PARKER PERFORMANCE INSTITUTE

PERCEPTION IN MOTION:

INTEGRATIVE STRATEGIES FOR NEUROPERFORMANCE

PRESENTER: DR. NICKY KIRK, PARKER PERFORMANCE INSTITUTE

2-HOUR SEMINAR STRUCTURE WITH CEU-ALIGNED LEARNING

OBJECTIVES

Participants will be able to:

0:00–0:15

Foundations of System Readiness

- Differentiate internal vs. external load across multiple physiological systems.
- Describe the “Glass” model of readiness and fatigue.
- Identify key drivers of system capacity and fatigue perception.

0:15–0:30

Respiratory Function and CO_2 Tolerance

- Explain how breathing patterns influence fatigue and neuromuscular coordination.
- Perform breath pacing strategies to shift CO_2 regulation and parasympathetic tone.
- Assess respiratory contribution to performance and recovery states.

2-HOUR SEMINAR STRUCTURE WITH CEU-ALIGNED LEARNING

OBJECTIVES

Participants will be able to:

0:30–0:45

Foundations of Oxygen Utilization

- Describe factors that enhance oxygen delivery and utilization.
- Link aerobic development to recovery speed and repeatability.
- Design aerobic interventions to support performance consistency.

0:45–1:00

Practical Application of Moxy (NIRS)

- Use NIRS technology to interpret SmO_2 and tHb data.
- Distinguish between compression, occlusion, and recovery patterns in muscle oxygenation.
- Apply real-time monitoring to adjust training or therapy sessions.

2-HOUR SEMINAR STRUCTURE WITH CEU-ALIGNED LEARNING

OBJECTIVES

Participants will be able to:

1:00–1:15

Fatigue Typing: Metabolic, Mechanical, and Central

- Classify fatigue into mechanical, metabolic, and central categories.
- Explain biochemical contributors (e.g., H^+, CO_2, pH shifts) and their systemic effects.
- Describe central fatigue mechanisms involving ACC and effort computation.

1:15–1:30

Blood Flow Restriction (BFR) and Perception Modulation

- Explain how BFR alters mechanical load while increasing perceived effort.
- Apply BFR for neuromuscular and vascular adaptation in low-load environments.
- Evaluate BFR's role in recovery, compliance, and perceptual tolerance.

2-HOUR SEMINAR STRUCTURE WITH CEU-ALIGNED LEARNING

OBJECTIVES

Participants will be able to:

1:30–1:45

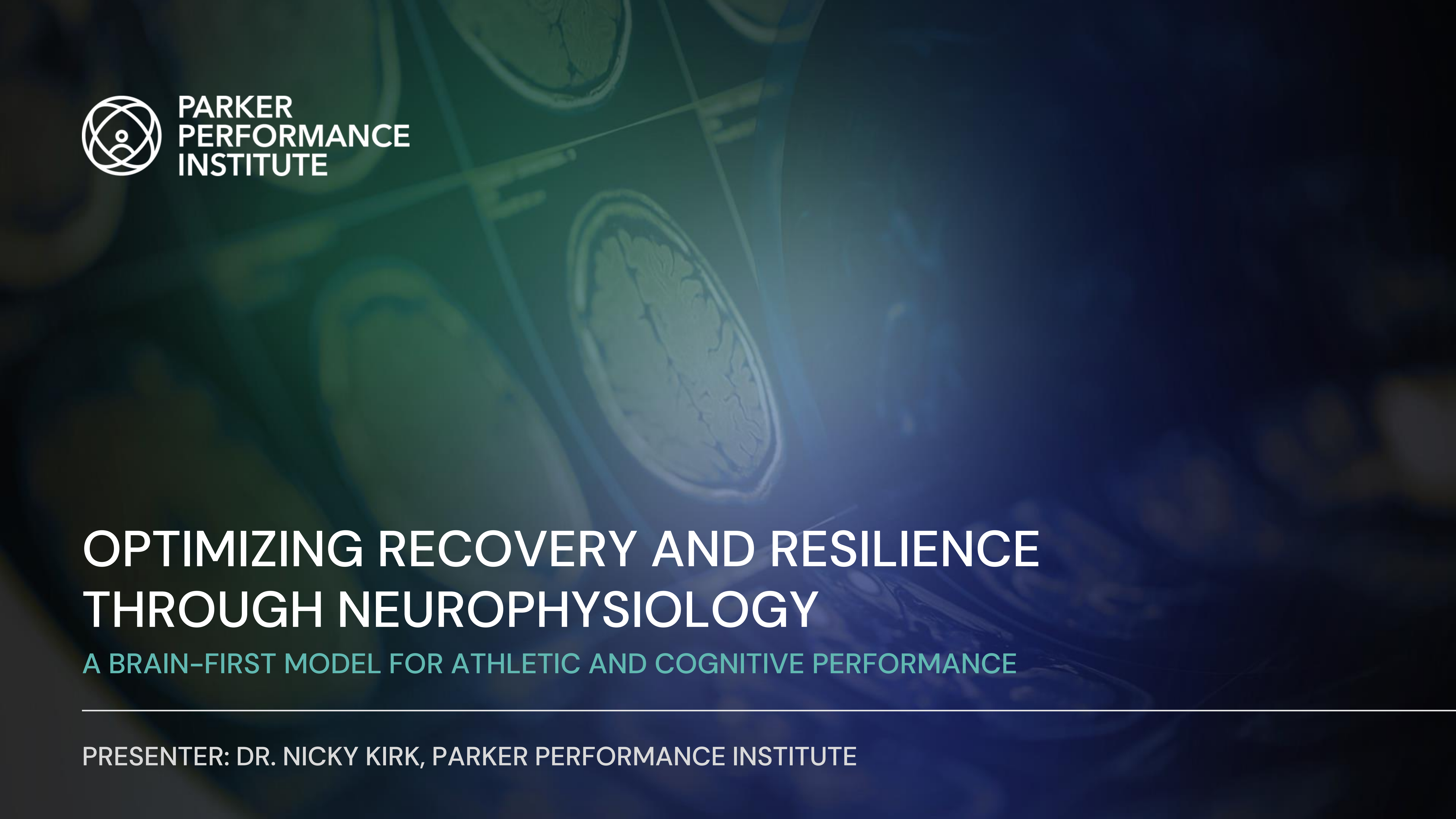
Recovery Strategies and Oxygen Kinetics

- Match recovery strategies (e.g., steady-state, breath work, ESTIM) to fatigue type.
- Interpret Moxy and subjective data to assess recovery efficacy.
- Choose appropriate interventions for rapid post-effort reset.

1:45–2:00

Adaptive Planning and Case Integration

- Integrate data from perception, oxygenation, and physical metrics into decision-making.
- Adjust training/recovery dosage based on dynamic readiness markers.
- Design case-specific interventions for complex fatigue or recovery scenarios.


PARKER PERFORMANCE INSTITUTE
OPTIMIZING RECOVERY AND RESILIENCE THROUGH NEUROPHYSIOLOGY
A BRAIN-FIRST MODEL FOR ATHLETIC AND COGNITIVE PERFORMANCE
PRESENTER: DR. NICKY KIRK, PARKER PERFORMANCE INSTITUTE

WHY RECOVERY MATTERS

- Recovery is not downtime; it's adaptation time.
- Influences readiness, resilience, and performance gains.
- Neurophysiological recovery = faster and more complete regeneration.

A NEW LENS ON FATIGUE

- Beyond “tiredness” – think system overload.
- Physical, cognitive, and emotional fatigue interact.
- Brain is both victim and regulator of fatigue.

FICK'S EQUATION:
THE CORNERSTONE

VO_2 = Cardiac Output x (CaO_2 – CvO_2)

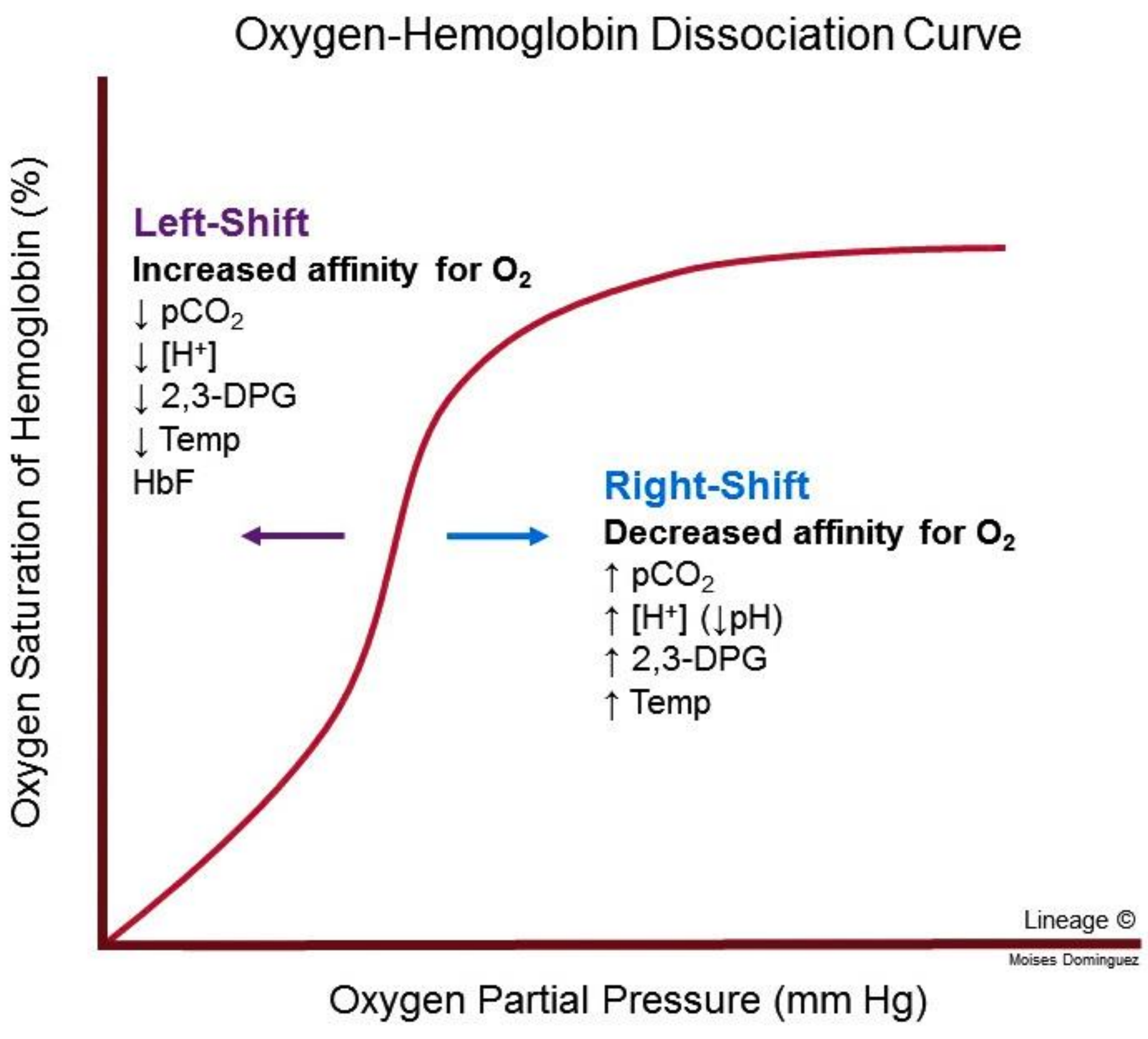
- Delivery x Extraction = Performance AND Recovery
- Determines lactate clearance, PCr resynthesis, O_2 rebound

MAPPING RECOVERY ONTO FICK

- ***Elevate delivery:***
  HR, stroke volume, vasodilation

- ***Improve extraction:***
  Capillary density, mitochondrial efficiency

- ***Interventions:***
  Breathwork, mobility, active recovery, heat

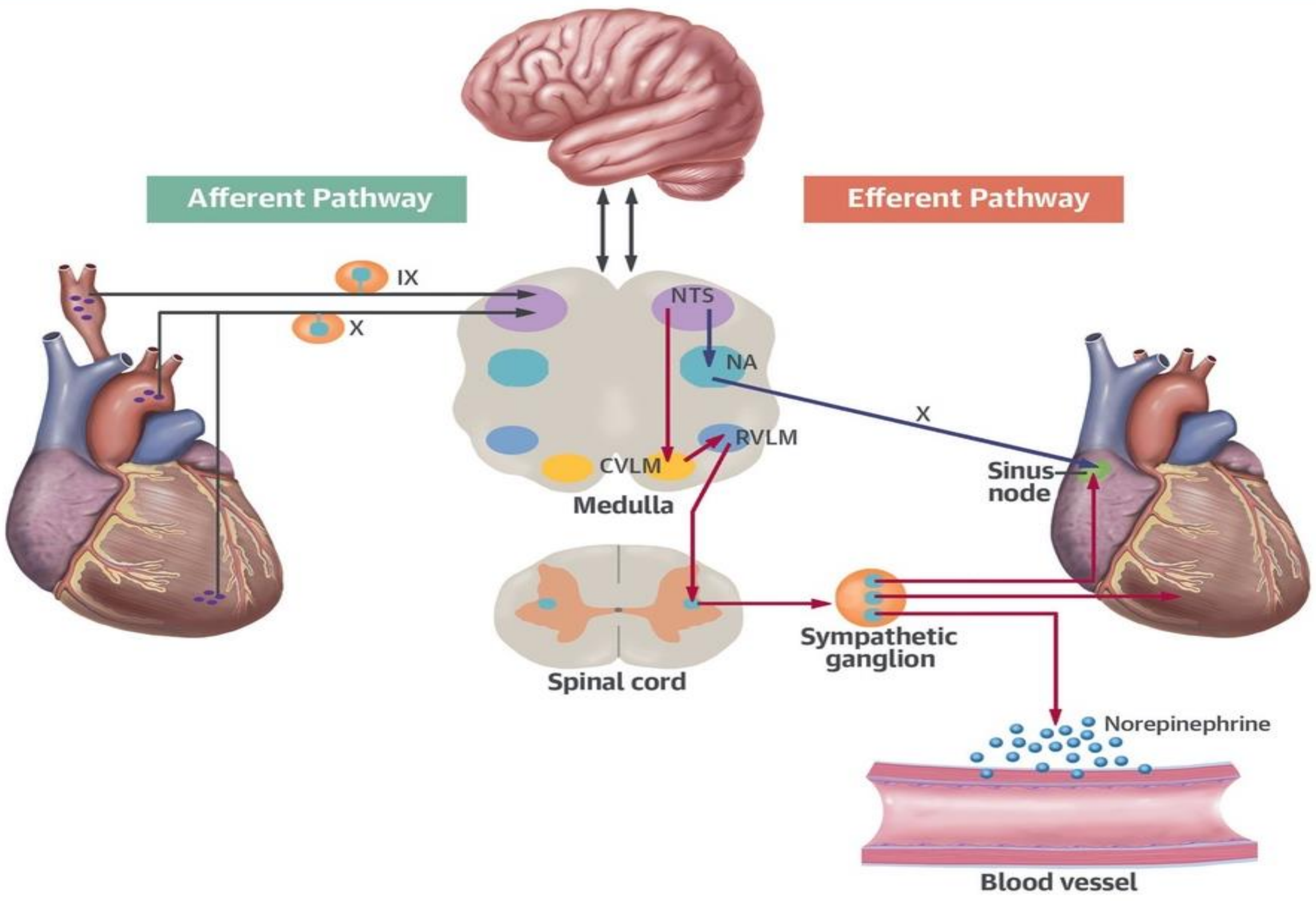


https://step1.medbullets.com/respiratory/117014/oxygen-hemoglobin-dissociation-curve

THE OXYGEN CURVE IN RECOVERY

- Right-shift: better unloading (heat, CO2)
- Left-shift: retention state (cold, alkalosis)
- Breath + heat = shift O2 availability post-exertion

Neurophysiology of Normotension



THE RECOVERY CONTINUUM

- From acute bounce-back to long-term resilience
- Tissue → Neuromuscular → Autonomic → Cognitive
- Goal: progress across the curve
- Stable Co2

DEFINING FATIGUE TYPES



Mechanical:

