High Intensity Training
How can we apply it to swimming?

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Aerobic Based Training Adaptations

Performance

Mitochondrial Changes

Endocrine Changes

Circulatory Adaptations

VO₂ Max

Enhanced Pathology
Evidence Based Aerobic Training

• Astrand
  – Textbook of Work Physiology

• NSCA
  – Essentials

• Holloszy 1967
  – Changes in mitochondrial enzymes

• Spina 1996
  – Short term aerobic adaptations
Short Term Aerobic Adaptations

• Spina et al
  – Endurance training
    • 2h/day at 60-70% of VO₂ peak
  – Support for quick adaptation
  – Mitochondrial enzymes increase in as few as 7-10d
  – Original support for 4-6w of training

Why Evidence Based HIT

• My background
• Desire for proof
  – Knowledge beyond what is cool .....  
  – Incorporate more than the latest fad
• Be Professional – Be Prepared
What is HIT

• Glorified Interval Training?
  – No!

• Differences
  – Interval purpose
  – Interval = various threshold & duration
  – HIT = 100% max intensity
  – Therefore HIT limited to ~ 20s activity
Evidence from Tabata

• Where it primarily started
  – Highly-trained endurance athletes
  – 7-8 exercise bouts
    • cycle ergometer
  – 20-s @ ~ 170% of VO$_2$max with a 10-s rest
    • < 3 min total work
  – HIT → Increased VO$_2$max
Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and VO_{2max}. TABATA, IZUMI; NISHIMURA, KOUJI; KOUZAKI, MOTOKI; HIRAI, YUUSUKE; OGITA, FUTOSHI; MIYACHI, MOTOHIKO; YAMAMOTO, KAORU Medicine & Science in Sports & Exercise. 28(10):1327-1330, October 1996.
Tabata Protocol

- 4 min long
- 20s of max training
- 10s of rest
- Total of 8 sessions or rounds

- Specific movements for specific results

- Risk of Injury
  - Mechanical considerations
Evidence from Gibala’s Lab

• Martin Gibala’s Lab
  – The current push

• Wingate HIT protocol established
  – 30s x 4 - 6 repeats @ 4 min rest
  – Total exercise time ~ 2 - 3 min

• Burgomaster
  – 6 Sessions study
  – Mitochondrial & Performance
Carl et al 2010

- VO$_2$ Peak enhanced
  - College age M F
  - 2 weeks
  - 4 X Wingate
  - 9 % Increase

VO$_2$ Peak Changes
HIT Support Continues

- Support for shorter duration
  - 30s Wingate to 10s
- Support for high intensity driven changes
- Increased risk of Injury?
Talanian et al 2007

• Evidence for Endocrine changes with HIT
  – College aged Women
  – 7 Training days (short duration)
  – 4 min bouts w 2 min rest (more aerobic)
  – 60 min cycling trial @ 60% VO₂ Peak

• Multiple measures of support
  – VO₂, Enhanced fat oxidation, Reduced HR & BLA
Broomall & Carl 2012

• Enhanced Pathology
• Limited!
  – Case study
  – Short bouts of moderate movement
  – Potential control of BG levels

"Your blood sugar is high, but your salt, pepper, ketchup, mustard and grated cheese levels are fine."
2Hr Postprandial Blood Glucose

Day

Pre-Exercise Intervention
Post-Exercise Intervention

Enhanced Pathology
Gillen et al 2012

• Gibala lab
• 1 Session HIT
  – 10 x 60s @ 60s rest
  – 24Hr CGM
  – Own control

Enhanced Pathology
Where do we go from here?

• How does this apply to swimming?
Implications for Swimming

• First: This is not new nor earth shattering

• Seek out a better understanding
  – Better understanding
    → special cases
Implications for Swimming

• How many have seen this?
• Phase I of typical season
  – Base aerobic yardage (6 – 8 weeks)
• Phase II
  – Followed by high volume, specific aerobic training (8 – 12 weeks)
Implications for Swimming

• Phase III
  – Greater emphasis on sprinting and anaerobic work (4 – 6 weeks)

• Phase IV
  – A reduction in volume and intensity known as the taper (2 - 4 weeks)
Concerns with Training

• Phase I
  – Often times swimmers perform decent times in the latter part of phase I and early part of phase II

• Phase II
  – Performances fall off during the specific, high volume aerobic work of phase II
Concerns with Training

- Phase III & IV
  - Majority of swimmers recover enough to perform well again during the end of phase III and specifically during the taper period

- Is this the necessary evil that all great swimmers must go through?
Concern of Overtraining

• In effort to overcome the mid season performance slump swimmers may push the boundaries of training

• The overtrained athlete fails to adapt and concludes the season with sub par performances
Implications for Swimming

• We do know it works…
  – But do we really know how and why?
• Evidence Based
• If we know how & why, then we can figure out how to best control & manipulate intervening variables such as overtraining
Implications for Swimming

• With this methodology of training there is an inherent failure to adapt the anaerobic capacity and thus swimming speed when the aerobic side is overloaded.

