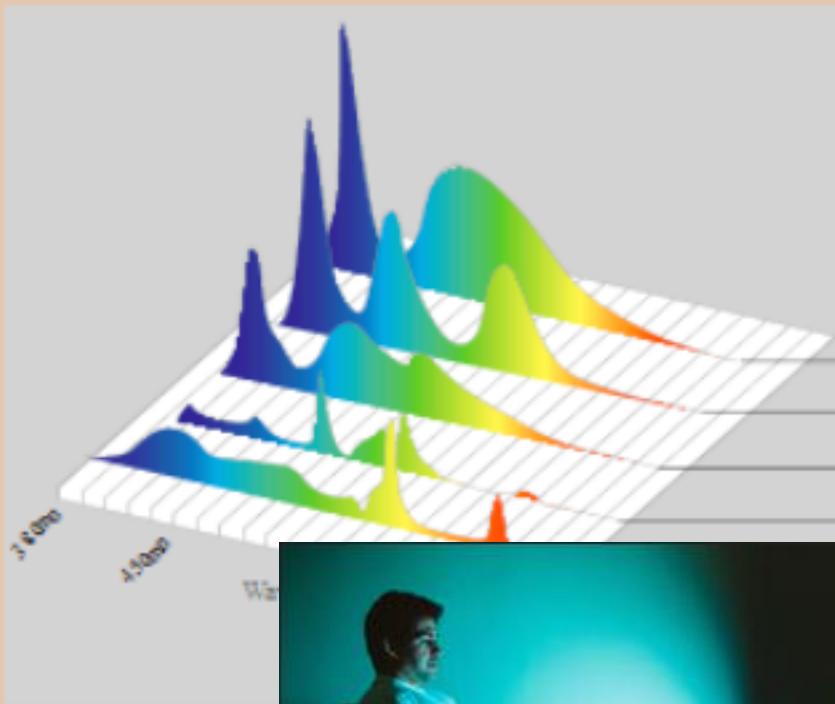
# MOST COMMON CAUSE OF SLEEP DISTURBANCES



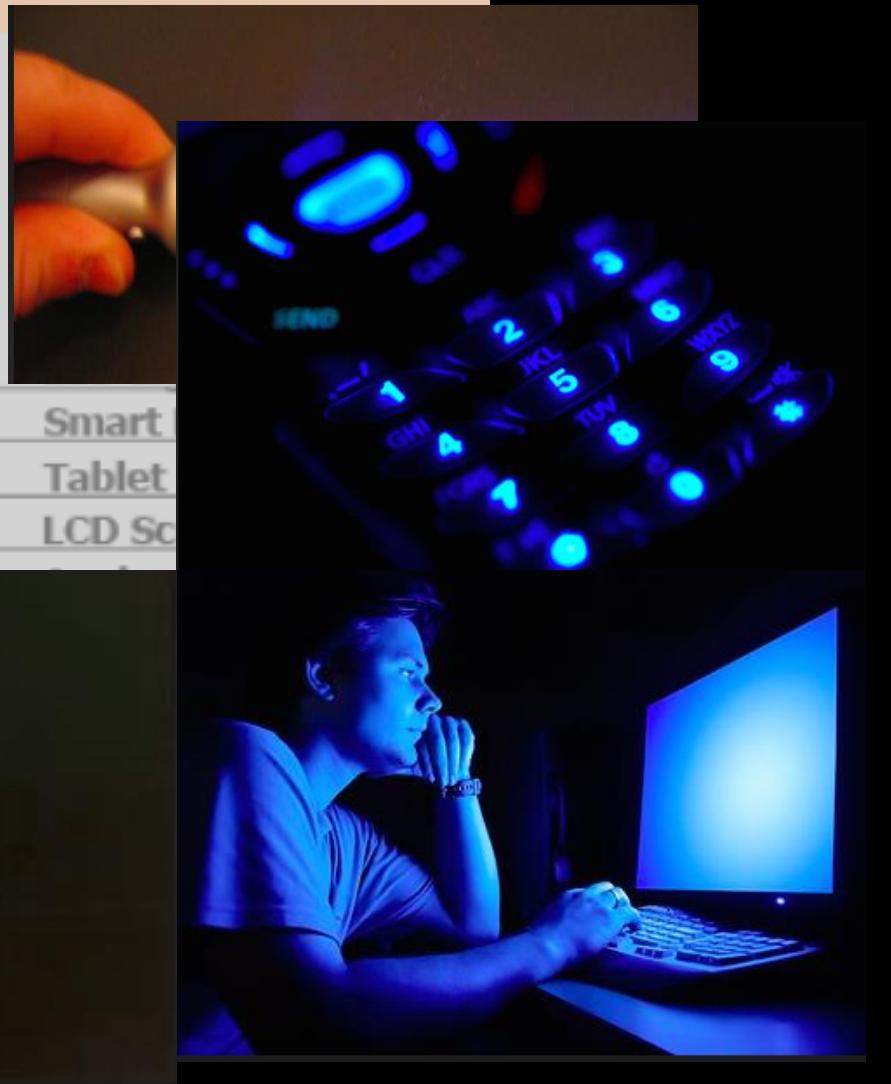
# SAME AS THIS

10,000 LUX

A photograph of a bright sun in a clear blue sky. The sun is positioned in the upper left quadrant, its intense light creating a radial lens flare effect. Below the sun, a layer of wispy white clouds is visible against the deep blue sky. The overall scene is bright and airy, suggesting a sunny day.