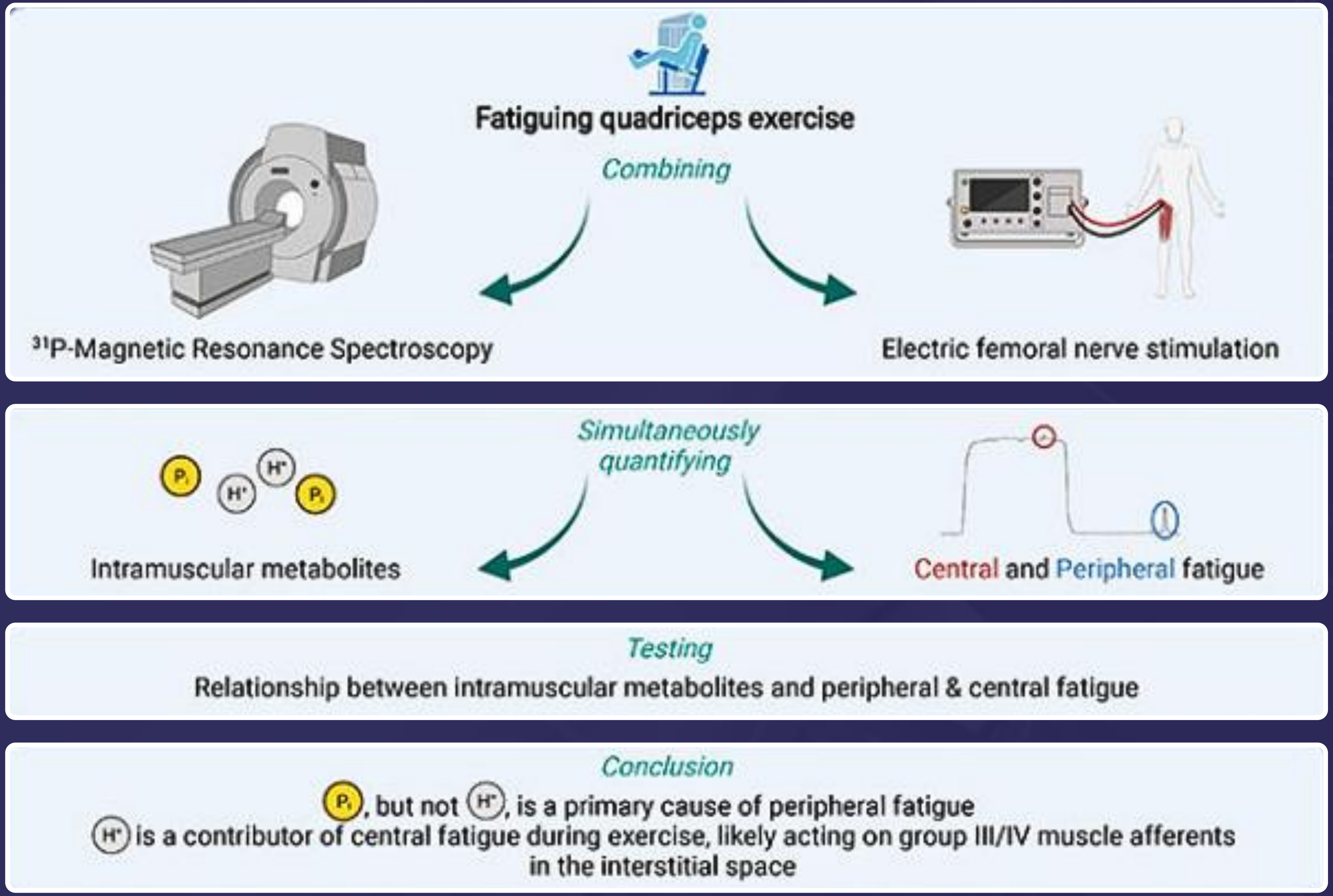
tissue damage,
soreness

Metabolic:

fuel depletion,
by-product accumulation

Central:

brain-derived inhibition,
motor drop-off


Fatiguing quadriceps exercise
Combining
^{31}P-Magnetic Resonance Spectroscopy
Electric femoral nerve stimulation
Simultaneously quantifying
Intramuscular metabolites
Central and Peripheral fatigue
Testing
Relationship between intramuscular metabolites and peripheral & central fatigue
Conclusion
P_i, but not H^+, is a primary cause of peripheral fatigue
H^+ is a contributor of central fatigue during exercise, likely acting on group III/IV muscle afferents in the interstitial space

What I see and what I feel: the influence of deceptive visual cues and interoceptive accuracy on affective valence and sense of effort during virtual reality cycling

Brendan Mouatt[1,2], Ashleigh E. Smith[3], Gaynor Parfitt[3], Ty Stanford[3,4], Jeremy McDade[5], Ross T. Smith[5] and Tasha R. Stanton[1,2]

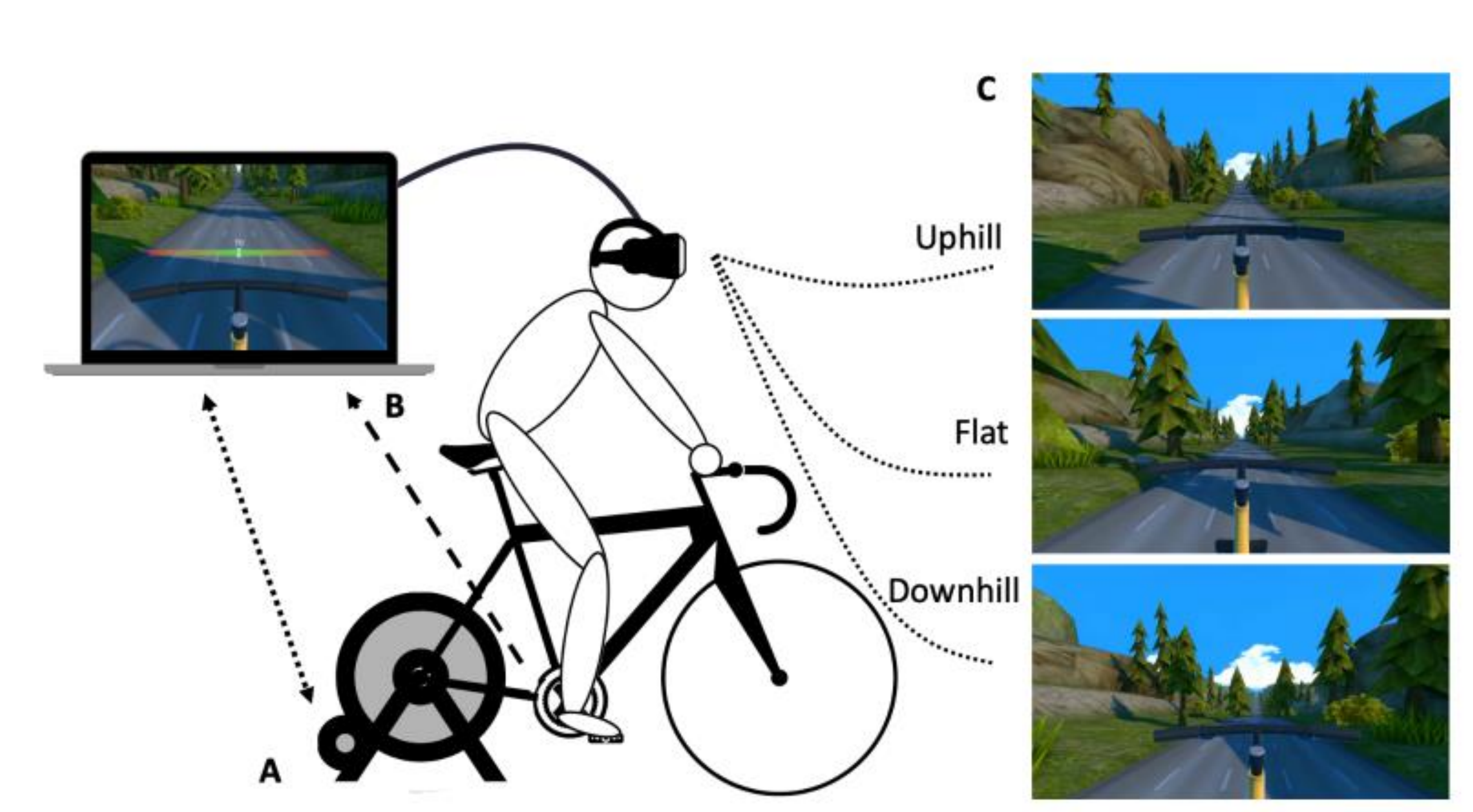
IIMPACT in Health, Allied Health & Human Performance, University of South Australia, Adelaide, South Australia, Australia

Persistent Pain Research Group, Hopwood Centre for Neurobiology, South Australian Health and Medical Research Institute (SAHMRI), Adelaide, South Australia, Australia

Alliance for Research in Exercise Nutrition and Activity (ARENA), Allied Health & Human Performance, University of South Australia, Adelaide, South Australia, Australia

Clinical & Health Sciences, University of South Australia, Adelaide, South Australia, Australia

Wearable Computer Laboratory, Mawson Lakes Campus, University of South Australia, Adelaide, South Australia, Australia

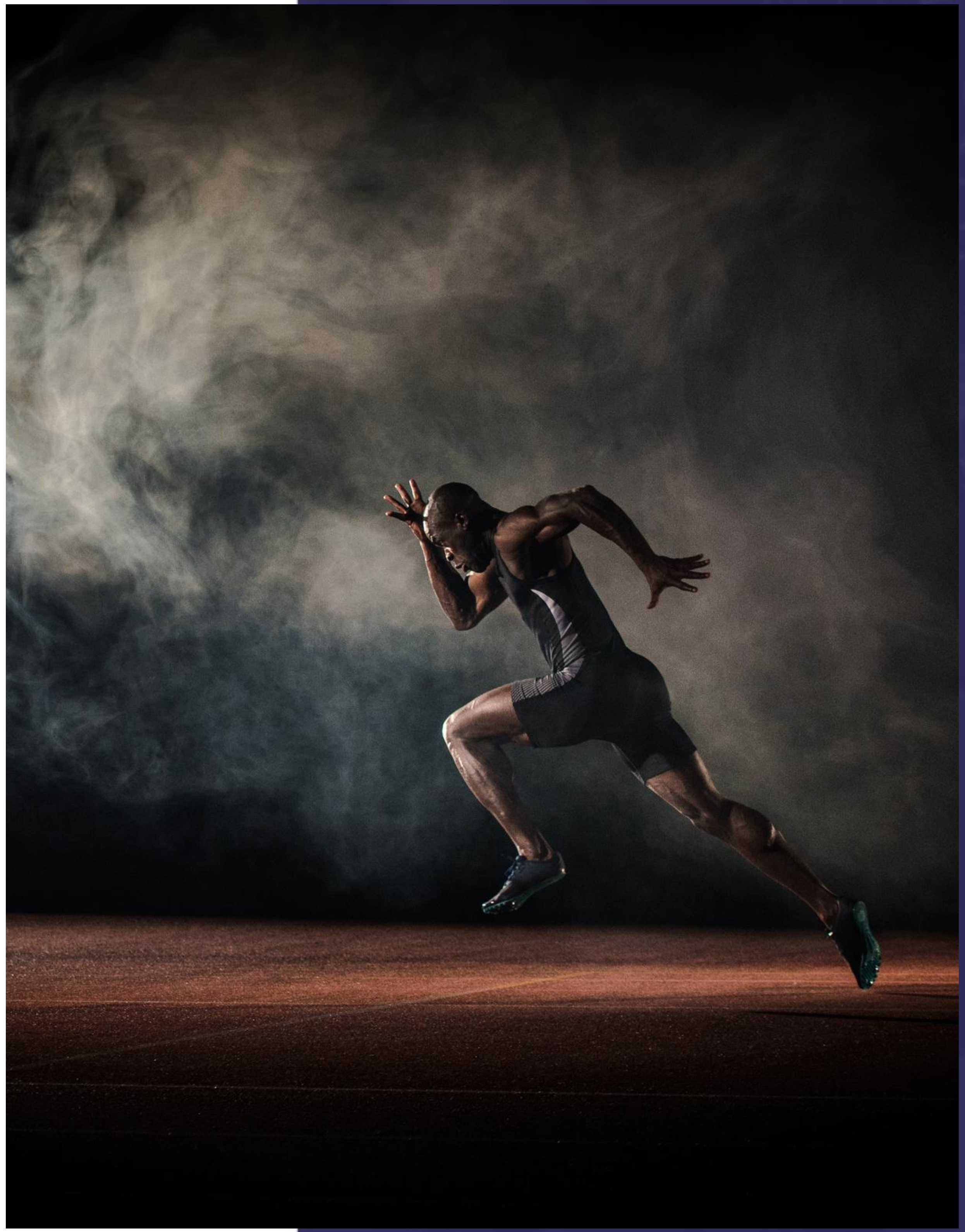


THE ROLE OF INTEROCEPTION

- Awareness of internal cues = pacing, regulation
- Trainable via breath, body scan, feedback
- Poor interoception → higher risk of fatigue collapse

PERCEPTION OF EFFORT (RPE)

- Driven by anterior cingulate cortex
- Self-talk, expectation, and load history modulate perception
- Use RPE as both gauge and training tool



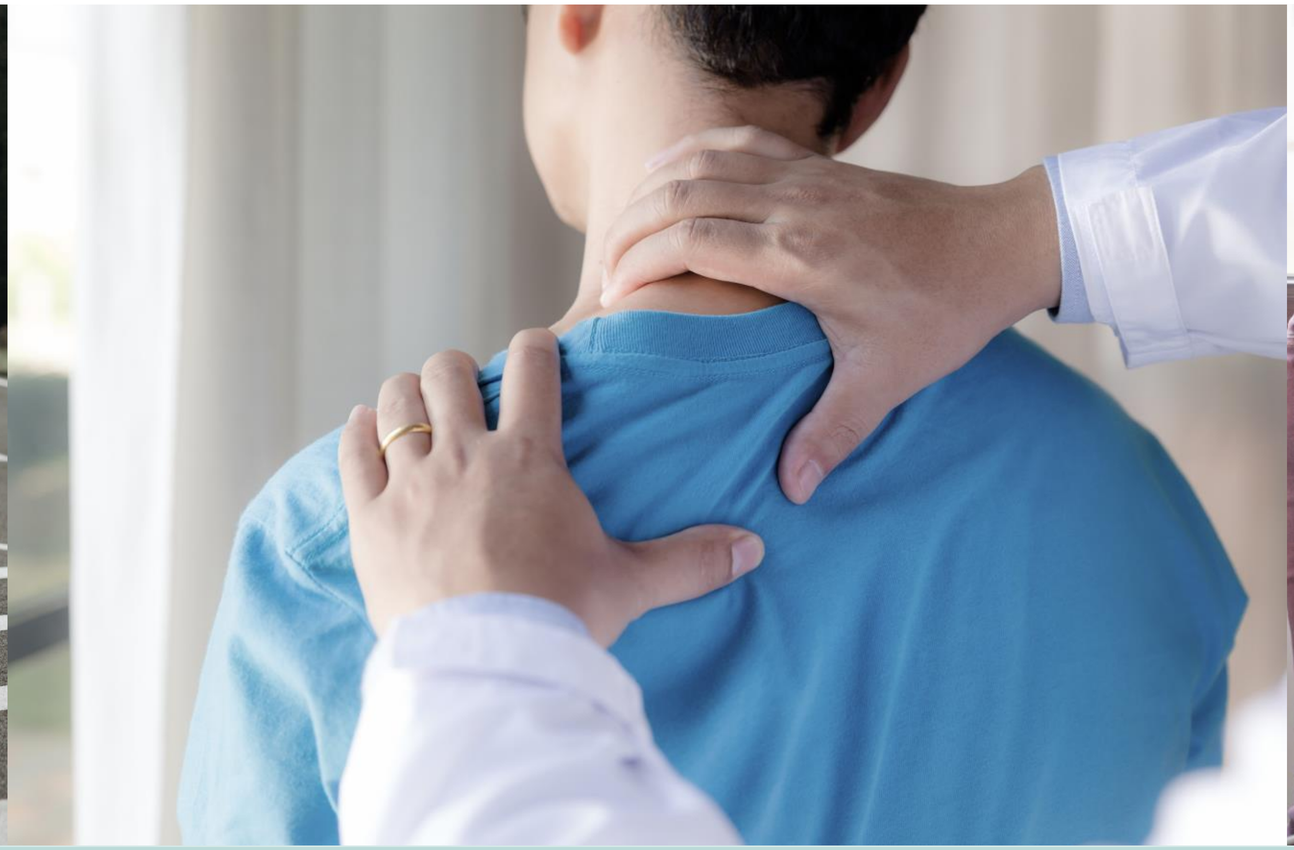
COGNITIVE FATIGUE IN FOCUS

- Marathoner mile 22: brain says stop before body gives out
- Low dopamine = increased perceived effort
- VR, dual-task, and breath drills extend mental endurance

