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Strategies for Velocity Based Training in Professional Baseball

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Conflict of Interest Statement

I have no actual or potential conflict of interest in relation to this presentation.

VBT Outline...

- Intro...
- What is Velocity Based Training (VBT)?
- Strength & Conditioning in MLB
- Current VBT Research
- Team / Individual Programming
- Challenges / Things to Consider...
- What's next?

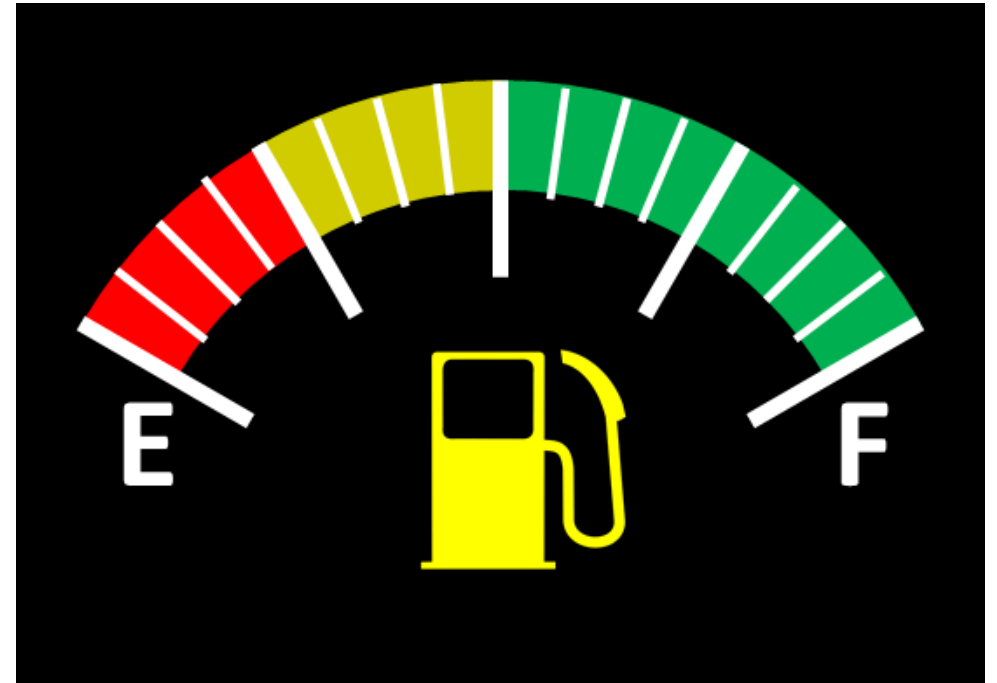


“VBT is the use of velocity to dictate the load of the barbell.”

-Dr. Bryan Mann (2017)

VBT is using velocity to...

- Determine the appropriate load to train at each day (Autoregulation).
- Track training adaptations over time.