THIS IS BUT ONE  
OR GREATER  
LONGER WAVE  
LIGHT SOURCE



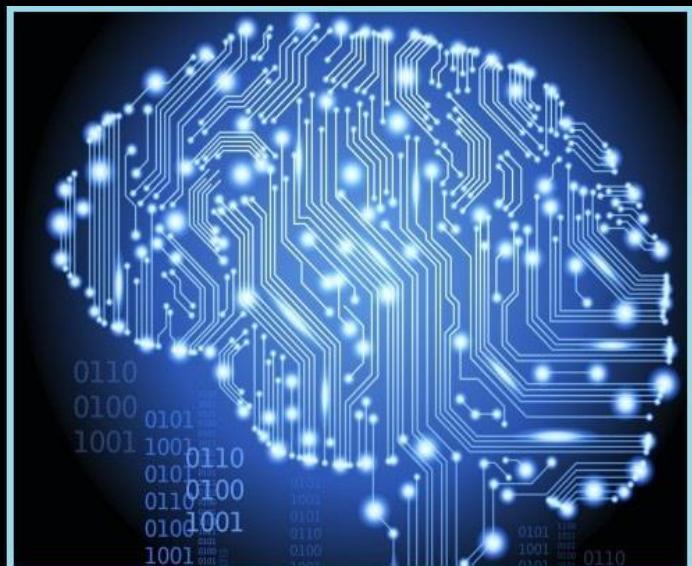
# Blue Light Sources

*Blue light has impact on all humans...*

A young boy is sitting on a wooden floor in a dark room, looking intently at a glowing blue screen. The scene is bathed in a cool blue light, suggesting the glow of a television or computer screen. The boy's expression is one of concentration or perhaps concern.

**STARTS  
VERY  
YOUNG**

# USA TEENS 8.5 hours/day



## Constant Stimulation

In the US, teenagers are spending 8.5 hours using computers, mobiles and other devices to learn, interact and play. This jumps to 11.5 if you take into account all of the tech multi-tasking that goes on, such as talking on the phone while you're watching TV. As they stare at these screens, they're taking in and sifting through an incredible amount of information; Constant input can create neural fatigue. When your brain is tired of processing this constant input it also begins to fatigue other critical areas of brain function. Combine these unprecedented hours of brain stim with minimal sleep and you have a generation of tired kids. Many of these individuals are athletes. Choices determine outcomes!



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# 11.5 with Multitasking

# We have identified more than 110 types of sleep disturbances

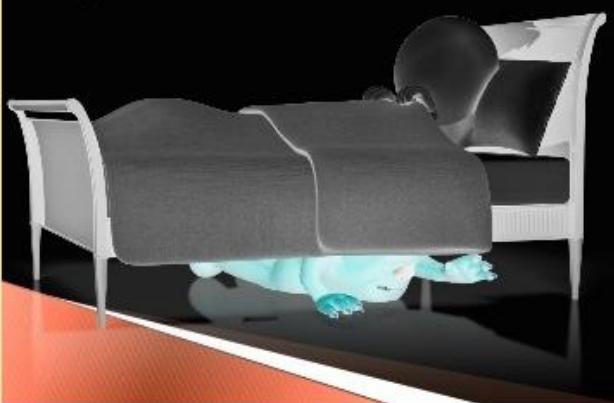
Sports Med  
DOI 10.1007/s40279-014-0260-0

REVIEW ARTICLE

## SLEEP

**Sleep and Athletic Performance: The Effects of Sleep Loss on Exercise Performance, and Physiological and Cognitive Responses to Exercise**

Hugh H. K. Fullagar · Sabrina Skorski ·  
Rob Duffield · Daniel Hammes · Aaron J. Coutts ·  
Tim Meyer



**Sleep restriction is generally associated with:**

- ↳ Cognitive Performance
- ↳ Alertness
- ↗ Reaction Time
- ↳ Memory
- ↳ Decision Making
- ↗ Sleepiness
- ↳ Overall Mood States

All capacities are diminished!



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# Causes of sleep disturbances

BLUE LIGHT SPICY FOODS ALCOHOL  
WEED CAFFIENE NICOTINE ENERGY  
DRINKS OVERSTIMULATION SLEEP DEBT  
SUGAR EXCESSIVE CARBS LATE AT NIGHT





# Life of an Athlete

## Human Performance Project



TV, smartphone, iPad, and computer screens emit a type of light that can stimulate your brain, suppress the production of melatonin, and interfere with your body's internal clock.



# LIGHT AT NIGHT



Avoid Blue Light  
and total darkness



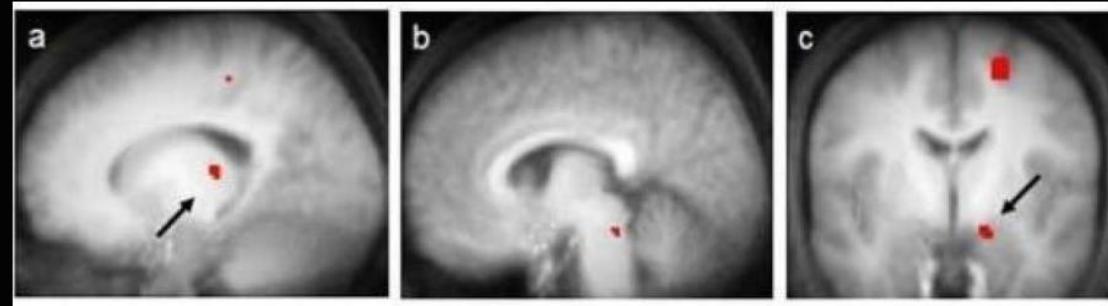
# It only takes a minute...