MONITORING RECOVERY

- HRV, SmO2, RPE, sleep, mood
- No single marker is enough
- Look for trendlines and deltas, not snapshots

RECOVERY TOOLS:
WHAT WORKS



Active recovery:

walk, bike

Passive:

sleep, massage, PEMF

Perception-based:

neuro reset, affirmations, light VR

COLD, HEAT,
AND MODALITY TIMING

Cold =

blunt adaptation,
enhance readiness

Heat =

improve O2 offload,
HR conditioning

Time

appropriately to avoid
performance tradeoffs

LAYERING INTERVENTIONS

- Example: 5 min breath → light bike → PEMF
- Stack in order of impact
- Goal: shift athlete back to parasympathetic state

MONITORING TOOLS OVERVIEW

HR strap

HR, HRV

Moxy

SmO2, THb

Pulse oximeter

SpO2 trends

Apps

Peripedal, Garmin IQ, EliteHRV

CASE STUDY:

ATHLETE RECOVERY TURNAROUND

- Before: HRV tanked, delayed rebound
- Intervention: breath/bike combo post-load
- Result: HRV + RPE normalized, fewer CNS days

MOVEMENT AS ASSESSMENT

Gait, breath,
coordination under load

Use squats + breathing bag
to challenge interoception

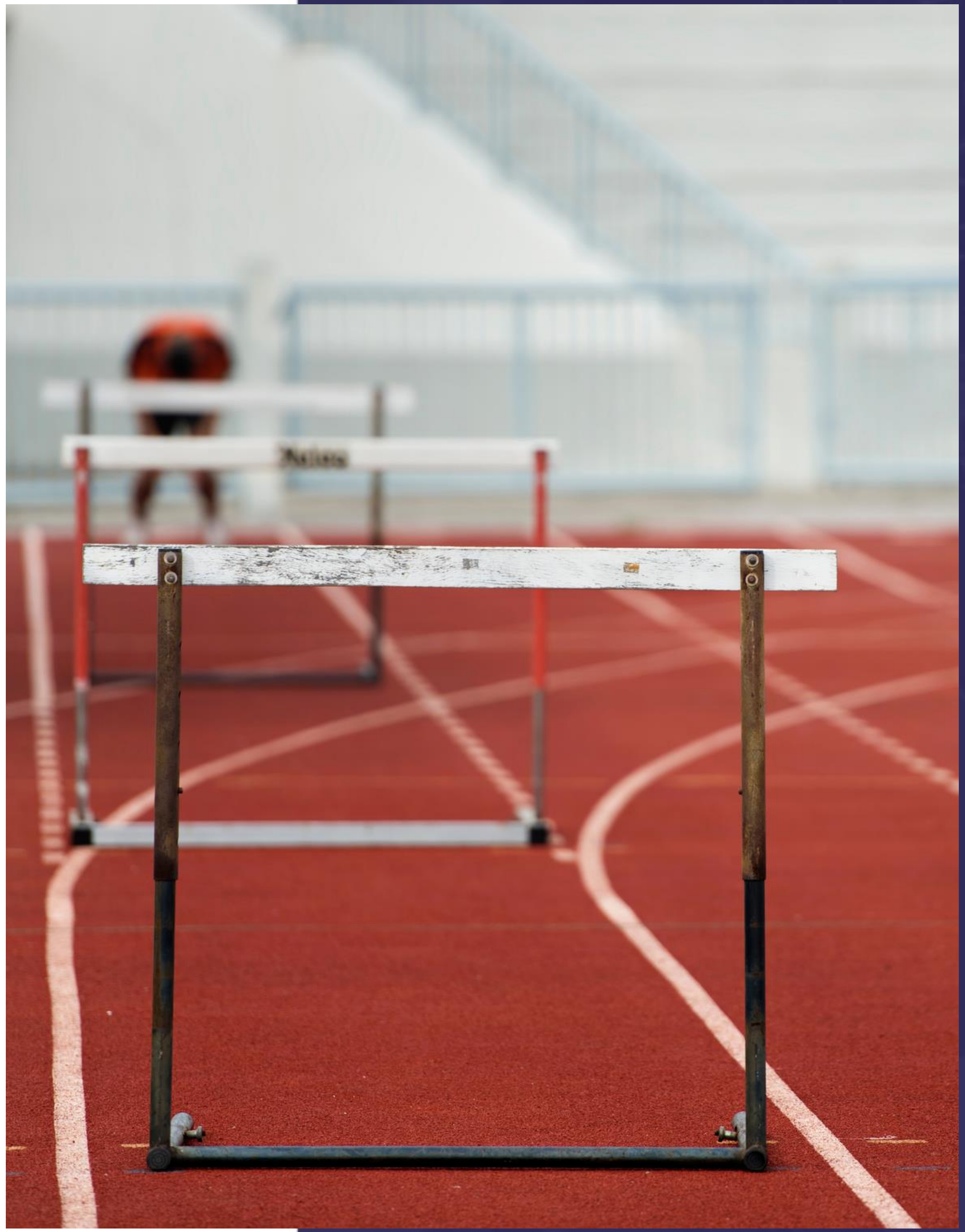
Watch recovery trend
on pulse oximeter

USE OF VR AND REACTION TIME DRILLS

- Brain fatigue → physical drop-off
- Add cognitive load to recovery days
- Builds resilience across fatigue domains

MENTAL OVERLOAD AND CNS DRAIN

- Tactical & sport overlap in decision fatigue
- Recover brain like you do muscle
- Build in quiet, HRV biofeedback, and positive cues



CASE EXAMPLE:
TACTICAL ATHLETE

- High tempo work leads to CNS drain
- Moxy shows delayed SmO2 rebound → poor oxygen resynthesis
- Perception drills + structured decompression improved load tolerance

CASE EXAMPLE:
HOCKEY PLAYER

- Post-shift HR spikes & poor HRV next AM
- 10-day block w/ active recovery + breath = HRV rebound, sleep gain
- On-ice performance improved

MOXY PROTOCOL DEEP DIVE

- THb rise/fall = compression or occlusion
- SmO2 + THb patterns inform session design
- Learn athlete’s recovery signature

THB RESPONSE TYPES



Light load:

compression → fast recovery

Medium:

venous occlusion pattern

Heavy:

possible arterial block → stress test

SQUAT-BASED TESTING PROTOCOL

- Moxy + pulse ox
- Observe O2 trend under fatigue and post-effort
- Adjust intensity to optimize flow vs restriction


3

BREATHING AS A RECOVERY INTERVENTION

- Manipulates CO_2, HR, vagal tone
- Impacts Fick by boosting O_2 delivery
- Protocols: 4:4 breathing, breath hold, nasal + resistance drills

HAUSER BREATHING POSITION

- Loaded breathing posture
- Add 4:4 breath under tension
- Enhances coordination under fatigue

BREATHING BAG PROTOCOL

- Plug bag: 30s own-air breathing
- Reopen bag → note SpO2 drop & recovery
- Teaches regulation & tolerance

CORE BREATHING SQUATS

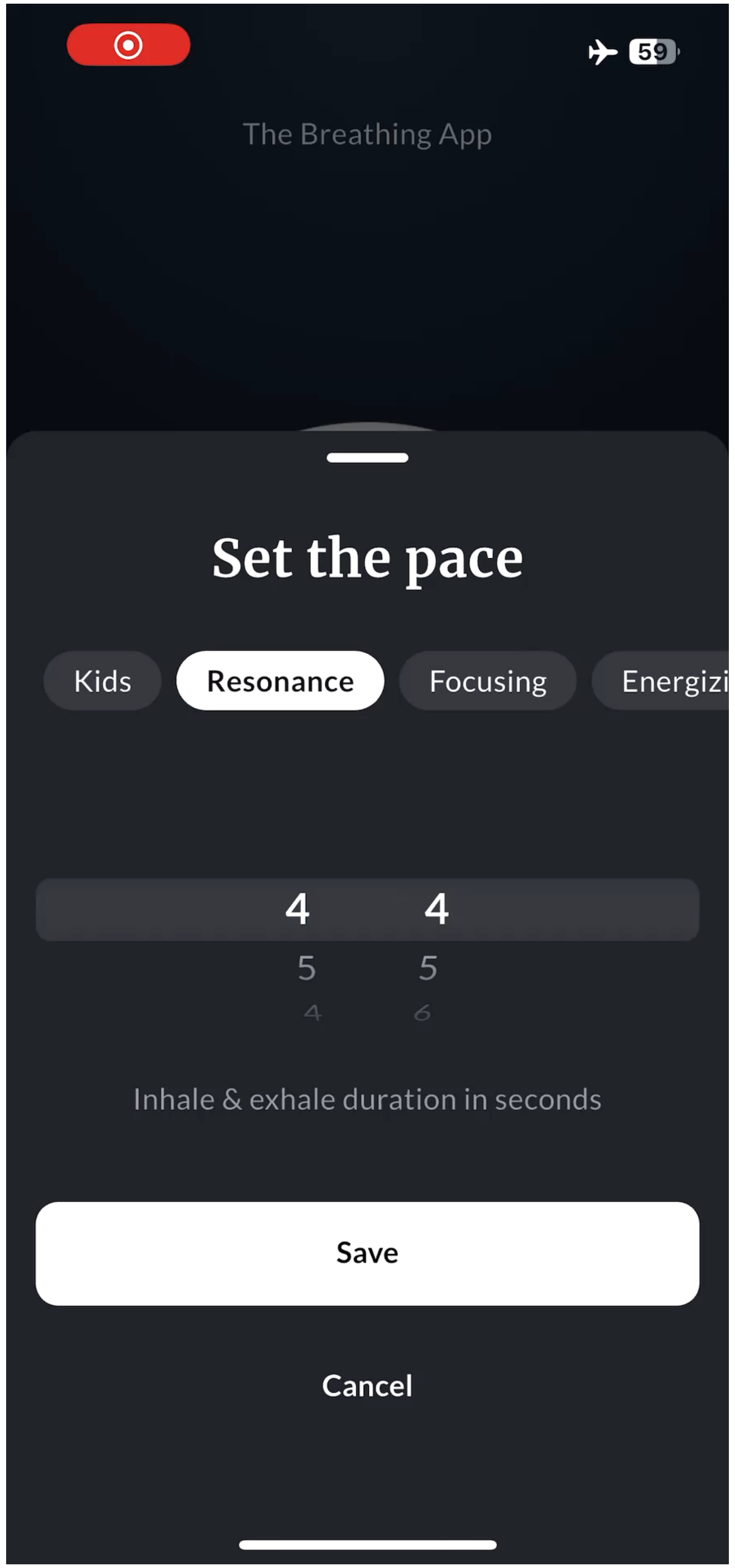
- 5-exercise circuit, 1-min each
- Breathing while moving = max challenge
- SpO2 drops → recover between rounds

RECOVERY BREATHING SQUATS

- Do 10 squats → sit → resume breathing
- Teaches down-regulation under fatigue
- Use with pulse oximeter for feedback

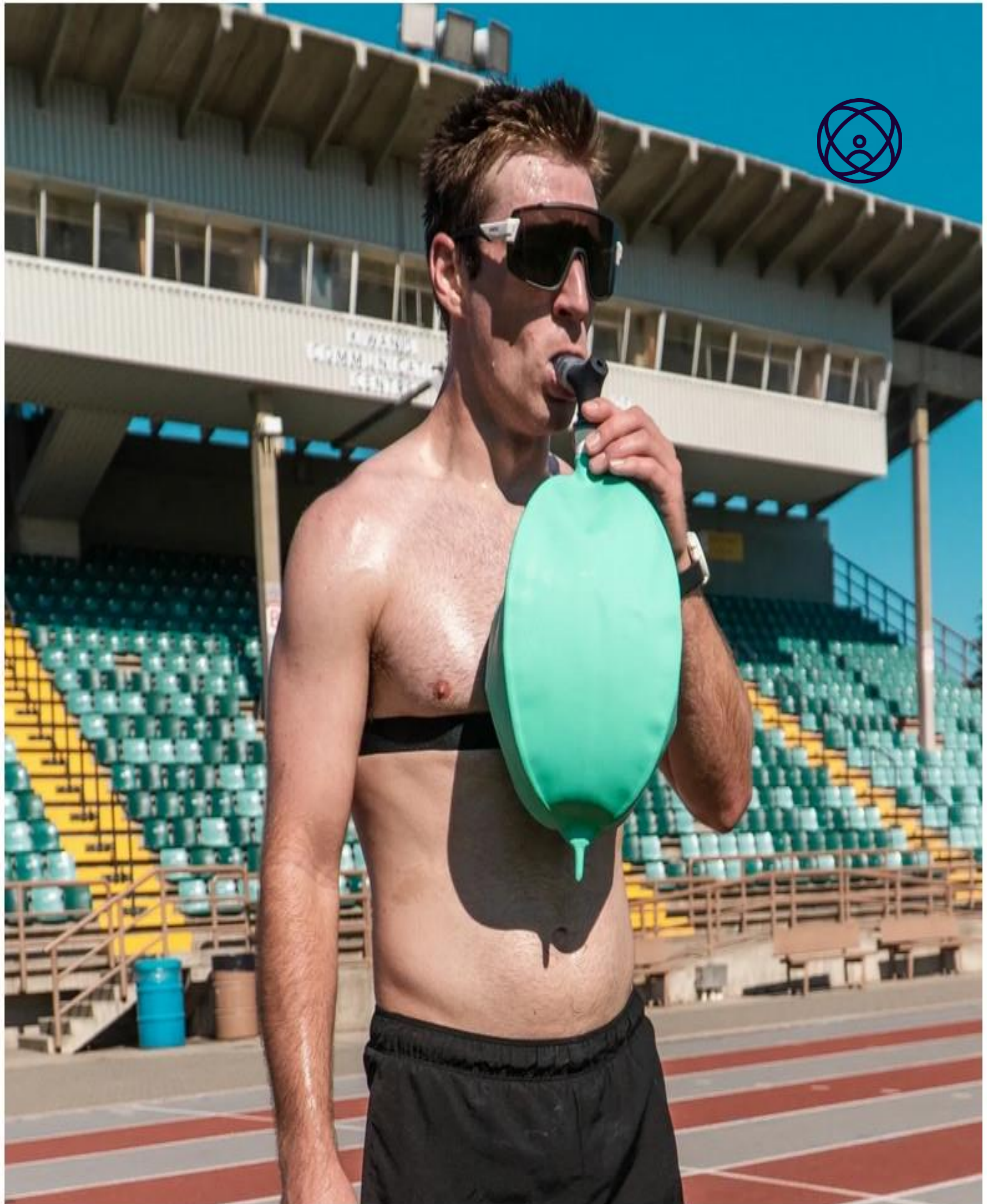
SPEED VS COORDINATION BREATHING

- Speed: diaphragmatic release, bag movement
- Coordination: match metronome (20–24 bpm), 10-count drill
- Builds neural control of breath


The Breathing App
Set the pace
Kids
Resonance
Focusing
Energizi
4
4
5
5
Inhale & exhale duration in seconds
Save
Cancel

ADVANCED BAG DRILLS

- Seal bag, exhale and delay air entry
- Increase breath-hold tolerance
- Watch for desaturation & recovery trend



Breathing Protocols Summary

Protocol	Breath Rate	Focus	Tools Used	When to Use
Speed Breathing	30–45/min	Volume + Coordination	Breathing bag + metronome	Training under fatigue
Power Breathing	~20/min (controlled)	Strength	Breathing bag	Respiratory muscle building
Coordination Breathing	20–24/min (paced)	Rhythm & Precision	Metronome + bag	Neuromuscular control
Recovery Breathing	12–15/min or slower	Oxygen reuptake	Pulse ox, bag, spiral	Post-exertion
44 Ratio / Hauser	4:4 cycle	Diaphragm relaxation	No/low resistance bag	Reset / pre-drill

What Is BFR?