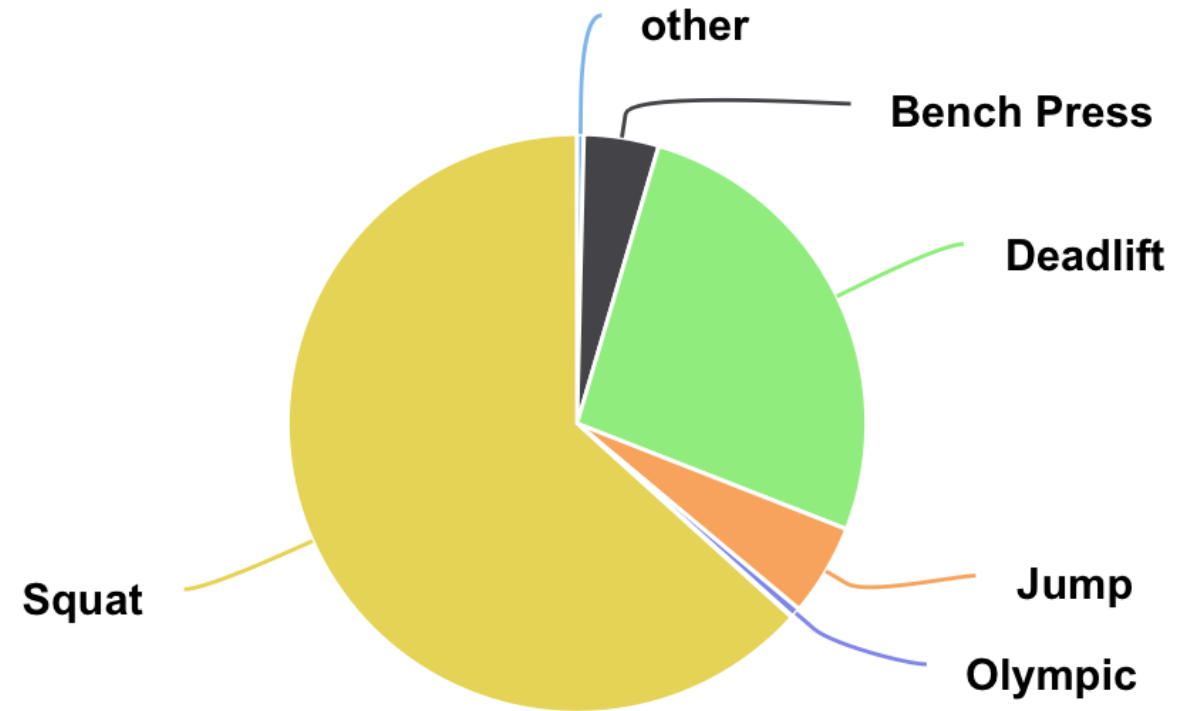
Squat, Deadlift, Bench Press, & Explosives...



2018 Usage (By Exercise)

- **6876 Sets across 27 Exercises...**

- 63% Squat Variations
- 26% Deadlift Variations
- 6% Explosive Movements
- 4% Bench Press (BB)
- 1% Other



VBT Technology...



- **Gym Aware:**

- Linear Position Transducer
- Factors In Angle of Pull

- **Other Options:**

- Tendo, Push, Bar Sensei, Beast, Form, Open Barbell, Keiser, etc...

What VBT looks like...



iPad (feedback)



GymAware (LPD)

MLB Organizations...

- 200 Players, Ages 16-40⁺
- MLB Calendar (162⁺ Games):
 - Pre / In-Season: *Feb - Sept (Oct)*
 - Off-Season: *Oct - Jan*
- MiLB Calendar (140⁺ Games):
 - Pre / In-Season: *Mar - Aug (Sept)*
 - Off-Season: *Sept – Feb*
 - Instructional League / Winterball



Photo: Kelly Gavin (2018)

Our Players...

- Varied Backgrounds...
- From USA, Latin America, & Pacific Rim
- Extensive Travel
- Off-Season Homes
- Private S&C Coaches

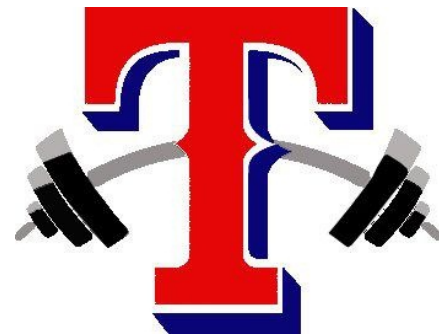


Photo: Kelly Gavin (2018)

Mixed Programming Methods

- **Off-Season:** Linear Periodization – 6 x 3-4 Week Load / Volume Cycles
- **In-Season:** Flexible / Non-Linear... Reduced Volume in 2nd Half
- *“Every workout is a test, every test is a workout.”* -Vern Gambetta
- Assign load based on previous workouts, recovery, other factors...
- **VBT is an alternative to using percentages...**

*Strength is the Foundation from
which All Other Physical Qualities of
Performance are Developed.*



VBT = Training For Power

- Workouts Become Focused on Explosive Strength
- Intent is Everything!!!
- Technique is our job...



Velocity as a Measure of Loading Intensity

(González-Badillo & Sánchez-Medina, 2010)

- 6 Week Training Study – Bench Press
- Velocity (m/s) and %1RM share a very close relationship.
- Load-velocity relationship remained intact despite 9.3% strength gains

- Authors suggested:

1. We can evaluate maximal strength without RM testing,
2. Determine the %1RM that is being used as soon as the first repetition with any given load,
3. Prescribe and monitor training load according to velocity.