*It only takes a little!*



*Less than one minute!*



*Modification of the activity of the thalamus (a), brainstem (b), and amygdala (c) induced by a blue light exposure.*  
Credit: Modified from Vandewalle et al. 2007 PLoS One

*By using very short exposures to light (< 1 minutes), in combination with brain imaging techniques, the researchers could identify the brain areas that are involved in the initial responses to this light. The brain areas that responded to blue light exposures included areas in the brain stem and the thalamus. These areas are involved in the regulation of very basic aspects of brain function, such as the regulation of alertness and sleepiness.*



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## BLUE LIGHT EXPOSURE



1:00

**Even one minute of blue light exposure  
can cause a sleep disturbance!**



Blue Light

Prevents Brain Shutdown



# SHUTS OFF SLEEP HORMONE

## BLUE LIGHT IS EVIL FOR ATHLETES



Blue light is integral to our health – in the correct amounts. When we're exposed to levels of anything in excess (or too little) of what we would have experienced for the bulk of our evolutionary history, problems arise. Blue light regulates our secretion of melatonin, the sleep hormone. Exposed to blue light, we limit the production of melatonin, and we stay alert and awake; in the absence of blue light, melatonin production ramps up, and we get sleepy. This system worked quite well for a long time. Reddish light from fire (our former primary source of nighttime illumination) has little to no effect on melatonin production, so sleep wasn't disrupted when we relied on fire. These days, though, we're subject to a steady barrage of blue light. During the day, blue light (natural or unnatural) isn't much of a problem because we're supposed to be awake, but at night, when we're "supposed" to be getting ready to sleep, we tend to sit in front of blue light-emitting appliances, and our sleep suffers for it. We minimize our release of melatonin and stay alert and stimulated rather than becoming sleepy. Use of blue light after dinner is a bad idea for athletes who want to sleep and recover and release HGH and get REM to reboot the CNS and brain for your workout or competition tomorrow.



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Delays brains transition from  
wake state to sleep



# 90 minute plan



No LCD or blue light or backlit devices  
for 90 minutes prior to sleep!



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Human Performance Project

Greatly reduces sleep disturbances



## Blue Light Tips for Athletes

Evening blue light is problematic, and there are some simple steps you can take to mitigate its late-night effect on your sleep.

Keep electronics usage to a minimum or completely eliminate blue light (alarms, TVs, laptops) after dark.

Go to sleep earlier.

Use candlelight.

Keep your room as dark as possible and your sleeping quarters pitch black.

Install F.lux (totally free) on your computer to cut down on blue light emissions.

If you want to try a somewhat extreme experiment you could even wear orange safety glasses at night.

Do not use blue light devices in total darkness (see pic)

Blue light keeps you awake and throws off your Bio-rhythms!



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Human Performance Project

# Limit blue light at night

## 90 MINUTE RULE



# BLUE LIGHT TIME 8:00 PM



## Create An Electronic Sundown.

The smallest amount of light can impact your Melatonin levels (the sleep hormone). About ninety minutes before bed, turn off all electronic devices in your bedroom.



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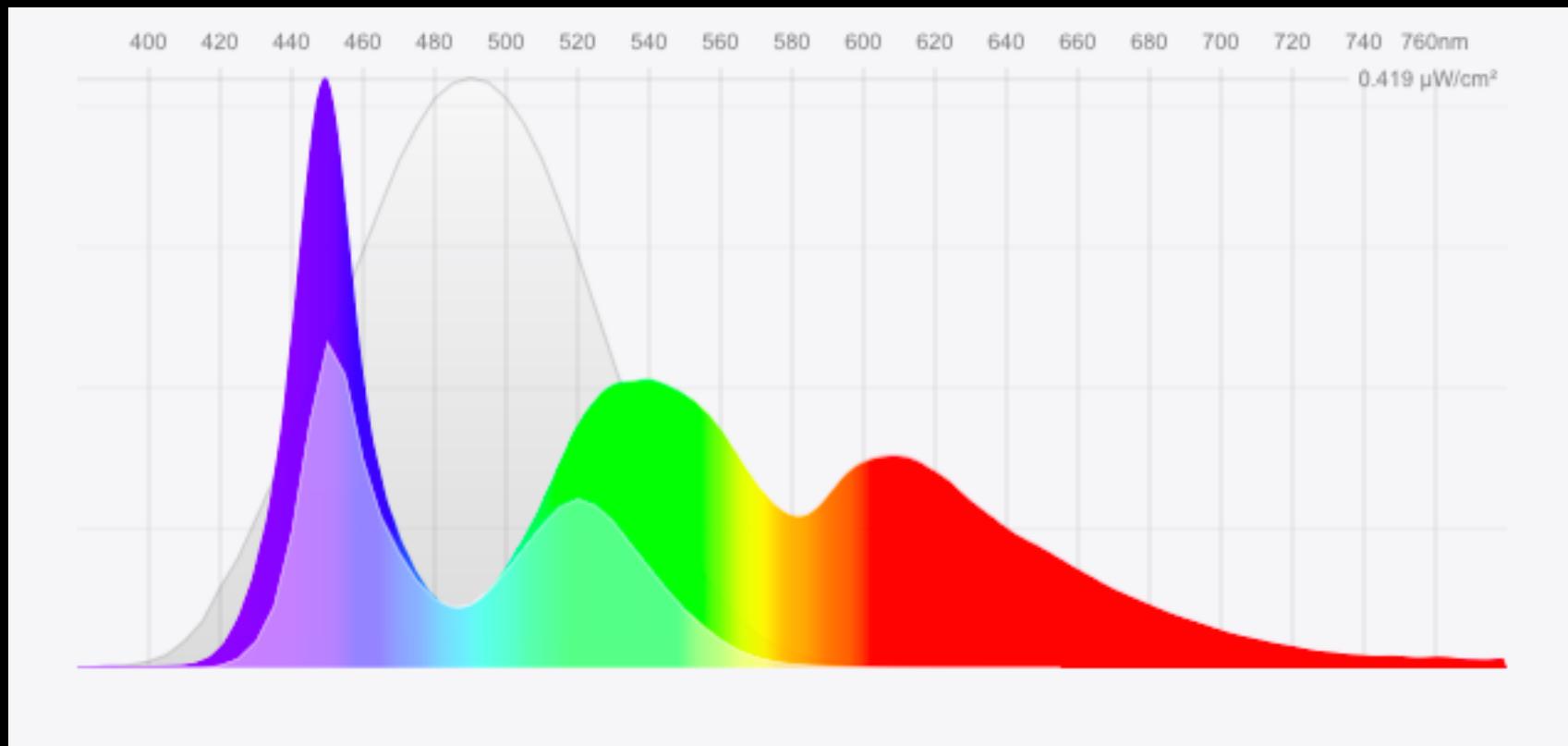
## Blue Light Reducing Computer Glasses