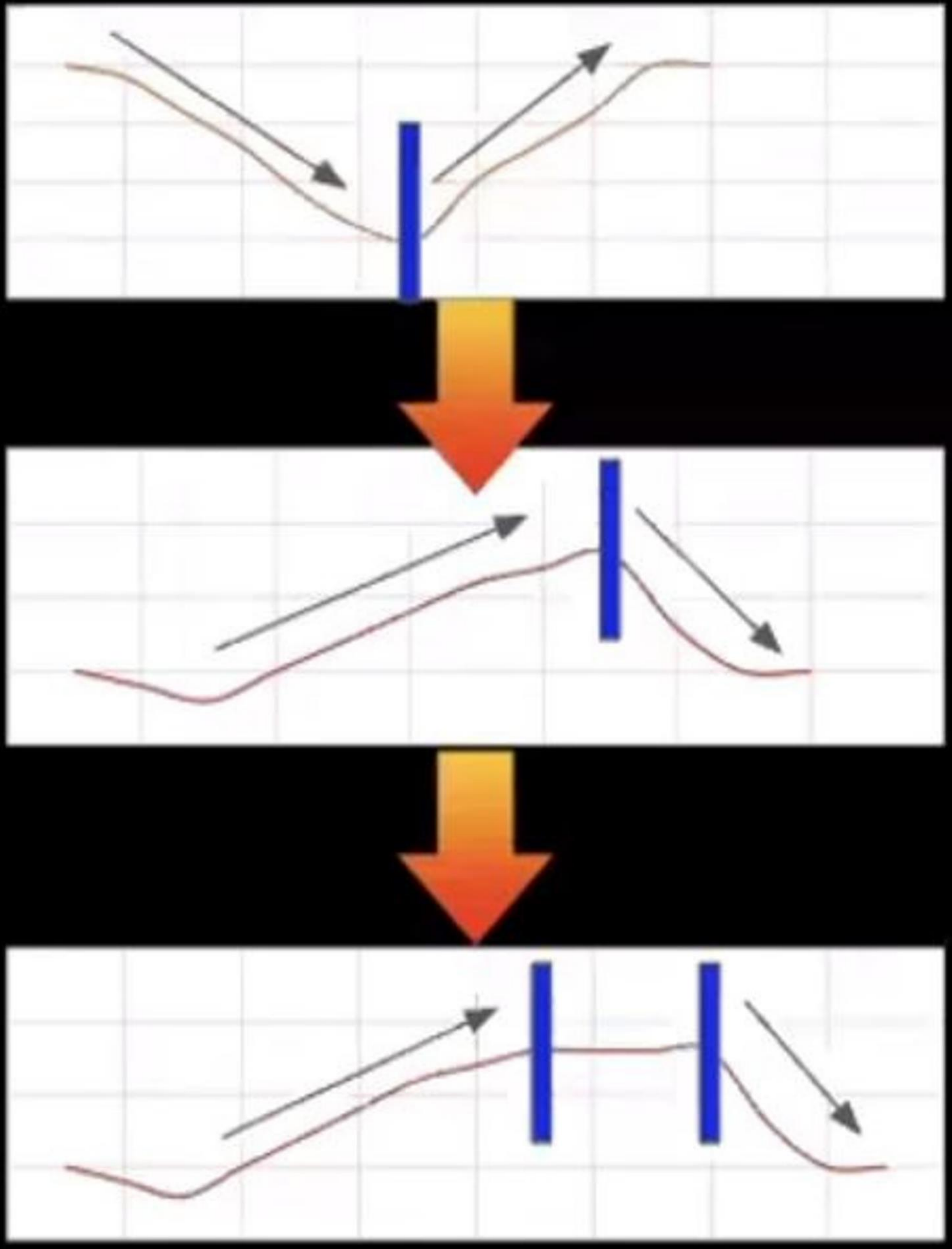
- Resistance and/or aerobic training performed under partial occlusion to the working limb.
- A cuff is placed above the working limb and inflated to 40-80% LOP.
- Low load training is performed at 20-40% 1RM

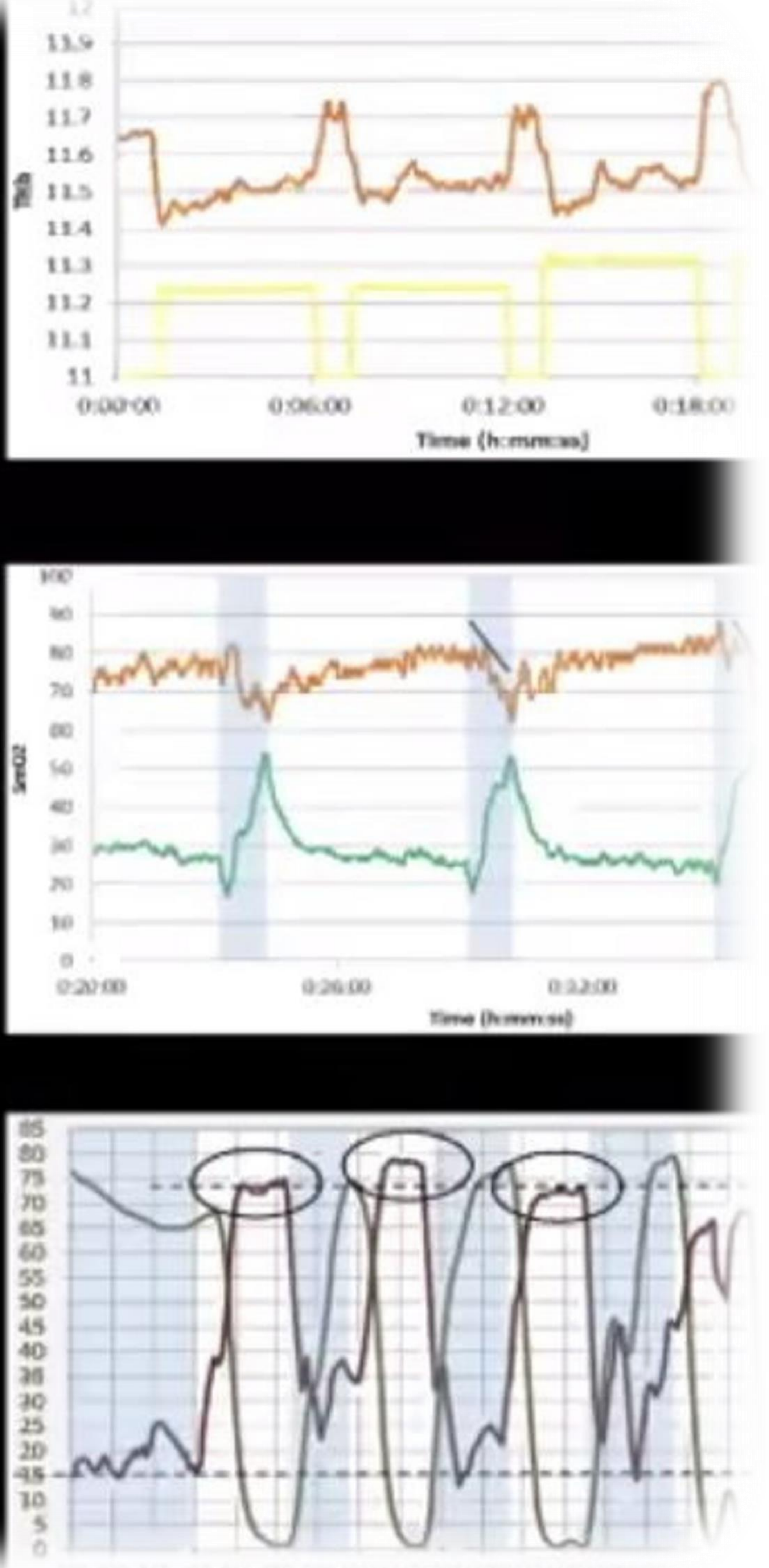
(Hughes et al., 2017).

compression

venous occlusion

arterial occlusion





Redistribution: Alternating UB/LB Work

🔁 Alternate Upper Body (UB) and Lower Body (LB) work under BFR

✅ One region recovers while the other trains

🔄 Sustains localized metabolic stress without systemic fatigue

🕐 Use short rest intervals (20–30 sec)

🏋️ Example: LB squats → UB rows → LB lunges

🚀 Improves recovery and work density across full-body training

Recovery: High-Tension BFR to Elevate THB

💢 Apply BFR passively — no active movement

🧠 Drives up Total Hemoglobin (THB) via vascular response

🩸 Promotes nitric oxide release and local circulation

🧘 Use during deload, between sets, or post-session

🔬 High occlusion pressures (e.g., 70–80%) for 5–10 min sessions

🔄 Reduces soreness and enhances next-session readiness

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NEUROCON COGNITIVE FATIGUE AND NEUROPERFORMANCE

PRESENTER: DR. NICKY KIRK, PARKER PERFORMANCE INSTITUTE

MENTAL FATIGUE IS A HIDDEN OPPONENT.

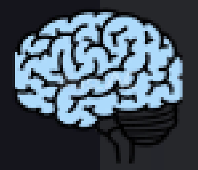
- Slows reaction time
- Impairs decision-making
- Increases errors and injury risk
- Reduces endurance and technical precision

Training the brain is essential for modern performance.

Mental fatigue is defined as a psychobiological state elicited by cognitive demands and is characterised by feelings of tiredness, a lack of energy, and impaired cognition.

It decreases an individual's ability to inhibit responses, process information and concentrate on task.

Mental fatigue has been identified as a critical issue in sport, highlighting the need to develop effective countermeasures...



BET REVIEW. ANDRE ET AL (2025)

“ Research has confirmed effectiveness in endurance exercises (limited support for strength protocols)

- Consistent benefits in time-to-exhaustion and lower perceived effort
- Subjective fatigue measures were mixed
- BET group showed higher prefrontal oxygenation during post-test endurance tasks (Dallaway et al., 2021 & 2023)
- May promote beneficial neural adaptations

Future studies should refine optimal protocol parameters and confirm neural underpinnings

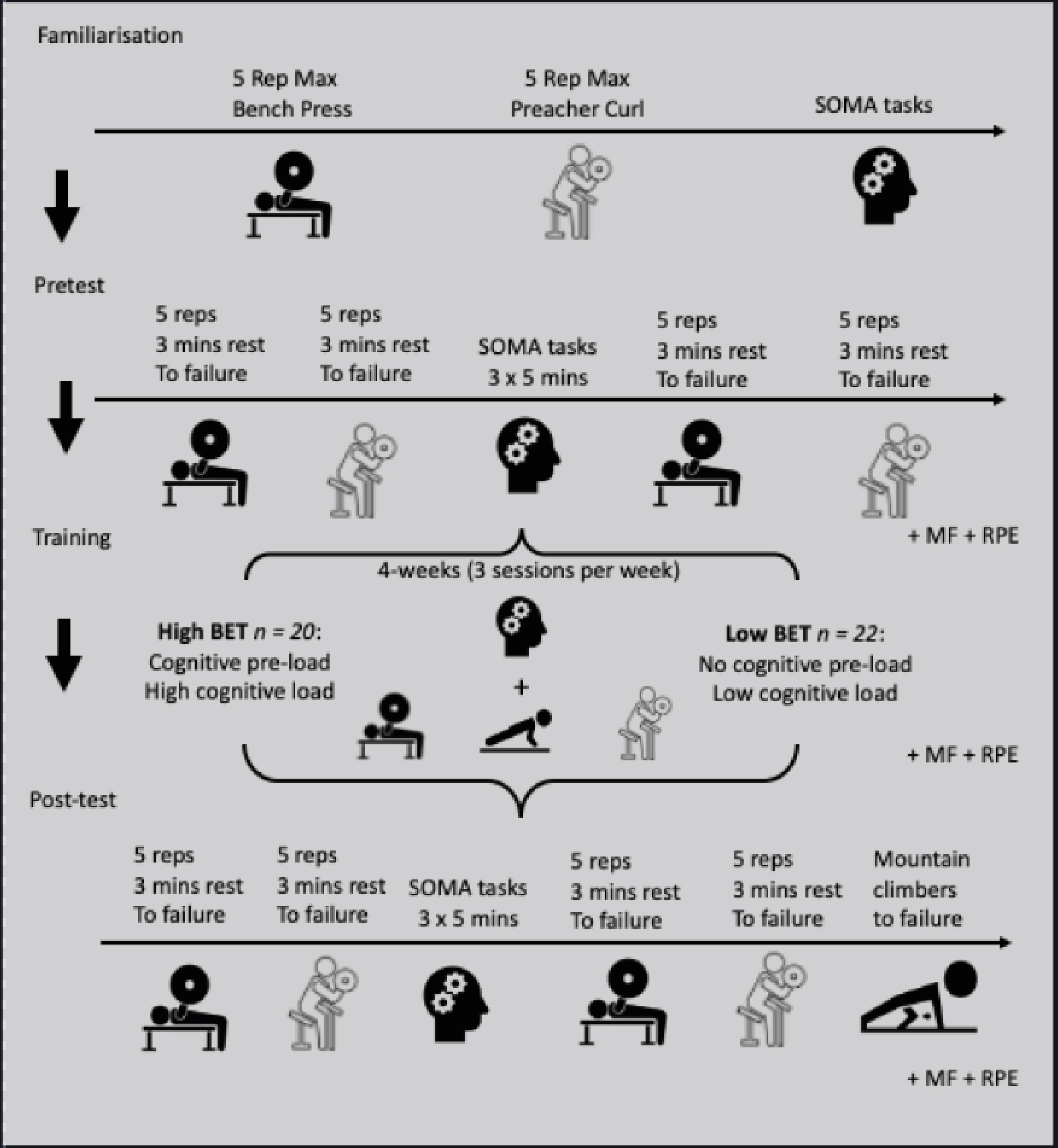
PROTOCOL. TESTING.

n42 (18 female, 24 male) resistant trained student athletes.

- 2 exercises [compound vs isolation]
- Reps to Failure in Fresh vs Fatigued State
- 60% estimated 1RM
- Testing: 3 x 5 minute cognitive tasks (different to training)
- High BET (hiBET) vs Low BET (loBET) to explore dose relationship

Testing:

- warm up: cycling, mobility and warm up set
- 4 channel sEMG - muscle activation
- Linear transducer - measure velocity and movement patterns

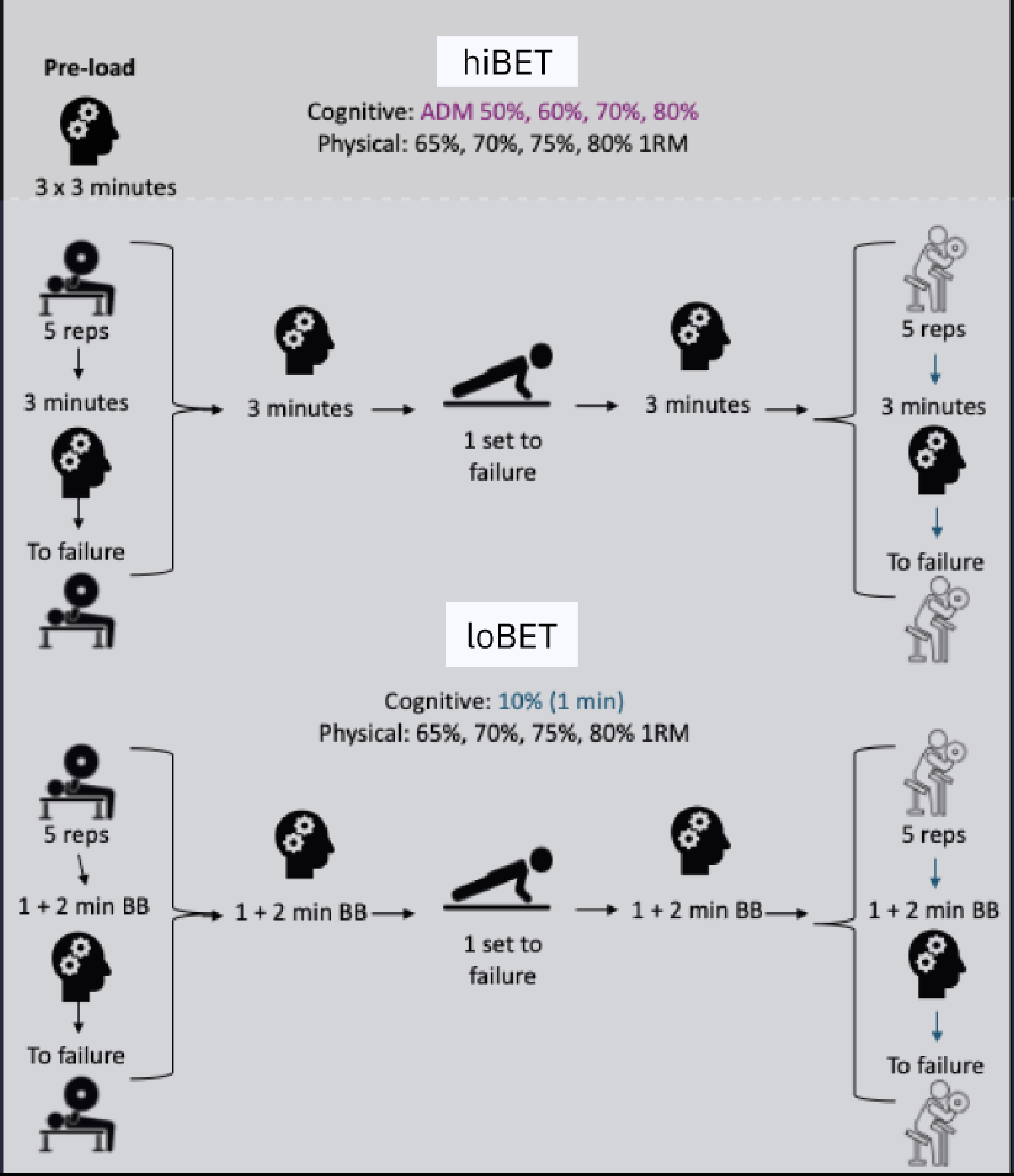


TRAINING PROTOCOL.