Velocity as a Measure of Effort / RIR

(Morán-Navarro et al., 2017)

- Velocities associated with RIR were very similar...
- Regardless of load (50-85% 1RM)...
- Or experience level (novice, well-trained, or highly trained).

Table 4. 95% Confidence intervals for the stopping velocities associated to leaving a certain number of repetitions in reserve for each of the four resistance training exercises analyzed.

Repetitions in reserve	Bench Press	Full Squat	Prone Bench Pull	Shoulder Press
2	0.26 - 0.28	0.40 - 0.43	0.50 - 0.53	0.32 - 0.34
4	0.35 - 0.37	0.45 - 0.47	0.56 - 0.58	0.41 - 0.43
6	0.41 - 0.44	0.48 - 0.50	0.62 - 0.64	0.50 - 0.52
8	0.46 - 0.49	0.50 - 0.52	0.67 - 0.69	0.56 - 0.59

Velocities (m·s⁻¹) correspond to the mean velocity of the propulsive phase of each repetition.

Building a Load-Velocity Profile

(Senn, 2016)

- Mapping velocities with %1RM can provide meaning to adjust training loads.

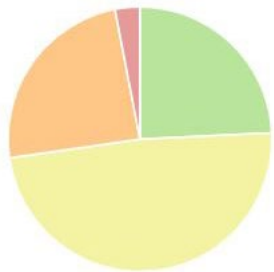
RIR	RPE	Reps												RE
		1	2	3	4	5	6	7	8	9	10	11	12	
3+	7	90%	87%	84%	81%	78%	77%	75%	74%	72%	71%	69%	68%	Moderate
		.37 m/s	.40 m/s	.43 m/s	.46 m/s	.49 m/s	.50 m/s	.52 m/s	.52 m/s	.54 m/s	.55 m/s	.57 m/s	.58 m/s	
3+	7.5	92%	89%	86%	83%	80%	78%	76%	75%	73%	72%	70%	69%	Moderate
		.36 m/s	.38 m/s	.41 m/s	.44 m/s	.47 m/s	.49 m/s	.51 m/s	.52 m/s	.53 m/s	.54 m/s	.56 m/s	.57 m/s	
2	8	94%	90%	87%	84%	81%	78%	77%	75%	74%	72%	71%	69%	Challenging
		.34 m/s	.37 m/s	.40 m/s	.43 m/s	.46 m/s	.49 m/s	.50 m/s	.52 m/s	.52 m/s	.54 m/s	.55 m/s	.57 m/s	
2	8.5	95%	92%	89%	86%	83%	80%	78%	76%	75%	73%	72%	70%	Challenging
		.33 m/s	.36 m/s	.38 m/s	.41 m/s	.44 m/s	.47 m/s	.49 m/s	.51 m/s	.52 m/s	.53 m/s	.54 m/s	.56 m/s	
1	9	97%	94%	90%	87%	84%	81%	78%	77%	75%	74%	72%	71%	Hard
		.31 m/s	.34 m/s	.37 m/s	.40 m/s	.43 m/s	.46 m/s	.49 m/s	.50 m/s	.52 m/s	.52 m/s	.54 m/s	.55 m/s	
1	9.5	98%	95%	92%	89%	86%	83%	80%	78%	76%	75%	73%	72%	Hard
		.30 m/s	.33 m/s	.36 m/s	.38 m/s	.41 m/s	.44 m/s	.47 m/s	.49 m/s	.51 m/s	.52 m/s	.53 m/s	.54 m/s	
0	10	100%	97%	94%	90%	87%	84%	81%	78%	77%	75%	74%	72%	Pushing Limit
		.28 m/s	.31 m/s	.34 m/s	.37 m/s	.40 m/s	.43 m/s	.46 m/s	.49 m/s	.50 m/s	.52 m/s	.52 m/s	.54 m/s	