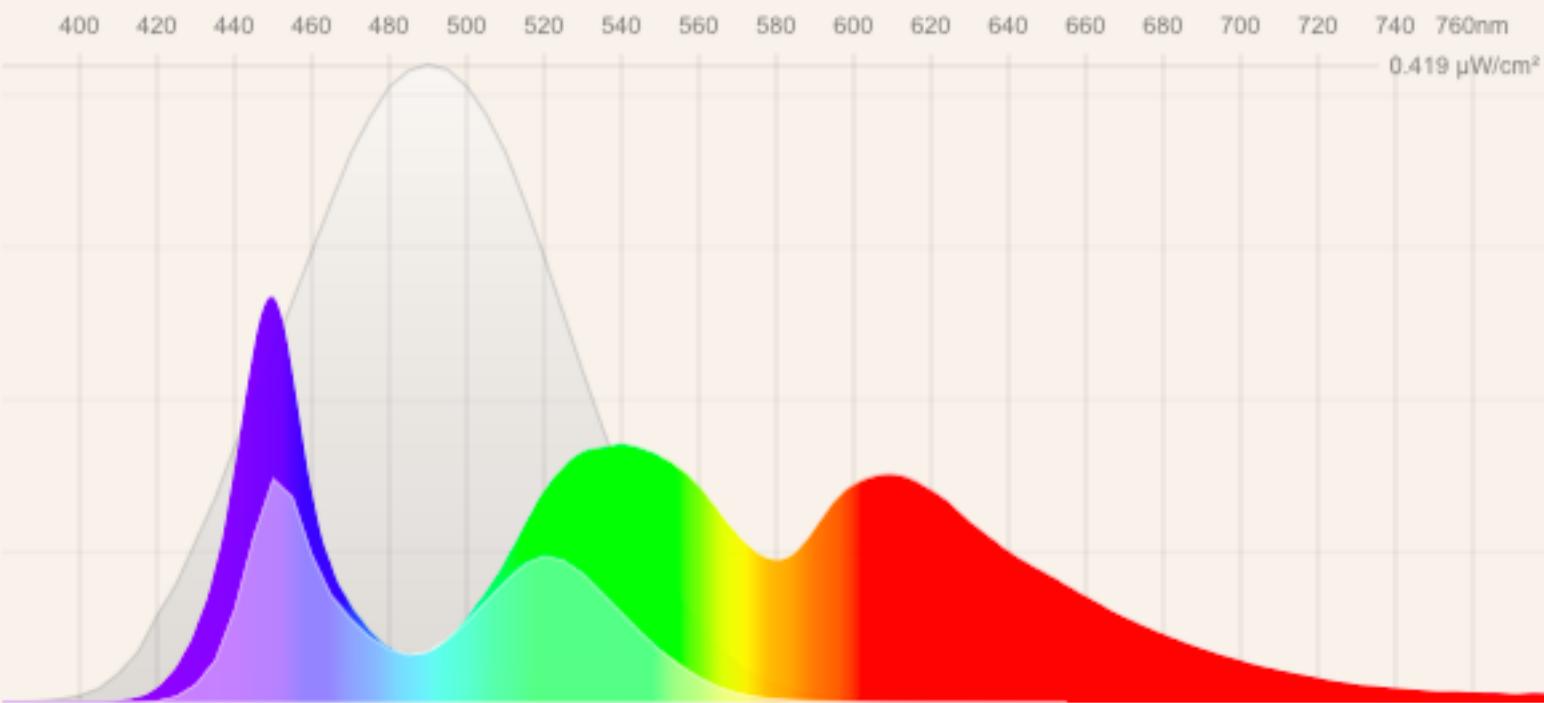
Blue light acts differently on the retina than the rest of the light color spectrum. Ever look at a blue LED and noticed a halo around the light? Staring at it gives you a headache, doesn't it? Guess why! Your eyes are straining to try and bring that fuzzy spot into focus, and it just can't!

Exposed to blue light, we limit the production of this melatonin, sleep hormone, and remain awake and alert. In the absence of blue light, however, melatonin production increases and we get tired.