3 training sessions a week, 4 weeks [12]

Periodisation of training

- physical training same (↑ 10% each week)
- hiBET ↑ cognitive load (↑ 5% each week)
- other training controlled via journal



CONCLUSIONS

hiBET outperformed loBET in strength-endurance and perceptual metrics

- Significant improvements in reps to failure
- Consistently lower RPE in hiBET
- Kinematic measures or EMG did not show group specific improvements
- Maintained movement quality may suggest improved fatigue resistance without changes in neuromuscular strategy.

+26%

Reps to failure (hiBET - CP - Fresh) vs. +5% in loBET

–16%

Overall RPE (hiBET vs loBET - all conditions)

+17%

Reps to failure (hiBET - PC - Fresh) vs. +4% in loBET

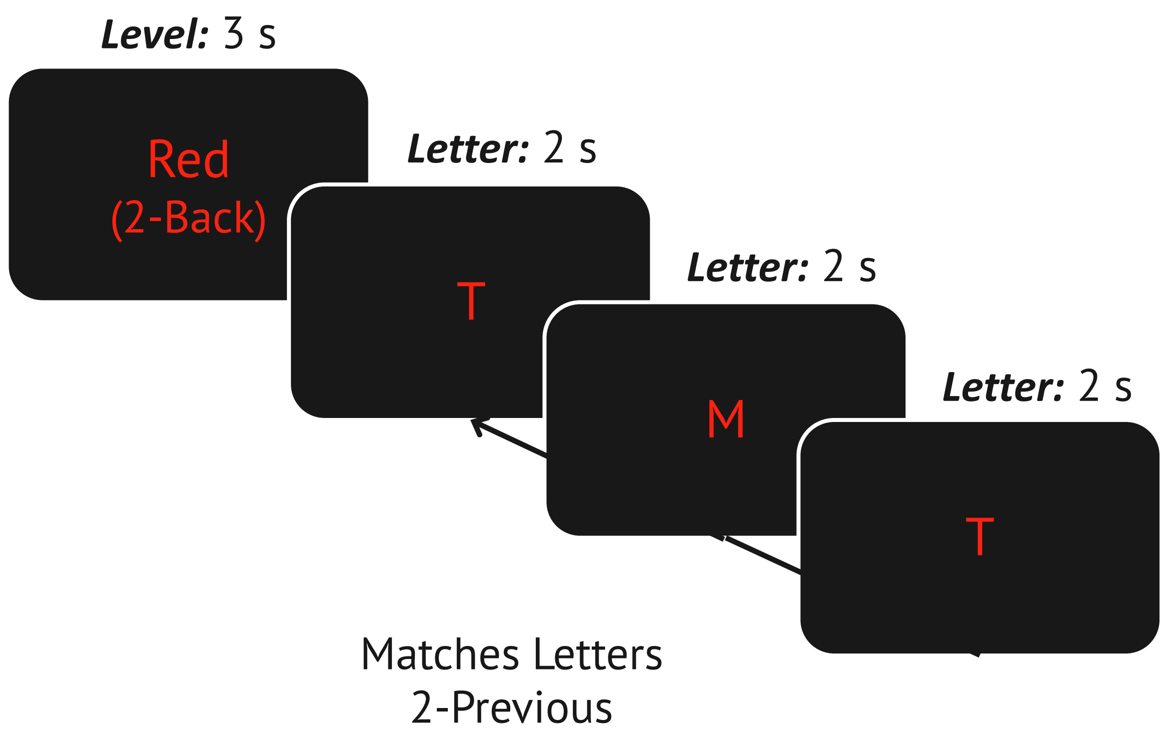
HOW MENTAL FATIGUE AFFECTS DECISION-MAKING

This study tested how increasing mental fatigue changes our choices when faced with harder tasks and bigger rewards.

MEMORY TASK

Participants performed a working memory task (2-back), where they responded if a letter matched the one shown two steps earlier.

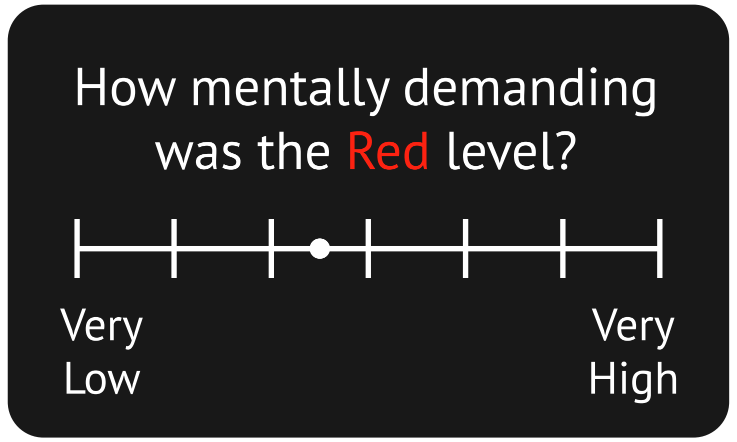
Purpose: Induce different levels of mental effort.



EFFORT RATING

After each memory task, participants rated how hard it felt using a scale from Very Low to Very High.

Purpose: Link colors to perceived task difficulty.



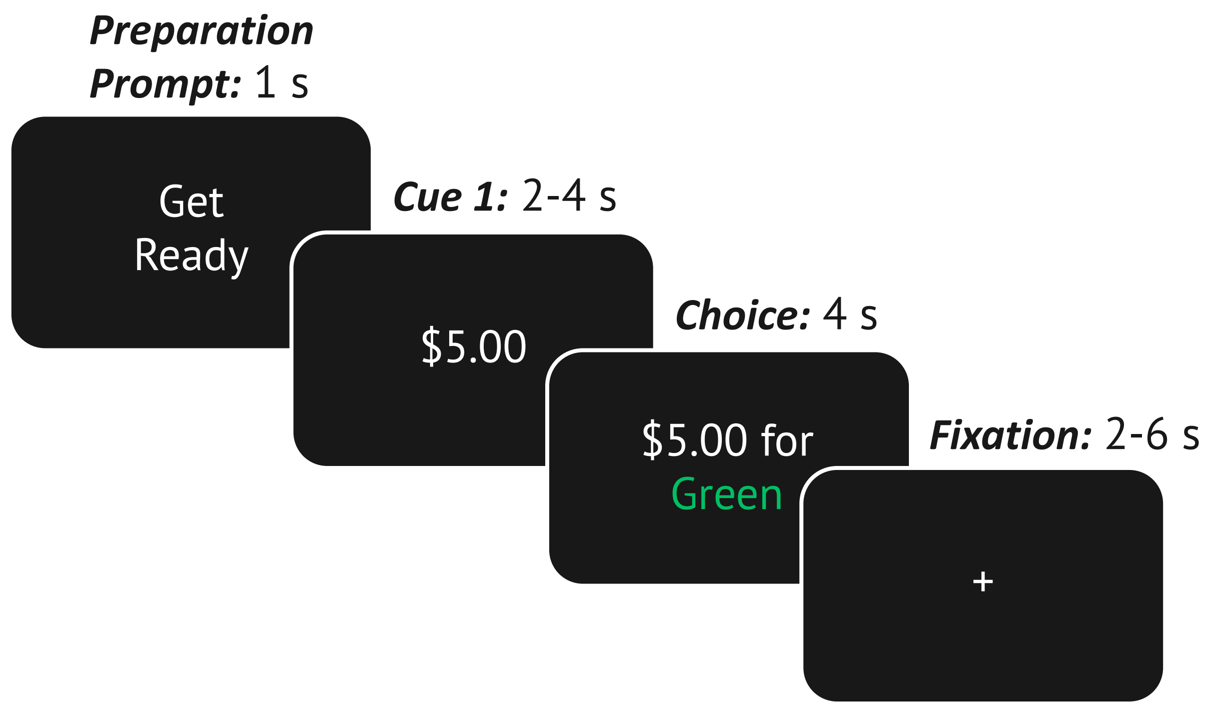
HOW MENTAL FATIGUE AFFECTS DECISION-MAKING

This study tested how increasing mental fatigue changes our choices when faced with harder tasks and bigger rewards.

EFFORT-BASED DECISION

Participants chose between an easy/low-reward task (e.g., $1 for 1-back) or a harder/higher-reward task (e.g., $5 for 3-back).

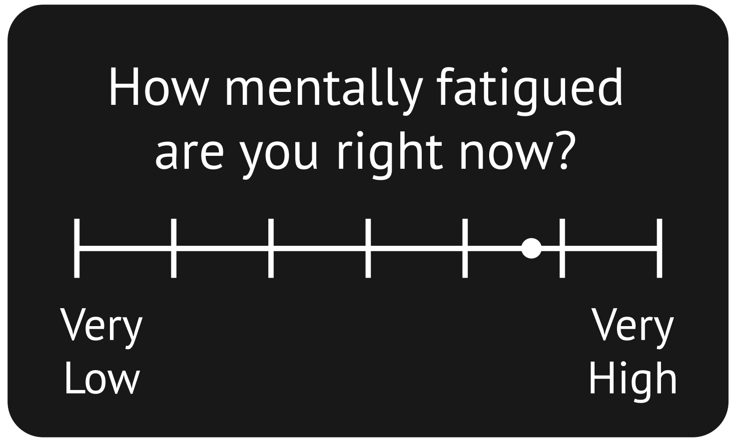
Purpose: Measure how fatigue affects effort/reward trade-offs.



MENTAL FATIGUE RATING

Participants rated their current mental fatigue at intervals using a sliding scale.

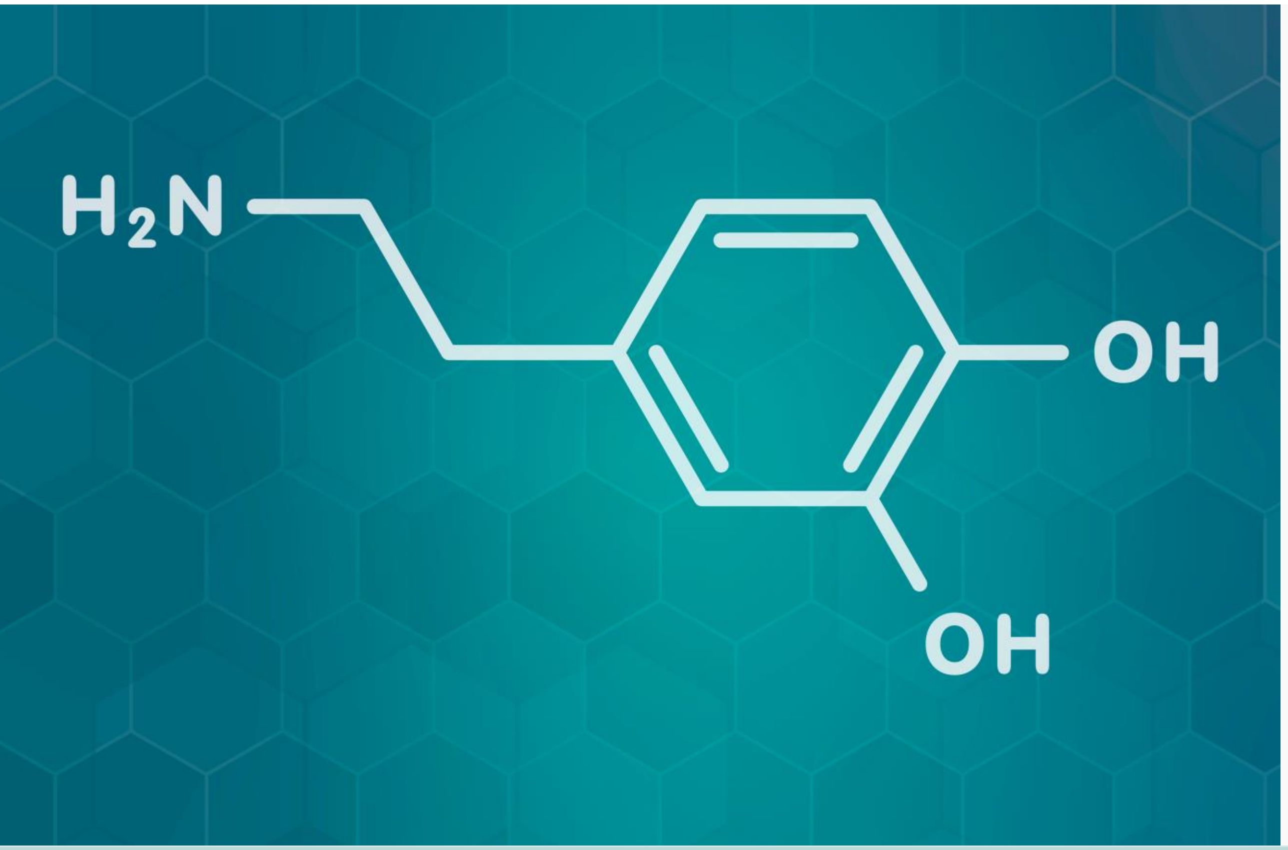
Purpose: Track changes in fatigue throughout the session.

