Effects of Self-regulation on Executive Function & Resilience for Soldier Health, Wellbeing and Warfighter Performance

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European Football

- 2006: Italian National Team – World Cup Champions
- 2009: Chelsea FC – UEFA League Champion 2012
- 2010: Real Madrid FC – La Liga Champions 2011–12
Olympic Training Centres

- 2007: Speed Skating Canada – 6 Medals at 2010 Winter Olympic Games
- 2010: Vancouver Canucks Hockey – Stanley Cup Finalists 2011–12
- 2011: INSEP, Paris, France
- 2012: India – London Olympic Games
- 2012: US Military Special Operations
- 2012: Russian Sports Ministry – Sochi Olympics
- 2013: Olympiatopen, Oslo, Norway
- 2016: Guatemalan Olympic Training Centre
- 2016: India – Rio, Brazil Olympic Games
• Self-regulation – “the ability to monitor and manage one’s thinking, attention, feelings, and behavior to accomplish goals.” (Thompson, 2009)

• Executive functions – include mental processes that enable us to plan, focus attention, remember instructions, and juggle multiple tasks successfully under time pressure.
Self-Regulation Research

- Cardiac regulation - Winkleman et al. (2016)
- Physiological regulation - Thayer et al. (2010)
- Emotional regulation – Thayer et al. (2012)
- Sustained attention – Thayer et al. (2009)
- Selected attention – Hovland et al. (2012)
- Executive Function – Jennings et al. (2015)
Fig. 2 Correlation coefficients with heart rate variability for predefined regions of interest according to Desikan et al. (2006).  a Left hemisphere (LH), b right hemisphere (RH). All p < .05; p < .01 for caudal anterior cingulate cortex \(^1\) (RH), transverse temporal cortex (RH) and inferior temporal gyrus (LH), no correction for multiple comparisons. \(^1\)Corresponding to anterior midcingulate cortex (Palomero-Gallagher et al. 2009)
Executive function and self-regulation skills depend on three types of brain function:

1) Working Memory
2) Mental Flexibility
3) Self-Control
HRV PHYSIOLOGICAL BASICS
HRV – R to R Interbeat Interval

HRV: Time Domain

SDNN: Standard Deviation of all R-R (or N-N) intervals

RMSSD: Root mean square of successive R-R differences

pNN50: percentage of adjacent R-R intervals that differ by more than 50 milliseconds
HRV – Frequency Spectrum

HRV: Frequency Domain

Spectral analysis

Power ($ms^2$)

Low frequency (LF) peak

High frequency (HF) peak

LF/HF Ratio: ratio of sympathetic to parasympathetic activity

Fast Fourier Transformation

Sympathetic + Parasympathetic
0.04 to 0.15 Hz

Parasympathetic
0.15 to 0.4 Hz
HRV 5min Analysis

HRV Analysis

- EQ01 Equivital Life Monitor (Lifestrap)

- 2-lead ECG with 256 Hz sample rate

- Data recorded during 5 minute rest period
Physiology of Stress

Stress: ↑Cortisol and adrenaline for fight or flight ⇒ Heart rate spike ⇒ Poor decision making

**Parasympathetic Nervous System**
- Constricts pupil
- Increases salivation
- Decreases breathing rate
- Slows heart rate
- Widens blood vessels
- Increases digestive activity
- Contracts bladder muscles
- Stimulates defecation

**Sympathetic Nervous System**
- Dilates pupil
- Decreases salivation
- Increases breathing rate
- Increases heart rate
- Narrows blood vessels
- Slows digestive activity
- Relaxes bladder muscles
- Causes salt and water retention
- Stimulates secretion of epinephrine and norepinephrine

- Increases digestive activity
- Stimulates defecation
Decision Making & Performance Cycle

Physical Response
- Normal vital signs
- Normal hormone levels
- Effective stress response

Psychological Impact
- Focus & concentration
- Balance
- Energy

Physical Response
- Release of adrenaline, cortisol
- Increased HR, BP, RR
- Poor stress response