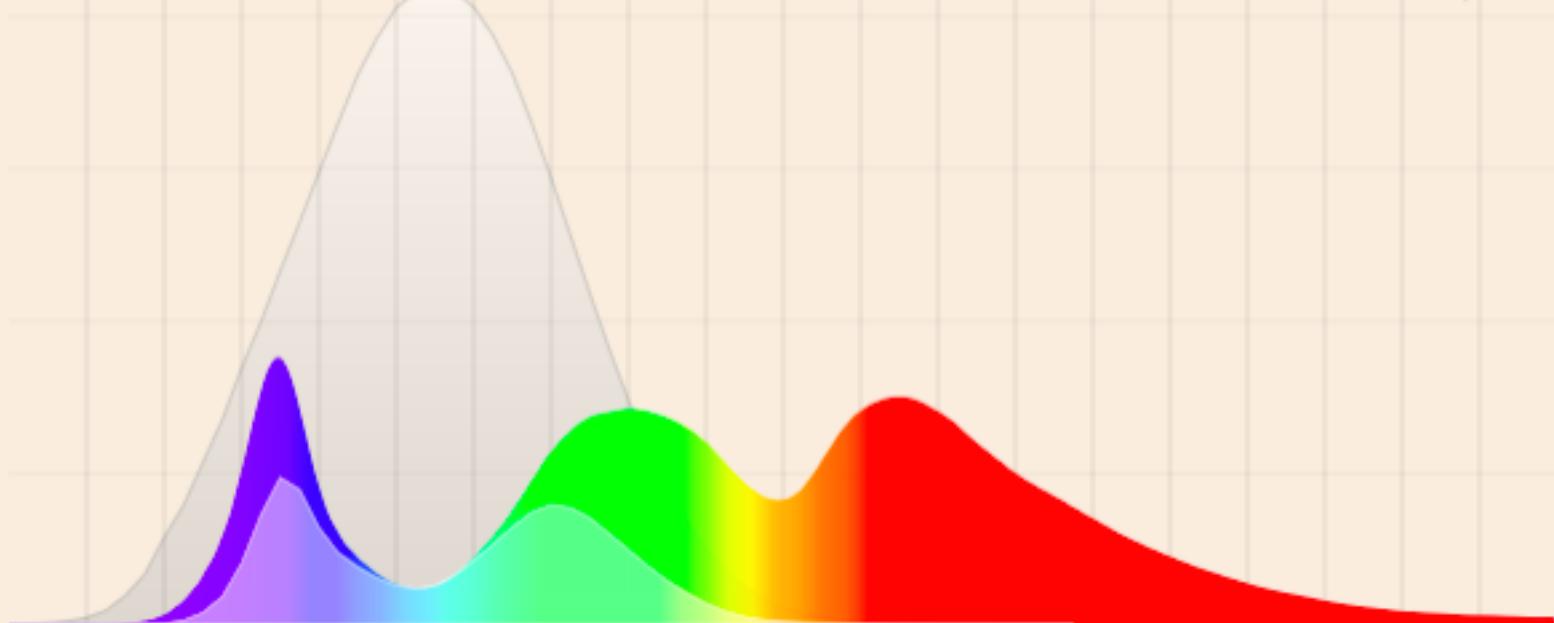
Getting enough sleep is a task that challenges many athletes, but doing what you can to help your body rest naturally can greatly improve the quality of the sleep that you are able to get. By avoiding blue light in the evening and right before bed, you can help your body produce the optimal amount of melatonin and you can fall asleep in a natural way. Additionally, you will reap all of the benefits that a healthy sleep cycle provides, which is pivotal to recovery in all body systems. Optimal training requires sufficient sleep.

# FILTERS





400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740 760nm  
0.419  $\mu\text{W}/\text{cm}^2$



# NBA TEAM PLANE



# WAKE UP



INCREASED ALERTNESS  
INCREASED WAKEFULNESS  
DECREASED GROGGINESS  
MELATONIN SHUTDOWN

10,000 LUX





Results in just 20-30 min/day; use while reading, working

Even brightness, ultimate eye comfort

100% UV free light - safe for eyes and skin

100+ years of Philips lighting and healthcare know-how

Improves energy levels, alertness and mood

Fights energy dips, fatigue and winter blues

Light is a natural energiser that fits in with a healthy lifestyle

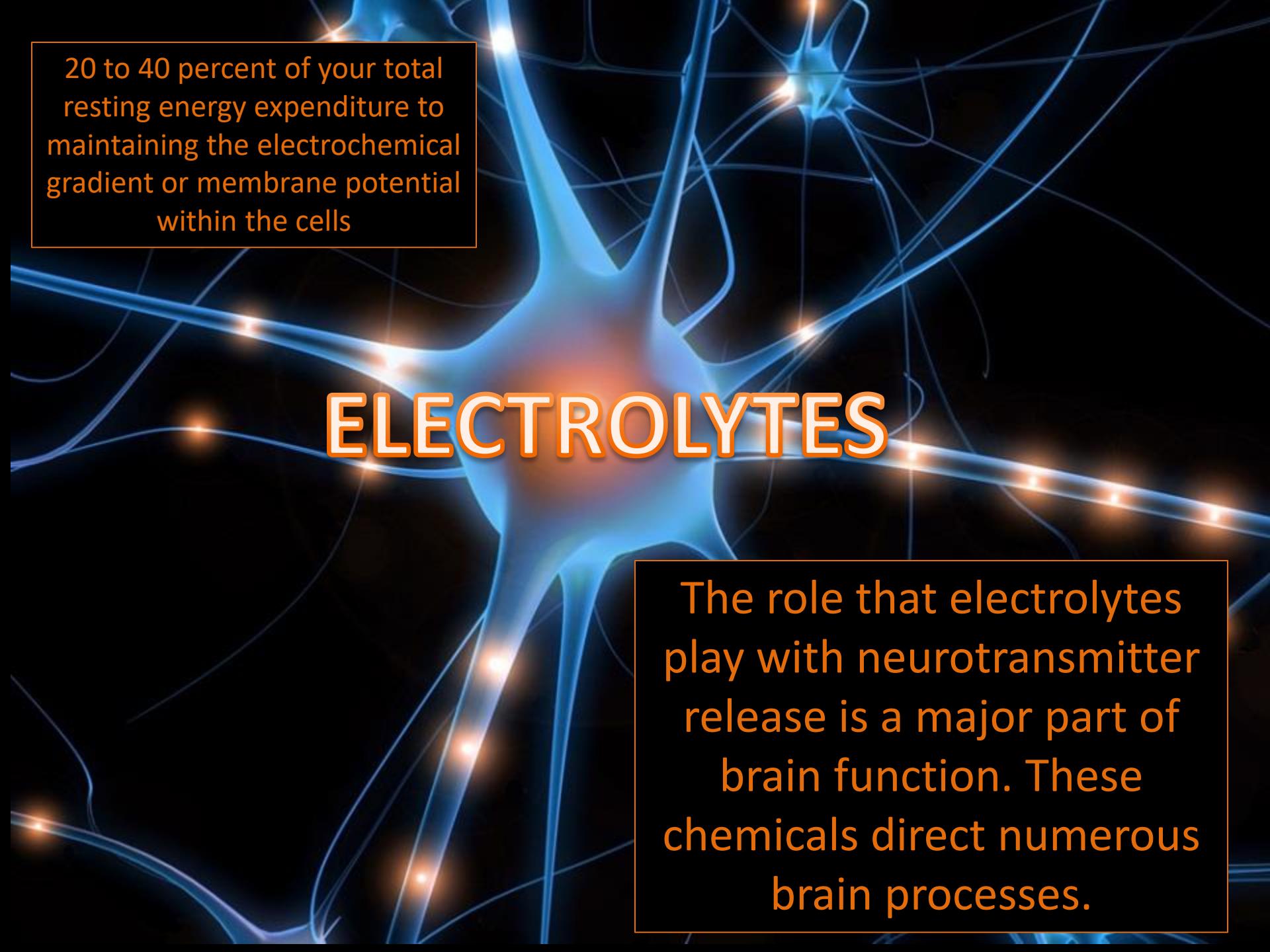
Independent research confirms improved energy levels