- AMRAP Testing Zone -

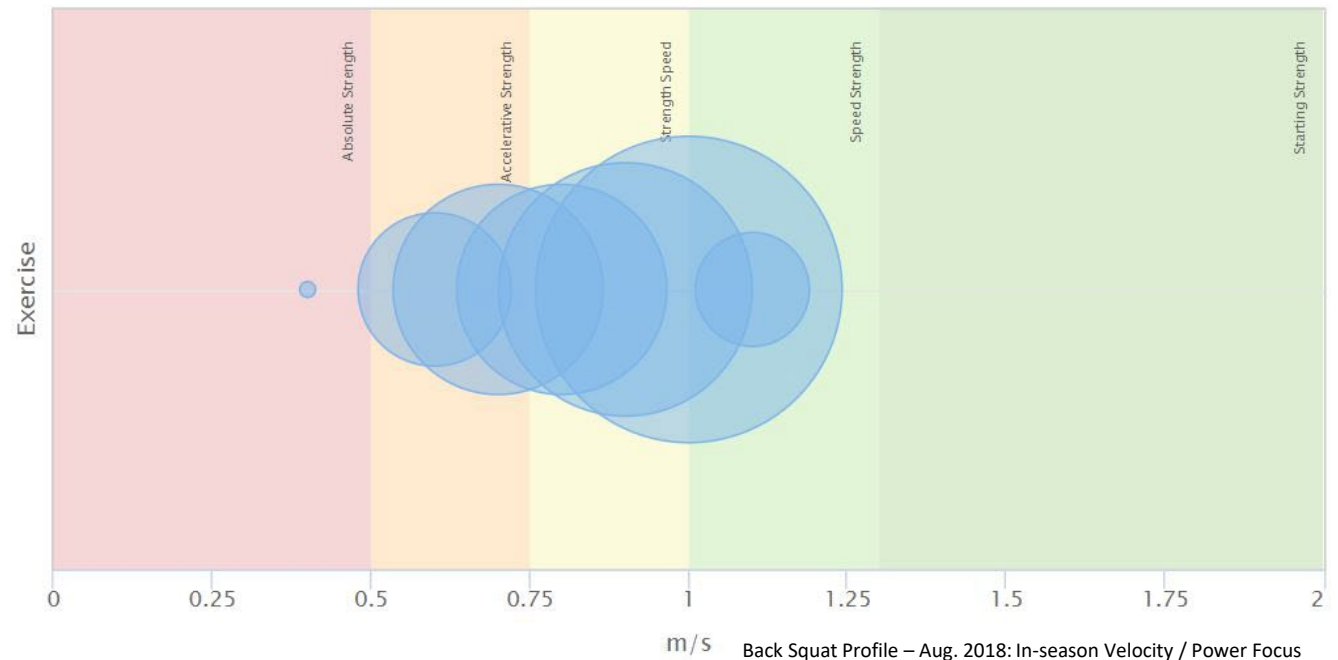
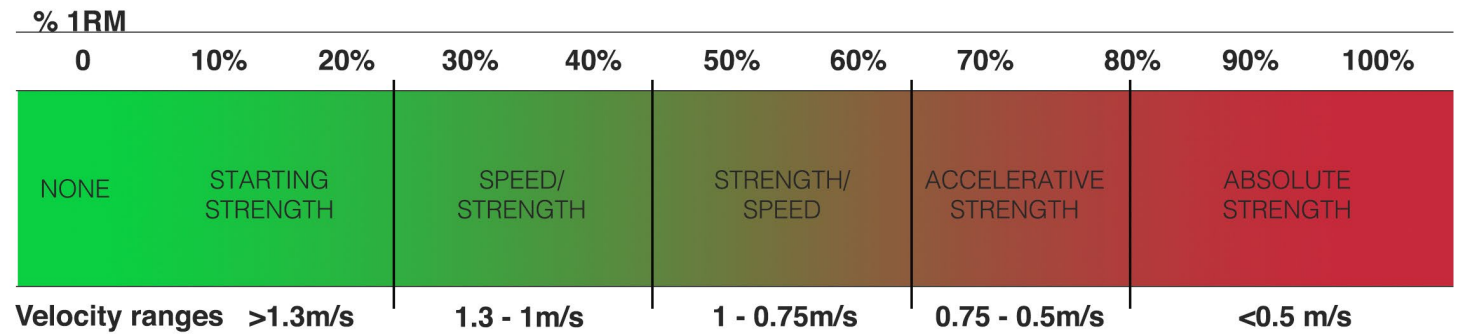
Velocity Zones