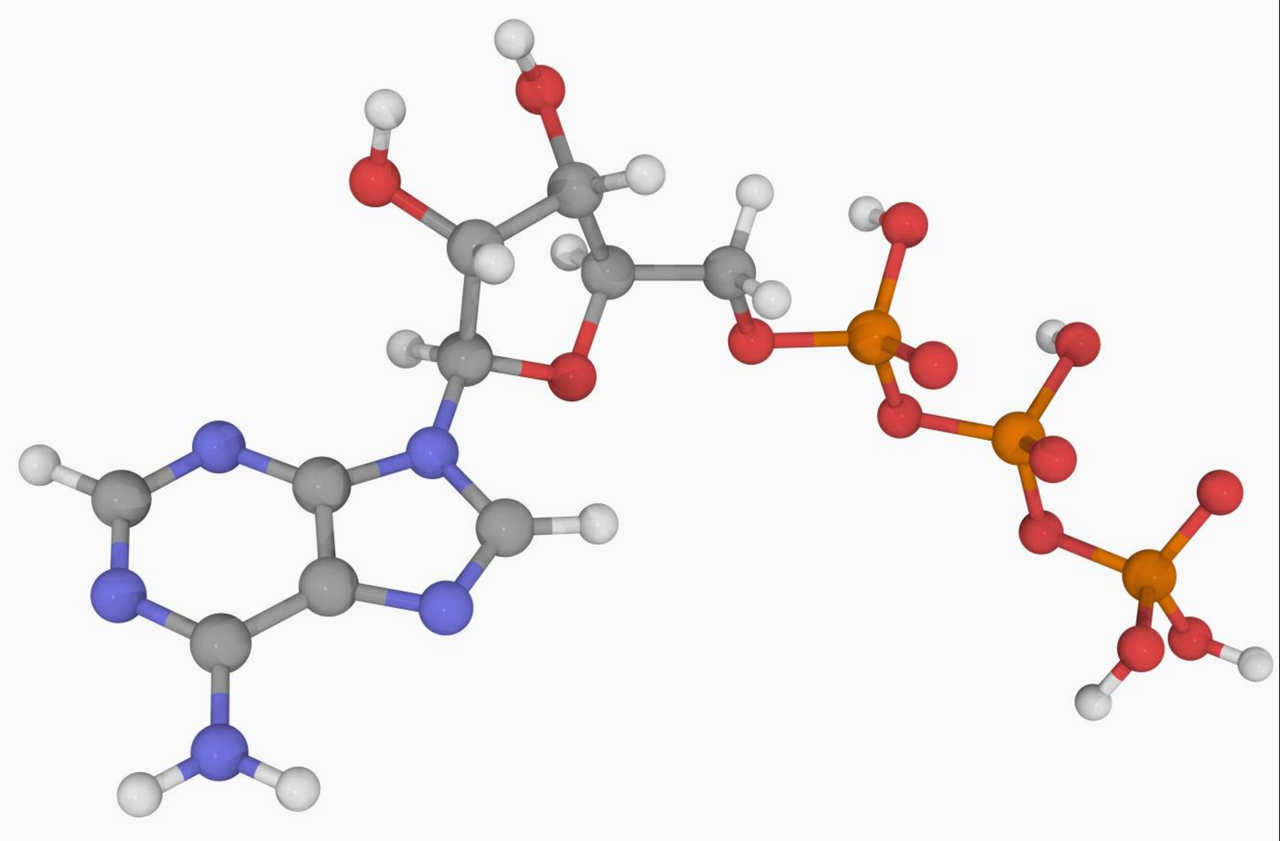


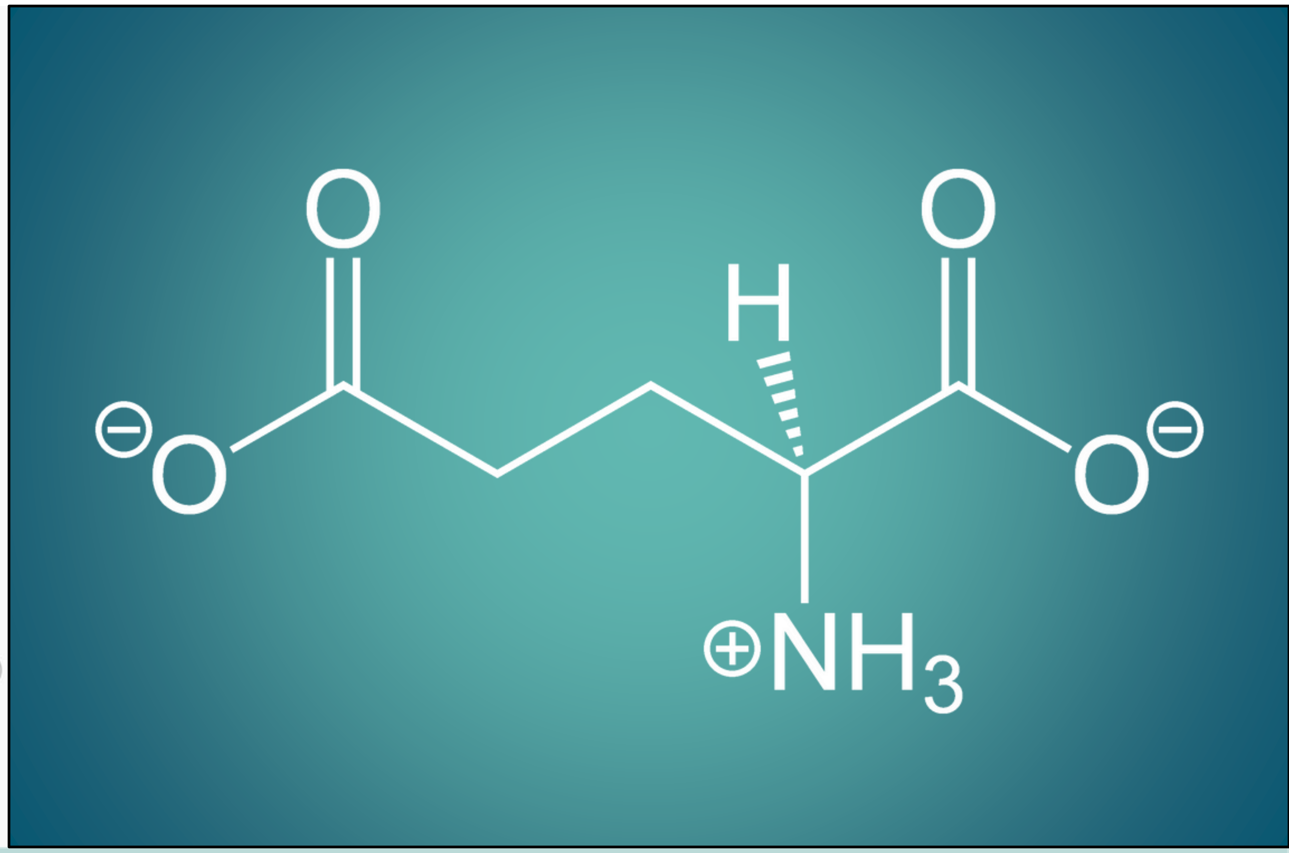
KEY FINDING:

The more mentally fatigued participants became, the less likely they were to choose the harder task, even for more money.

NEUROTRANSMITTER PATHWAYS IN FATIGUE







Dopamine

Motivation regulation

Adenosine

Signals effort tolerance

Glutamate

Cognitive control

Notes: These chemicals shape the brain’s budget for effort.

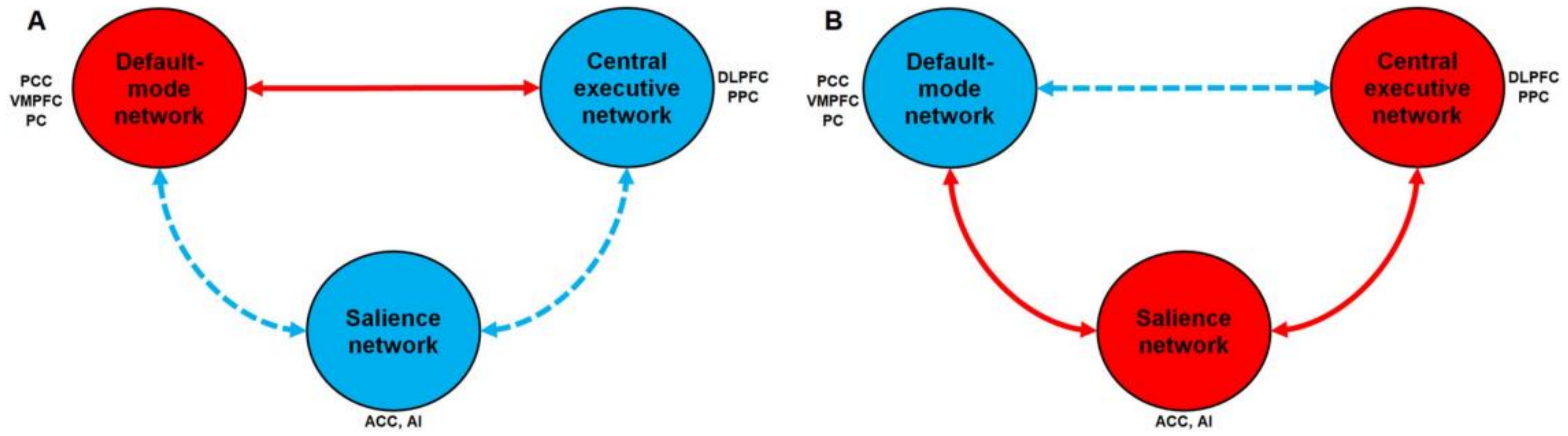
EFFORT-BASED DECISION MAKING

- Cost-benefit models
- vmPFC integrates reward
- ACC tracks effort cost

Notes: Fatigue shifts these toward quitting or disengagement.

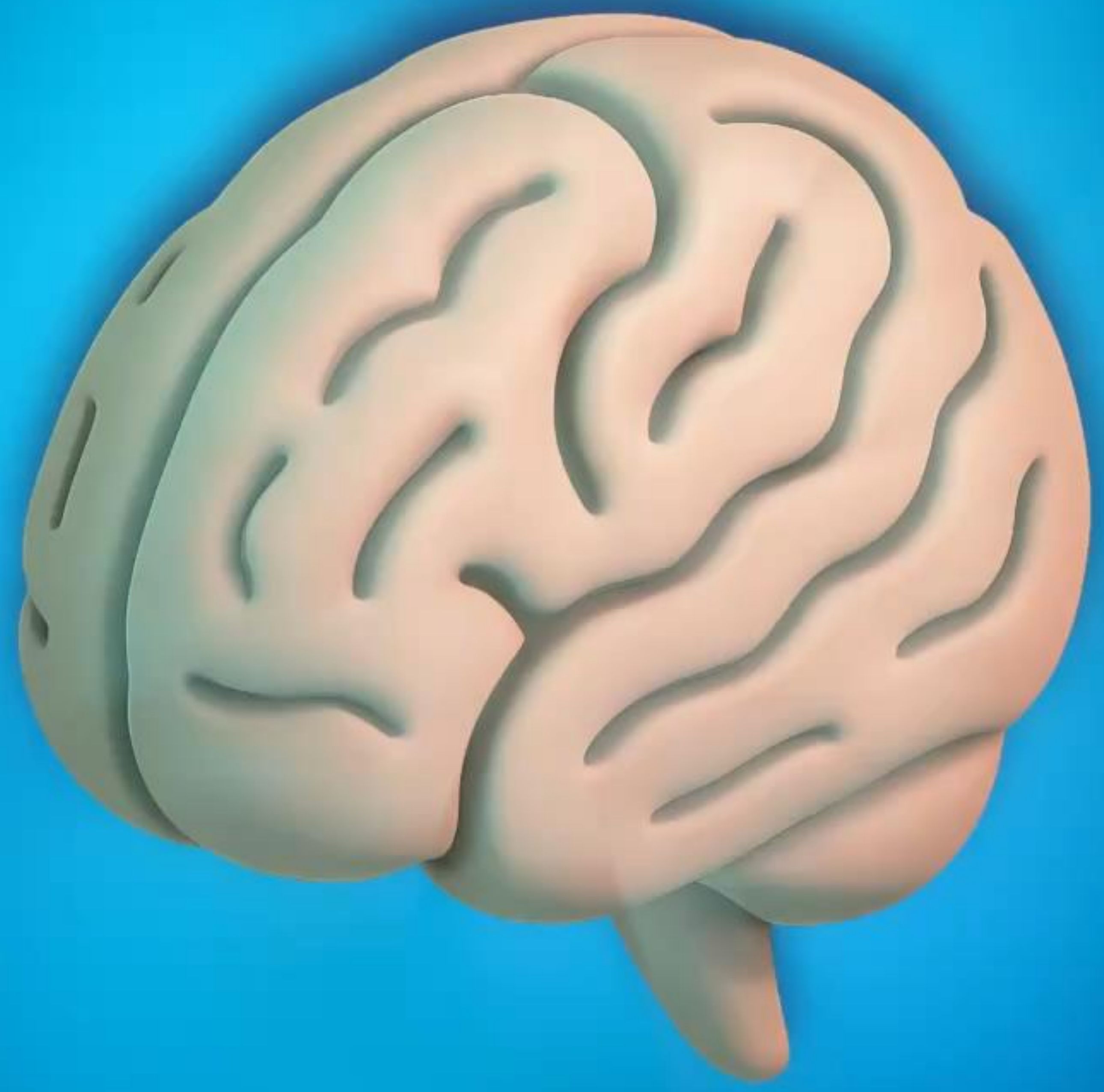
BRAIN ENDURANCE TRAINING (BET)

- Combines cognitive + physical stress
- Targets SN/DMN/FPN
- Early evidence supports its use

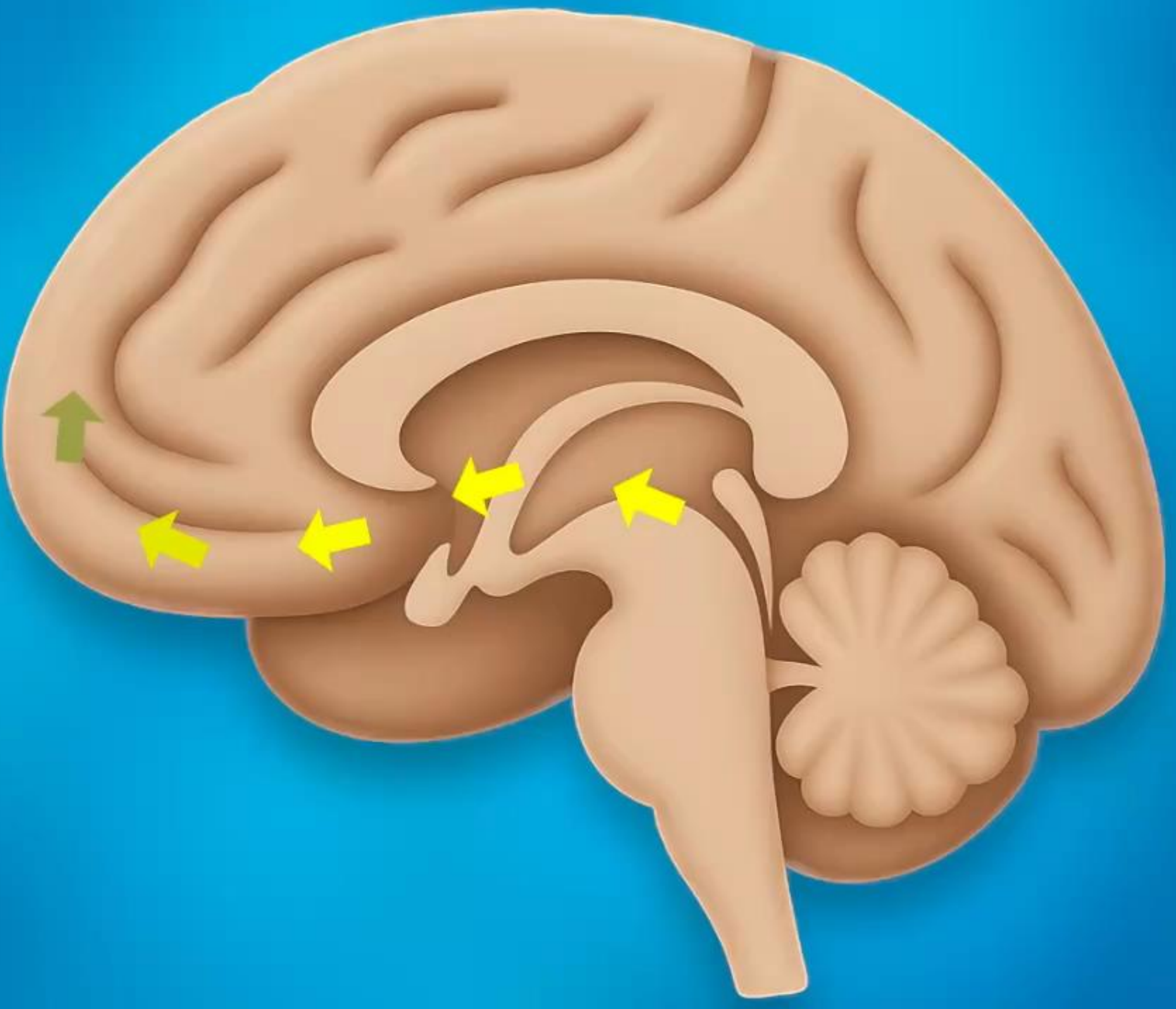


Notes: Shows neuroplastic benefits for performance and rehab.