As effective as much larger 10,000-lux white lights

Has a similar effect on wellbeing to a sunny blue sky





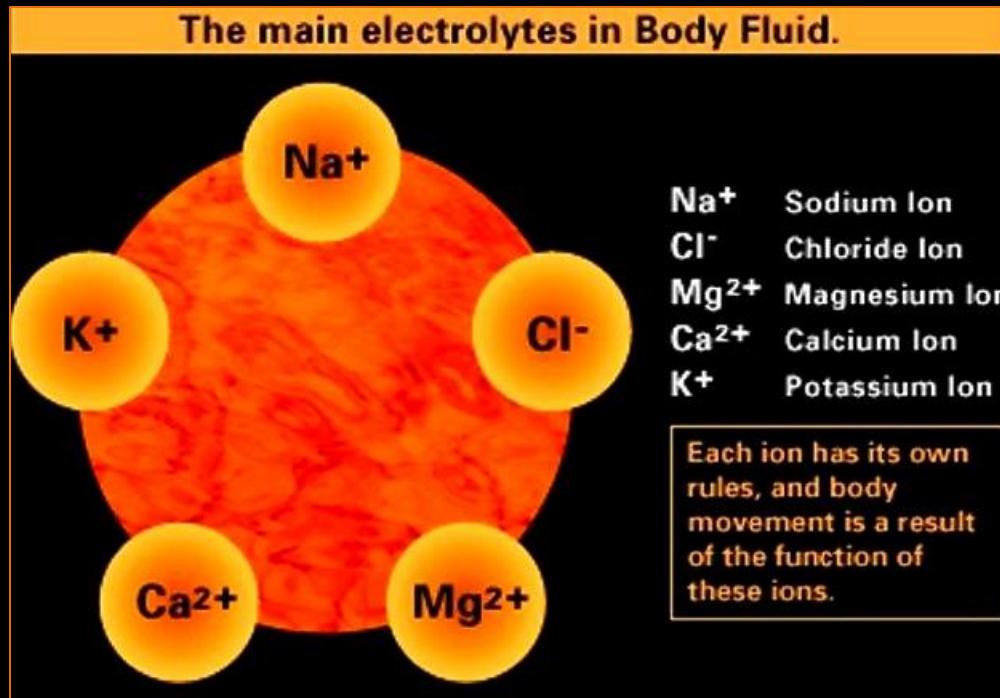


20 to 40 percent of your total resting energy expenditure to maintaining the electrochemical gradient or membrane potential within the cells

# ELECTROLYTES

The role that electrolytes play with neurotransmitter release is a major part of brain function. These chemicals direct numerous brain processes.

# Electrolytes Pivotal to Movement



Each ion has it's own rules and body movement is a result of each of these ions!