Psychological Impact
- Stress & fatigue
- Impaired judgement
- Anxiety/Emotions

HRV Modulation
- Deep Breathing (RSA)
- Emotional Regulation
- Relaxation

PERCEPTION
VISION
FOCUS
PARASYMPATHETIC
REST & DIGEST
SYMPATHETIC
FIGHT-OR-FLIGHT

NEGATIVE OUTCOME
HIGH QUALITY DECISION & ACTION
PROFESSIONAL SPORT APPLICATIONS & SIMULATION
Mindroom PSP

Mindroom Self-regulation 5-step Approach:

1) Assessment (HRV, RSA, PSP, Neurotracker Baseline)
2) Education - Circular diaphragmatic rhythmical breathing
3) Training - Breathing exercises – 4min; 8min; & 12min
4) Simulation - Integrated with athlete routines in simulator
5) Evaluation – Observe changes in physiology and actions
Interpreting Your HRV Score

Color Zones of Recovery

The number under your name on your report is your RMSSD (Root mean squared standard deviation of your R to R Intervals). This index is on a scale that represents your HRV. Unlike resting-pulse, a higher HRV number is better than a lower one.

The charts below will aid you in interpreting your RMSSD score, and understanding how it can guide your work or training.

<table>
<thead>
<tr>
<th>RMSSD</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>RMSSD ≥ 80</td>
<td><strong>Blue Zone Normal Training</strong> - Suggests that you are sufficiently recovered and healthy.</td>
</tr>
<tr>
<td>RMSSD 50-79</td>
<td><strong>Green Zone Normal Training</strong> – Monitor your health &amp; lifestyle behaviors.</td>
</tr>
<tr>
<td>RMSSD 30-49</td>
<td><strong>Yellow Zone Lighter Training</strong> - Suggests that you need to consider rest &amp; recovery strategies.</td>
</tr>
<tr>
<td>RMSSD ≤ 29</td>
<td><strong>Red Zone Rest Day</strong>- Demonstrates that you need to take a time out from work or training.</td>
</tr>
</tbody>
</table>
Mindroom PSP

Attentional Focus
Dual Task - Tactical Awareness
Executive Summary

Mindroom Performance Results

<table>
<thead>
<tr>
<th>Metric</th>
<th>Change</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate Variability</td>
<td>Increase</td>
<td>93%</td>
</tr>
<tr>
<td>Stress Profile</td>
<td>Increase</td>
<td>53.5%</td>
</tr>
<tr>
<td>Selective Attention</td>
<td>Increase</td>
<td>83.6%</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>Increase</td>
<td>10.8%</td>
</tr>
<tr>
<td>Decision-making</td>
<td>Increase</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Top Multidimensional Performance Factors

- Sport Specific Skills
- Physical (Power, Strength, Endurance)
- Technical Motor Skills
- Tactical Skills for Competition
- Psychological Skills for Competition - Confidence
- Functional Readiness State (Biomarkers)
- Emotional Regulation (CNS & ANS)
- Attentional Focus (e.g., Selective)
Mindroom PSP - Athlete Readiness Index

- Biographical Data
- Neuro-Cognitive Function
- Cardiac Function (HRV)
- Neuromuscular Function
- Metabolic Function
- Allostatic Training Load
- Sleep Quality & Quantity
- Overall Functional State
MILITARY APPLICATIONS AND SIMULATION

Mindroom PSP & Cognisens Joint Offering
Mindroom PSP - The Performance Loop

**Vision**
Absorbing a complex scene.

**Perception**
Updating mental picture. Anticipating what’s next.

**Cognition**
Evaluating options. Making decisions.

**Execute**
Complete the Action
Step 1: Self-Regulation Tr.
Step 2: MOT- Neurotracker
Mindroom PSP - Cognisens

Threat Recognition

Athlete calls out decision

Step 3: Dual Task Identification
Cognisens - Threat – No Threat

Step 4: Video Decision Training
Close Quarters Simulation Combat

Step 5: Simulation Training
Mindroom PSP

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