Cognitive fatigue changes how your brain functions

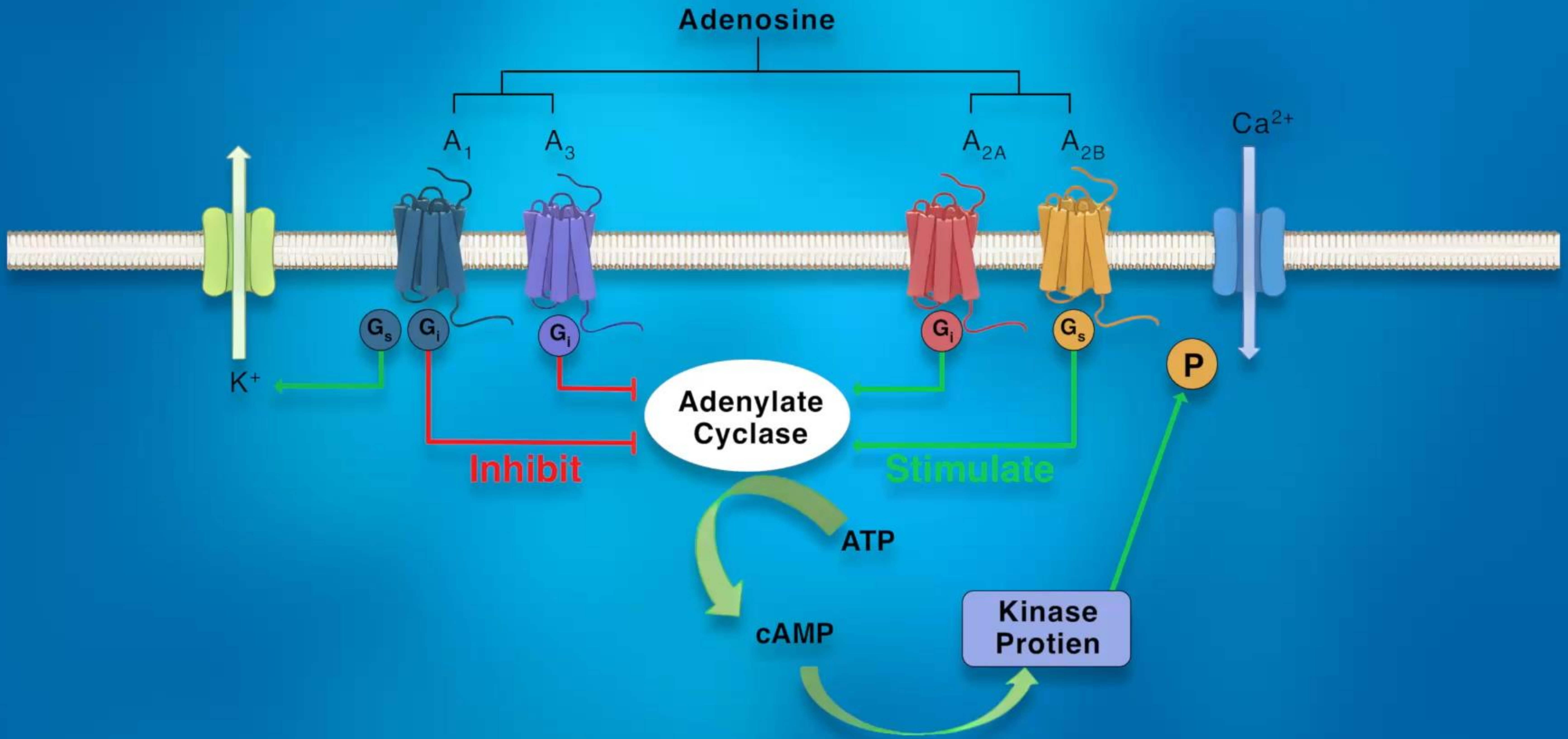


Motivation lower

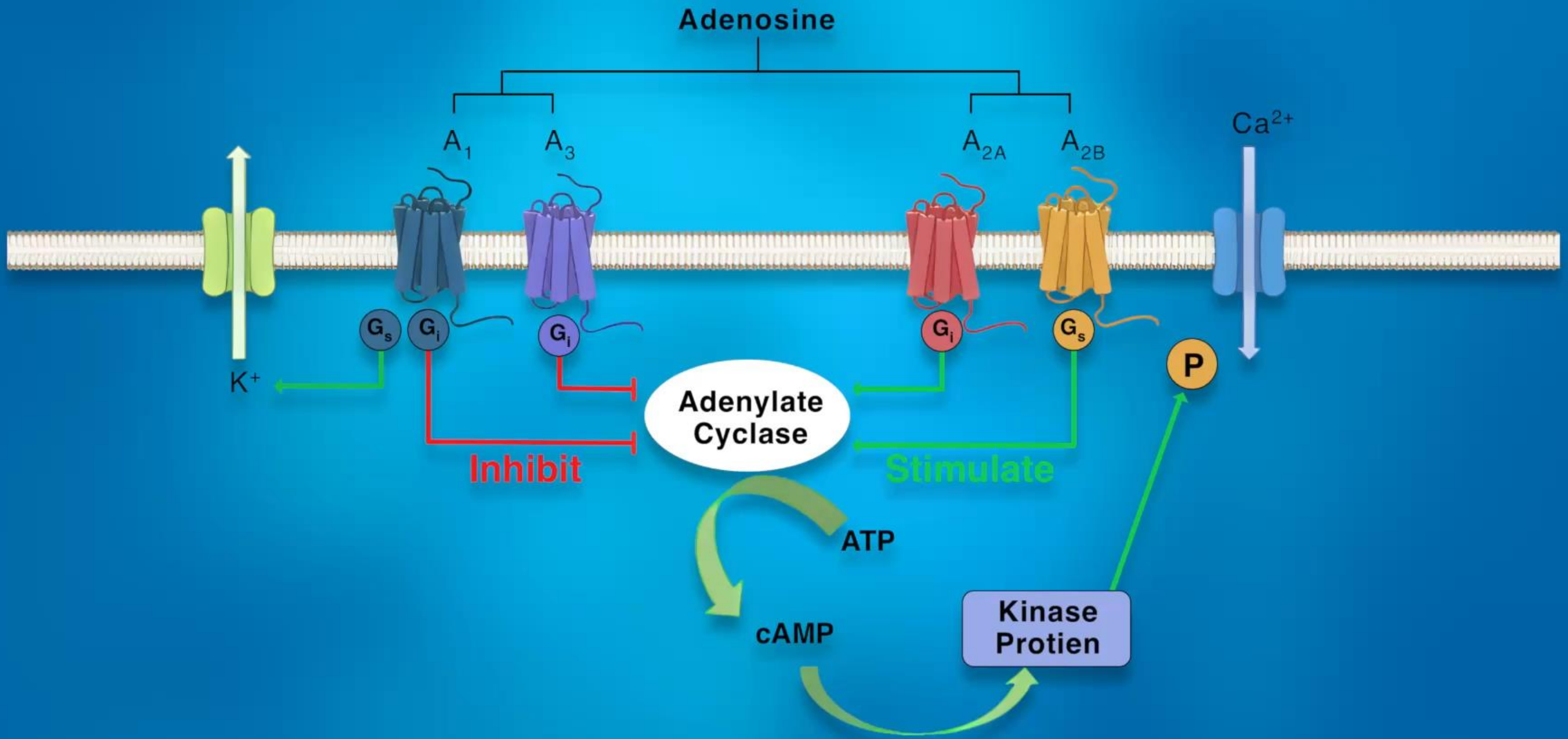



Effort tolerance reduced

Effort tolerance reduced



Effort tolerance reduced

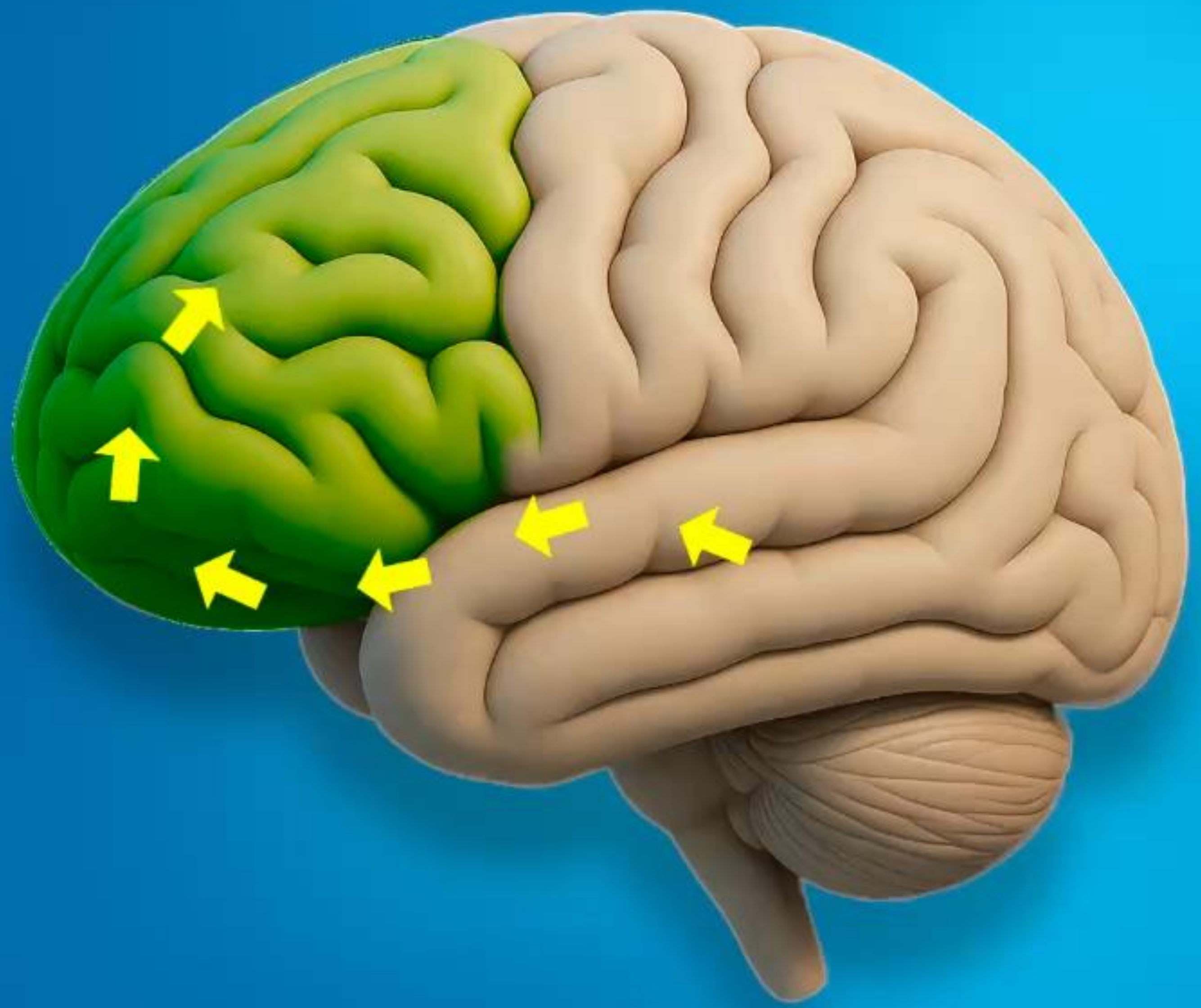


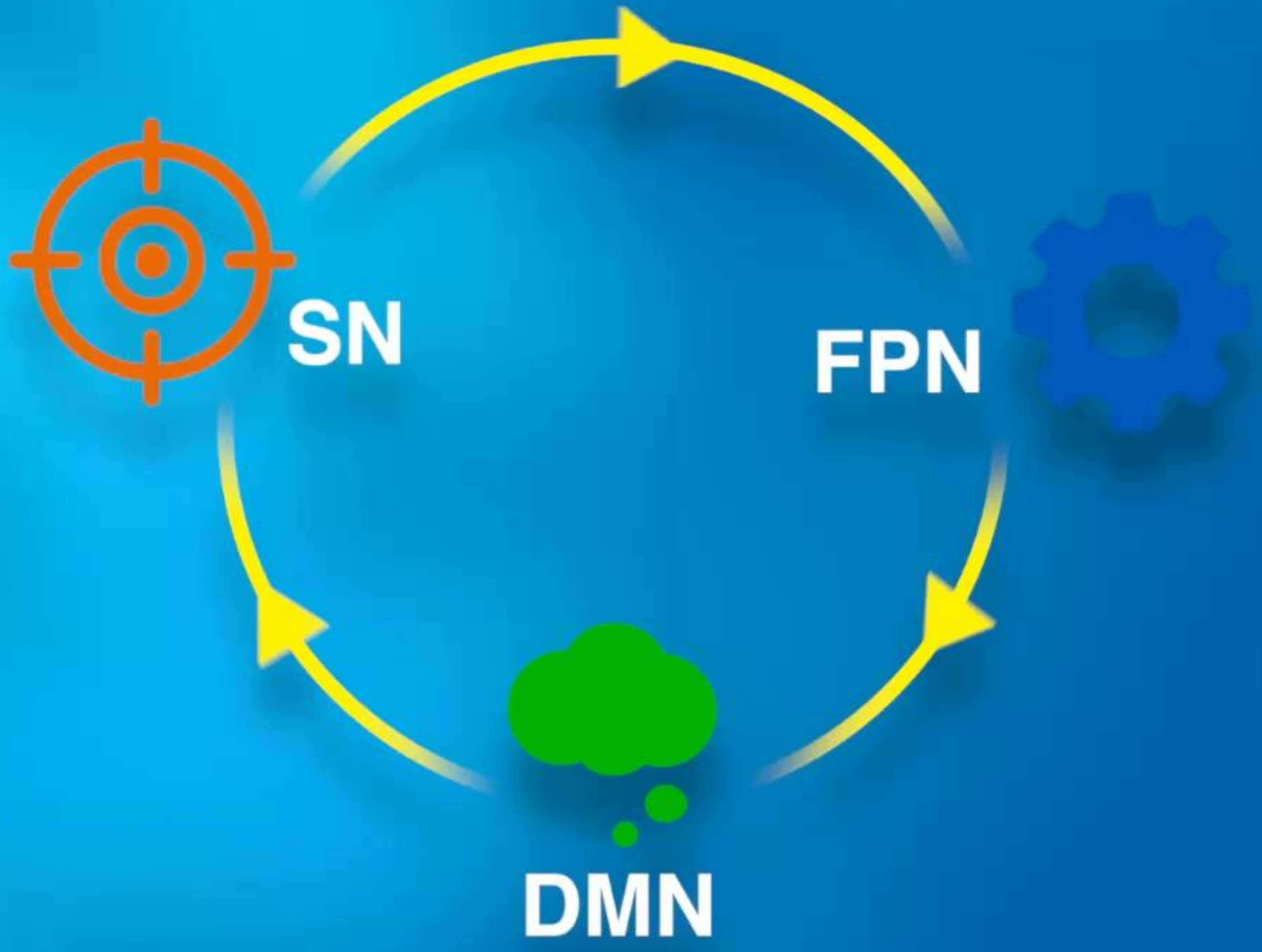
Cognitive control disrupted

Cognitive control disrupted


Performance errors increase

Performance and Resilience = Grit





WHY

BRAIN ENDURANCE TRAINING?

BET = COMBINING COGNITIVE + PHYSICAL DRILLS

- Challenges focus, inhibition, memory while exercising
- Uses dual-task approach
- Builds "mental toughness" against fatigue
- Improves both brain and body

Key concept: Train the mind under the same stress as the body.

BET EVIDENCE

Studies show BET:

- Improves endurance (time-to-exhaustion, VO2max)
- Protects technical skills under fatigue
- Reduces mental fatigue effects
- Modifies brain networks
  (salience, executive, default-mode)

Think of it as preparing the brain to handle stress better.
(André et al., 2025; Díaz-García et al., 2024)

BET IN ATHLETES

EXAMPLE OUTCOMES

Passing improved	+5%	
Shooting improved	+4%	
Shot sequence time	7%	faster
Agility test	3%	faster
Repeated sprints improved	5%	

Control group showed no change

Basic message: Sharper, faster, steadier under stress.