## Overlooked

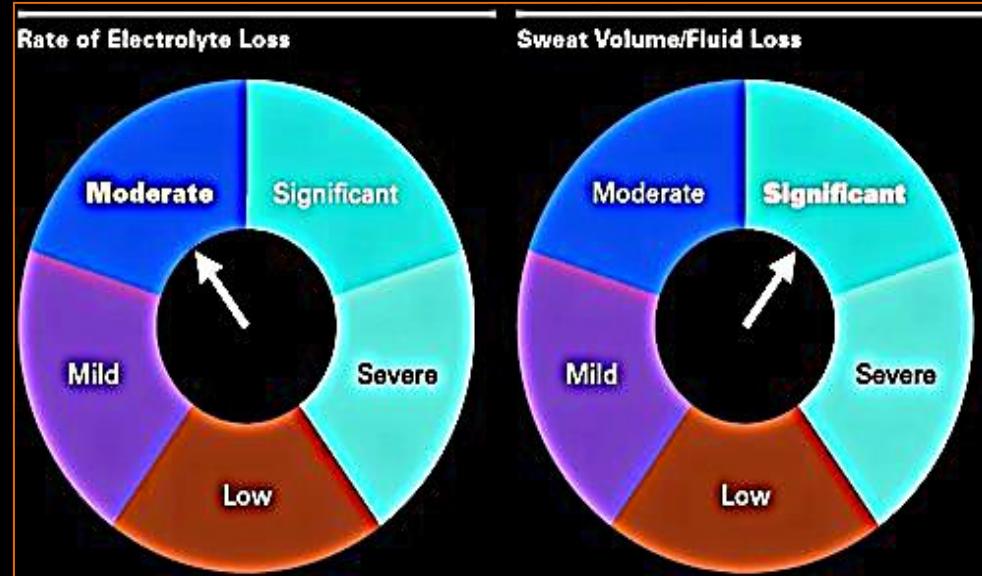
# NFL Electrolyte Monitoring

Player	WBGT (°F)	LBS IN	LB OUT	CHANGE	Δ IN kg	% Dehy	Fluid Pre liters	Fluid post liters	Fluids (L) consumed	time (hr)	Gross Swt liters	SwtR l hr	%replaced	Swt Na+ mmol/l	Na+ loss (mg/l)	Total Na+ loss (mg)	Na+ loss per hr (mg)	Swt Cl- mmol/l
2014																		
239.6	235.1	4.5	2.045455	1.87813	3.22	1.613	1.607	2.15	3.652455	1.698816	43.99781	15	345	1260.097	586.0915	21	743.4	2715.235
246.3	242	4.3	2.0	1.7	2.027	0.836	1.191	2.0	3.15	1.57	38	16	368	1158	579	23	814	2,561
240.8	237.2	3.6	1.6	1.5	2.668	1.745	0.923	2.0	2.56	1.28	36	121	2783	7123	3561	108	3,823	9,785
250	250.1	-0.1	0.0	0.0	3.885	1.209	2.676	2.0	2.63	1.32	102	11	253	666	333	17	602	1,583
251.8	249.6	2.2	1.0	0.9	2.857	0.473	2.384	2.0	3.38	1.69	70	24	552	1868	934	29	1,027	3,474
345	341	4	1.82	1.2	3.006	0.87	1262.9	3975.3315	1848.9914	0.3697983	40	920	3632	1816	3	106	419	
312.5	309.2	3.3	1.50	1.1	3.788	0.73	1,281	3,719	1,859	0.37	54	1242	5656	2828	35	1239	5642	
282	272	10	4.55	3.5	2.274	0.41	4,892	16,908	8,454	1.69	34	782	5005	2503	36	1274	8157	
							792	2,249	1,124	0.22								
							1,737	5,342	2,671	0.53								
							210	4052	2026	0.4								
							2821	11298	5649	1.1								
							4078	13162	6581	1.3								

# ELECTROLYTE ANALYSIS



## PATCHES



Cotton thread to monitor athletes' dehydration



Bradley



# Mg

## 200 Functions in BRAIN CNS

Better Than Coffee or Energy Drinks – Magnesium Gives You Energy on a Cellular Level!

Life of an Athlete Human Performance Project

Magnesium Deficient Athletes

You will never know what real power feels like 'til you get your Mg!

Take 450–650mg of Mg!

60% Mg Deficiency

24.000

12

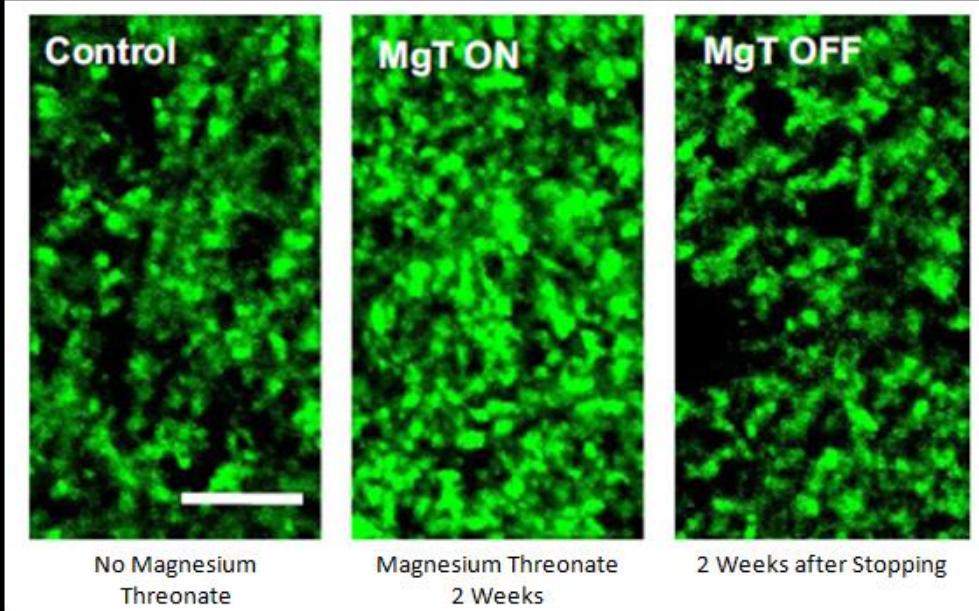
Magnesium Deficiency

Degree of Mg Deficiency

- Fatigue
- Headaches
- Muscle cramps
- Constipation
- Insomnia
- Headaches
- Numbness
- Poor digestion
- Impaired cognitive function
- Muscle cramps, spasms & cramps
- Mental focus deficiency

200 Brain/CNS functions related to Mg levels!

Take 450–650mg of Mg!