• The converse of this is true in that too much work on the anaerobic capacity side may result in a decline in aerobic conditioning.
Implications for Swimming

• What about those select few?
  – The few that are simply off the chart
  – The ones that come out of nowhere and are simply awesome

• How do we know they simply didn’t grow?
Implications for Swimming

• The trend over the past decade has seen many of our leading coaches moving away from a total base, high volume program to one that includes a periodization with more specific anaerobic work scheduled throughout the season
HS Swimming

• # 1 Shorter season
• Ohio HS
  – 16 W season max
    • *Club swimming
  – Rest for majority follows 12 weeks
• Theory: Need to implement speed work more quickly
HS Swimming

• # 2 Shorter events
• Dual meet swims / entry
  – 50 = 9 swims
  – 100 = 8 swims
  – 200 = 2 swims
  – 500 = 1 swim
• Fact: Anaerobic contributions should not be overlooked
## HS Swimming

<table>
<thead>
<tr>
<th>Distance</th>
<th>ATP – PC</th>
<th>Anaerobic Glycolysis</th>
<th>Aerobic Glycolysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Free / 9 swims</td>
<td>65%</td>
<td>30%</td>
<td>5%</td>
</tr>
<tr>
<td>100 Free / 8 swims</td>
<td>20%</td>
<td>55%</td>
<td>25%</td>
</tr>
<tr>
<td>200 Free / 2 swims</td>
<td>10%</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>500 Free / 1 swim</td>
<td>5%</td>
<td>25%</td>
<td>70%</td>
</tr>
</tbody>
</table>
HS Swimming Cont.

• # 3 Shorter meet format
  – Ohio majority
    • 1 day meet
    • 4 events max
    • Most have 2 events

• Belief: More rationale for more intensity
Taper

- **Mujika 1996**

- 21 – 40% Dec in both volume & intensity
- 3 – 4 week duration
- Gradual vs abrupt
Taper Cont.

• Trinity 2008

• Increasing intensity $\rightarrow$ Inc performance
  – Increased power (8-14%), velocity & torque

• Decreasing intensity $\rightarrow$ Dec performance
Fig. 2 Maximal power during taper. LIT = low-intensity taper, HIT = high-intensity taper. Closed circles (● - LIT) and open circles (○ - HIT). * Indicates significant difference from week 3 - LIT (p = 0.007). † Indicates significant difference from CONF - HIT (p = 0.002). ‡ Indicates significant difference from week 2 - HIT (p = 0.03). # Indicates significant differences between LIT vs. HIT at a given week of the taper (p < 0.05).
Taper

• Maintaining intensity?

• Papoti (2007)

• Volume-only taper
  - 48% reduction in volume over an 11 d
  - No change in intensity.
  - Improved race times by 1.6%
  - Improved force output by 3.6%.
Implications for HS Swimming

• If maximizing your taper requires maintaining or increasing your training intensity.....

• Then wouldn’t it make sense to make sure you spend enough time increasing your anaerobic capacity

• Therefore, more support for HIT training in HS
Additional Taper Thoughts

- HIT is critical in maintaining taper power
- Anecdotal evidence
- Bi modal taper
  - Aerobic based
  - Shorter rest (2 weeks)
  - Anaerobic
  - Longer (3-4 weeks)
Implications for injury

• Possible to reduce the repetition load and still get some physiological adaptations

• Personal case study
  – No formal measurements
  – Gut instinct coupled with his decision making
  – No clinical interpretations
Injury

• Male 18 yo HS
• USA-S Sectional cut
• Previous base
  – 6K
  – 9 sessions / week
• Non-Typical impingement
  – Bicipital tendinitis
  – Surgery post season
• Approx 4K & 5/W
• Rest → dec intensity not necessarily yardage
• LTB 100 Fly = 53.3
• HS Season
  – 53.9 / 55.1* / 53.4
• Week 4 matched relay LTB 100 Free
Staleness

• *If I were a fish I could swim and swim all day, but I’m a little person so I like to swim and play*

unknown
Staleness

• Overtraining
• Studies → adherence
  – Elderly & diseased populations
  – Swimming?
• If no detriments then why not?
  – Correctly implemented
Anaerobic Capacity

- Rushton, C.; www.swimformation.com
- Bowman Training for Capacity versus Utilization - Bob Bowman; www.usaswimming.org
Where do we go from here?

- More research → more evidence base
- Continue to share and divulge
- Don’t be afraid to be fast!