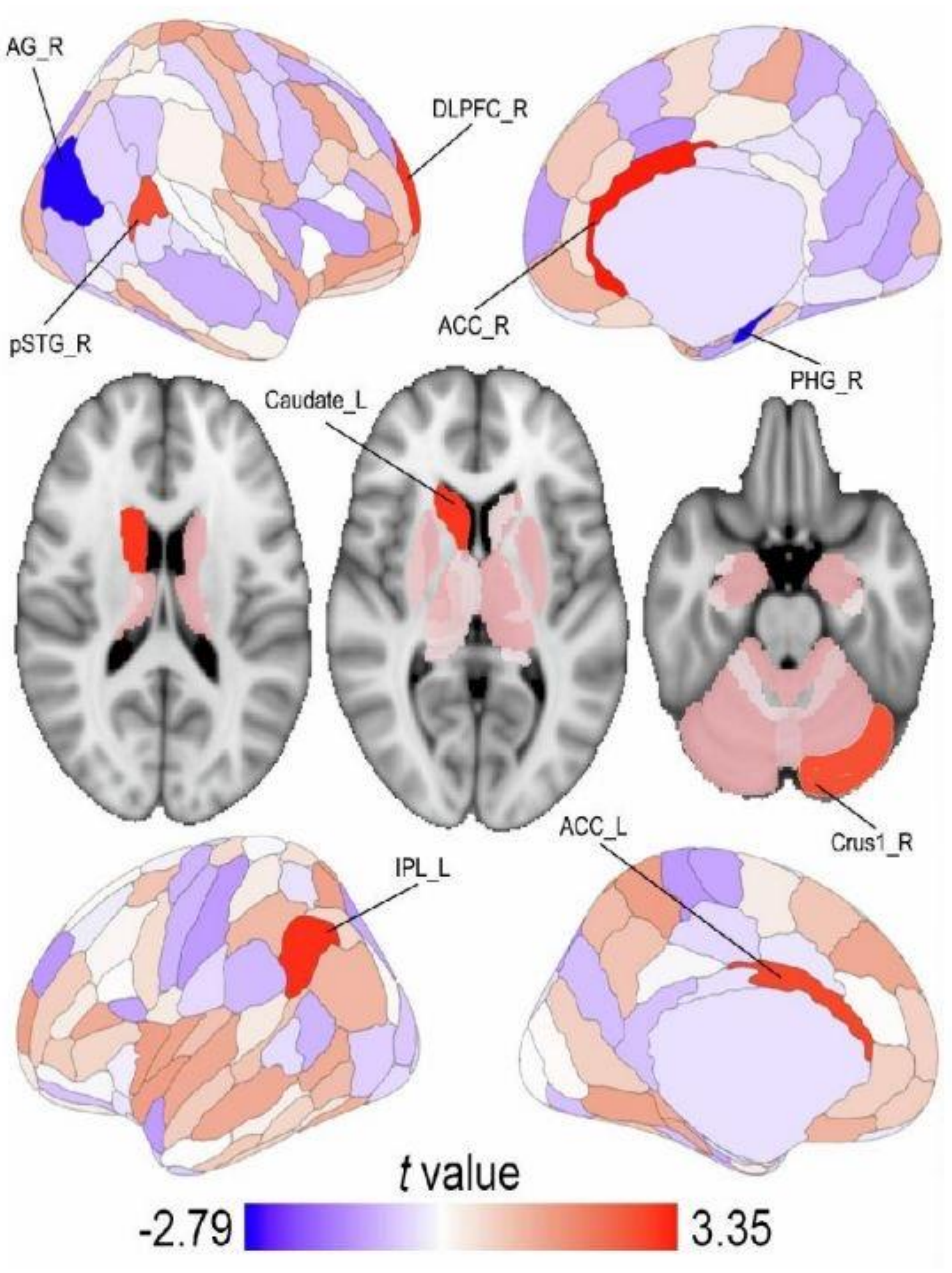
NEUROIMAGING OF BET

Increased activation in decision-making and control areas:

- ACC
- DLPFC
- Parietal cortex
- “Mental gym” got stronger

Red = more activation with BET ***Blue*** = cleaner, more efficient activity

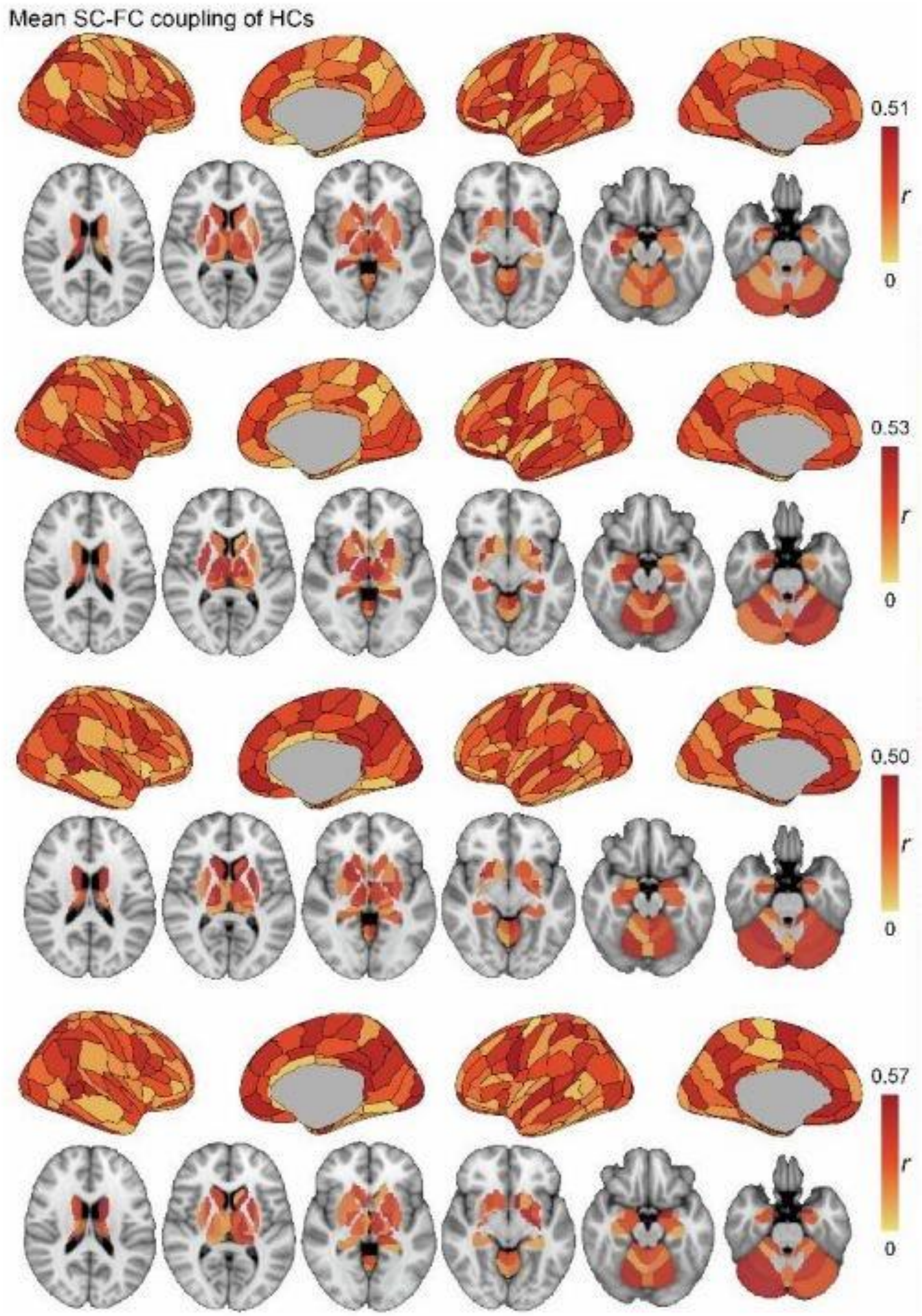
(Russell et al., 2023)



BRAIN CONNECTIVITY

- Improved brain wiring
- Better functional connectivity between:
  - Salience network
  - Executive network
  - Less default-mode wandering
- Helps stay “locked in” under pressure

The GPS and the car finally in sync. *(André et al., 2025)*



HANDBALL MINDFULNESS STUDY

6-Week Mindfulness-Based Intervention (MBI) using:

- mPEAK (Mindfulness Performance Enhancement, Awareness & Knowledge):
    - Developed by UCSD Center for Mindfulness
    - 2-day immersive, live training
    - Focuses on resilience, non-judgmental awareness, and performance under pressure
- Headspace:
    - App-based daily guided mindfulness
    - 20 minutes a day, 5 days per week
    - Supports consistency and habit formation

79 Elite Handball Players:

- Improved focus (SART No-Go, Stroop)
- Faster directional sprints
- Better reactive agility
- Fewer hand errors
- Lower mental demand and frustration, especially under induced mental fatigue

Takeaway: Mindfulness preserved technical skills and decision-making under mental fatigue, with no extra physiological load. (Staiano et al., 2025)

AIS PROTOCOL RESULTS

Testing 5 protocols for mental fatigue:

SOMA-NPT

Best for building mental load

Guided Breathing

Best for mental recovery

Social Media

Reduced motivation and readiness

Quiet Rest

Mixed

Coach-designed Mini-games

Promising

Short brain-training blocks are effective. *(Russell et al., 2023)*

PRACTICAL IMPLICATIONS

Combine:

- Dual-task drills (BET)
- Mindfulness-based programs (mPEAK, Headspace)
- mPEAK: deep skill-building in live setting
- Headspace: scalable app-based practice
- HRV biofeedback breathing
- Athlete-specific mental recovery

Note: Parker University has successfully trialed the Calm app as an alternative mindfulness tool for athletes and patients

Best Practices:

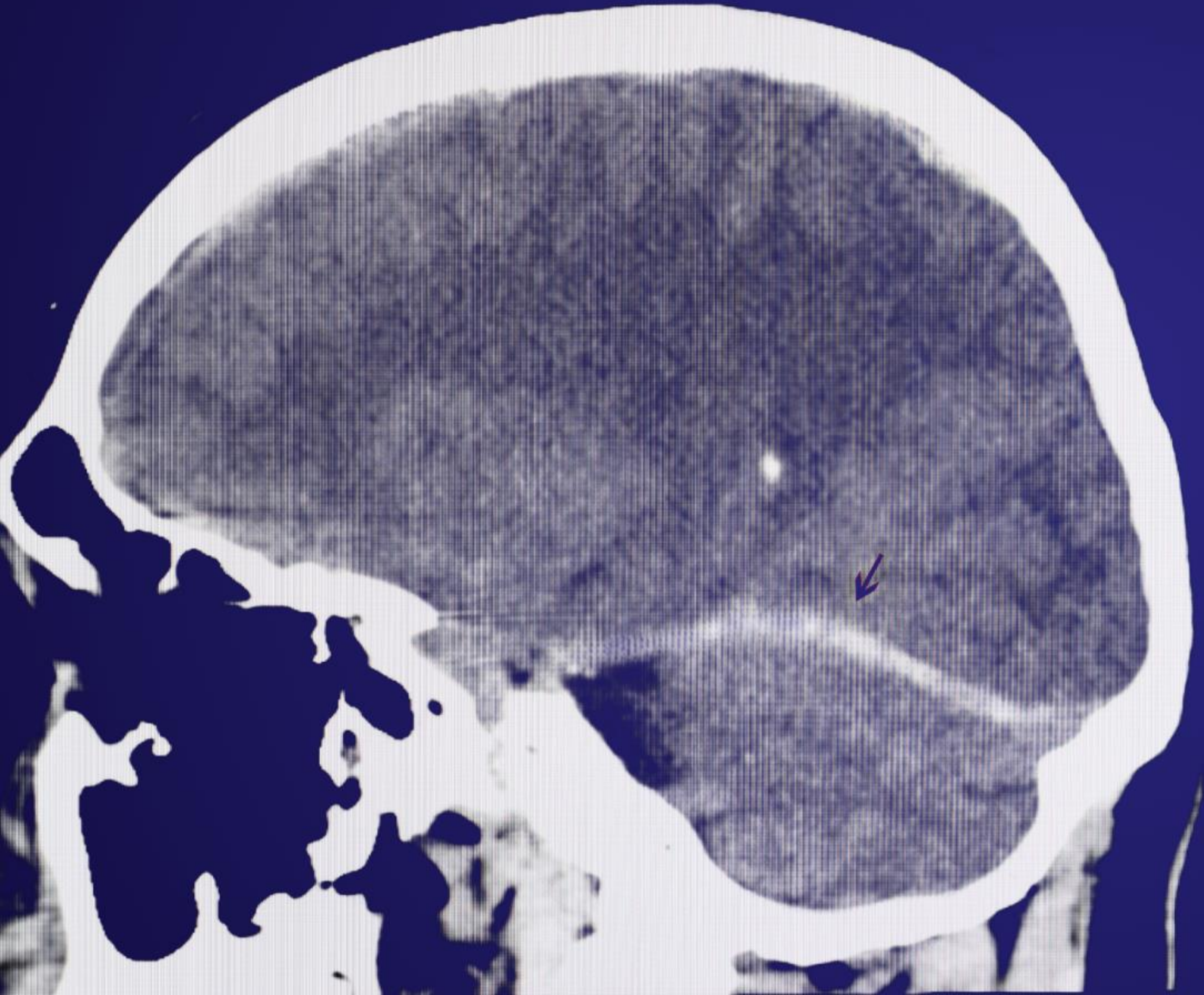
- Schedule mindfulness away from video/tactical sessions
- Integrate during heavy match weeks
- Use micro-sessions in late-game or high-pressure drills

Protects decision-making, preserves reaction time, and reduces injury risk.

KEY TAKEAWAYS

- Train the brain like you train the body
- Blend cognitive + physical
- Protect performance under mental fatigue
- Future research:
  - Neuroimaging
  - Protocol standardization
  - Broader sport application

Build a brain that won't break under pressure.



CLINICAL:
CONCUSSION

- DMN suppression disrupted
- Simple tasks cause overload
- Dual-task therapy strategy

Notes: Helps patients retrain attention networks.

CLINICAL:
STROKE

- Reduced FPN activation
- Low motivation, high perceived cost
- Reward-based graded rehab

Notes: Supports adherence and effort rebuilding.

TACTICAL & EXECUTIVE

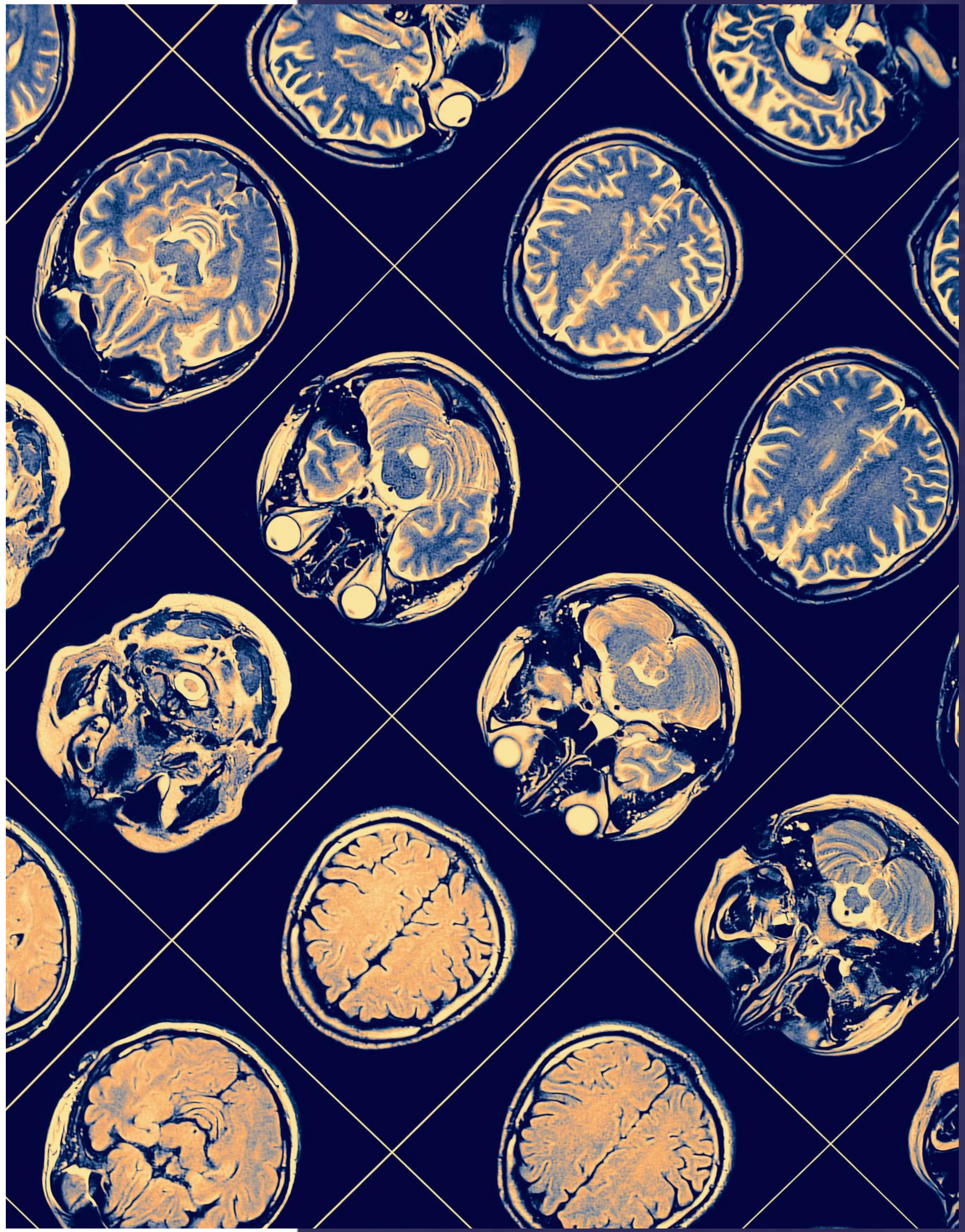
- High-pressure vigilance
- Decision-making under fatigue
- Dual-task approaches

Notes: These skills transfer across sport, military, and leadership.

NEUROIMAGING EVIDENCE

- DMN overactive
- FPN underactive
- SN switching failure

Notes: Supports using neuroimaging to track brain training benefits.



WRAP-UP:

WHAT CHANGES PERFORMANCE?

- Perception: Brain limits effort
- Physiology: Fick explains capacity
- Behavior: Recovery drives long-term success

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QUESTIONS & CONTACT

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Let's push the frontier of brain-first recovery.