Life of an Athlete  
Human Performance Project

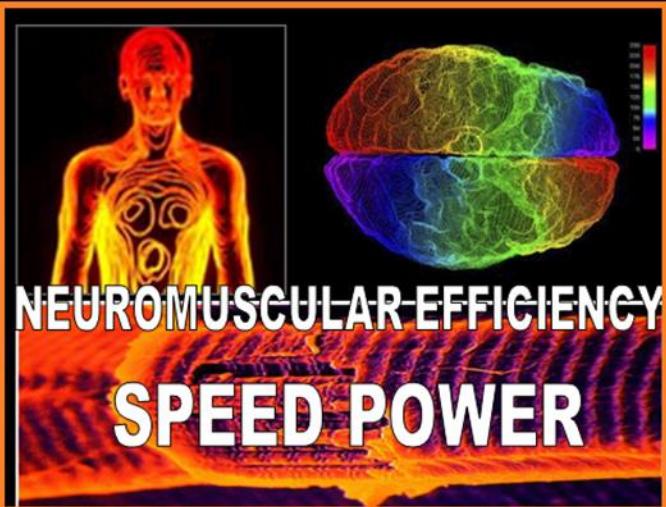
eed Mg

*J Neurosci. 2011 Oct 19;31(42):14871-81*

## Synaptic Density

Mg > greater brain function!

# Neuromuscular connection is lost or diminished



## How Optimal Happens

The connection between the brain and CNS and muscle must be trained and rested for optimal performance capacity to take place on a regular basis!

Random optimal performance can be seen occasionally in all athletes.



Life of an Athlete  
Human Performance Project

## Time and Reconnective Processes

# GOALS Learning from examples





The Miami Heat are tired!

# Fatigue 4 Levels

Neuro-Muscular  
Endocrine  
Structural  
Metabolic

4 games in 7 days

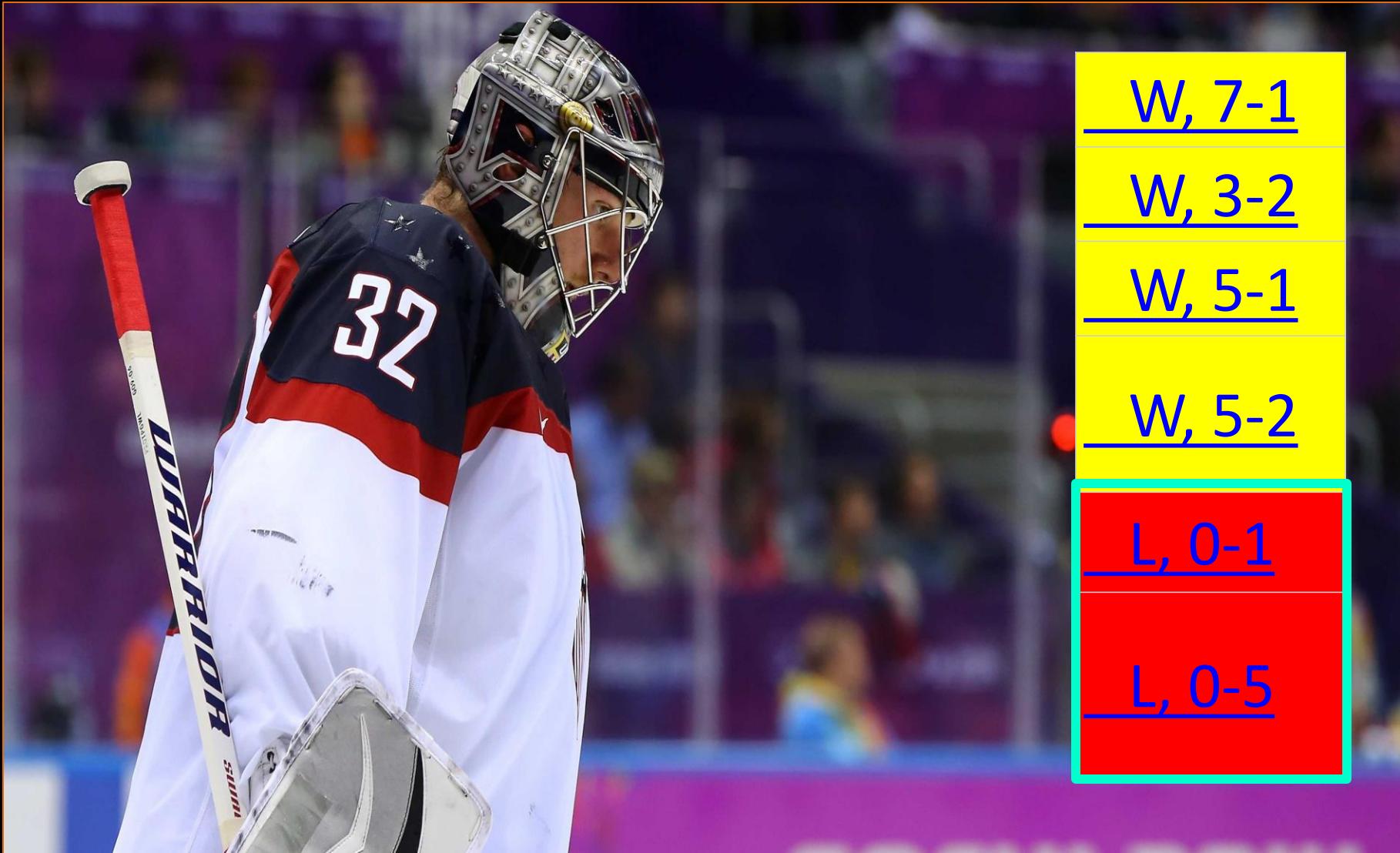
5 games in 7 days

# RECOVERY



The key factor in training and competing consistently at a high level is RECOVERY

# Cumulative Fatigue



W, 7-1

W, 3-2

W, 5-1

W, 5-2

L, 0-1

L, 0-5

Nothing good happens after midnight



Remember what is important... You are an Athlete

# facebook

wasting athletes time since 2004