(Mann, 2016)

- Simplifies use for team environments
- Allow us to target specific strength qualities:



- Speed Strength
- Strength Speed
- Accelerative Strength
- Absolute Strength




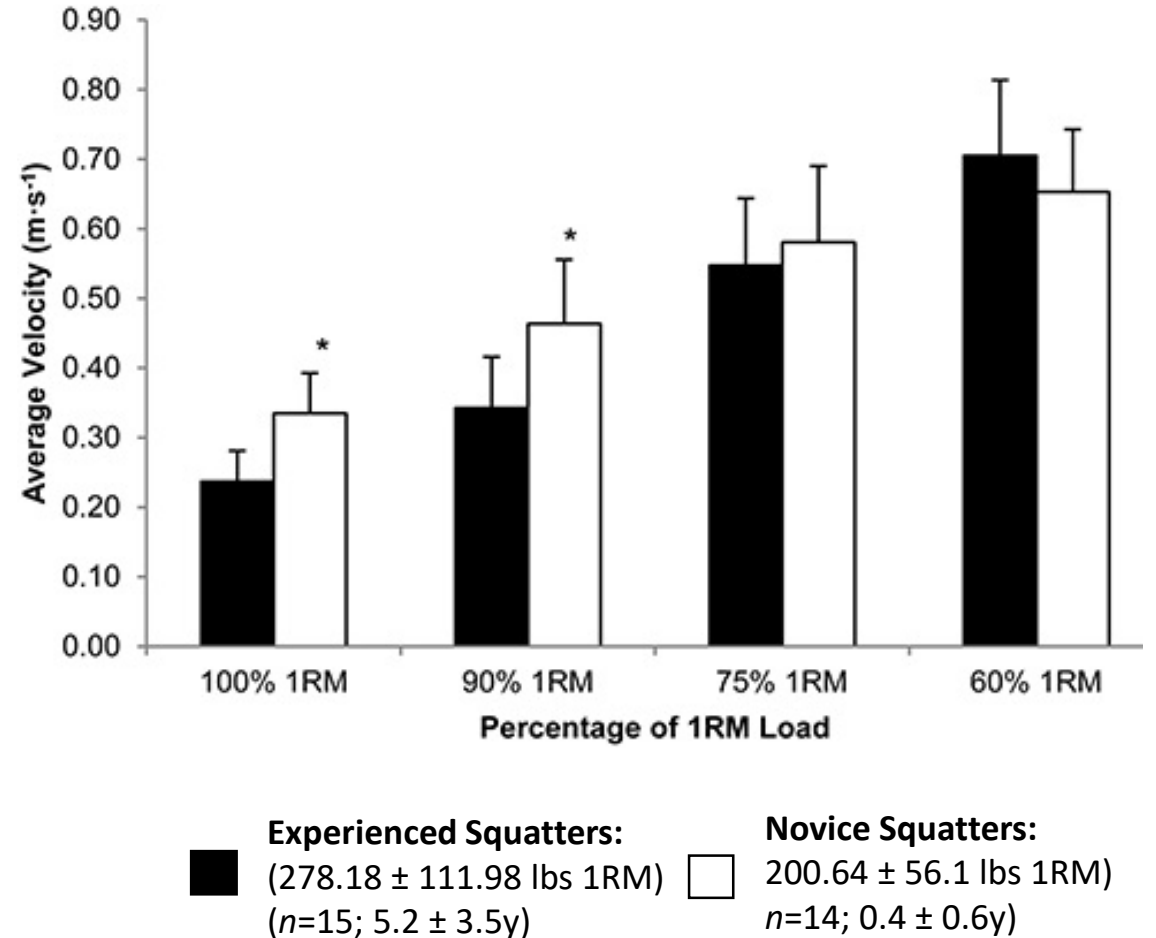
Velocity Zones

(Mann, 2016)

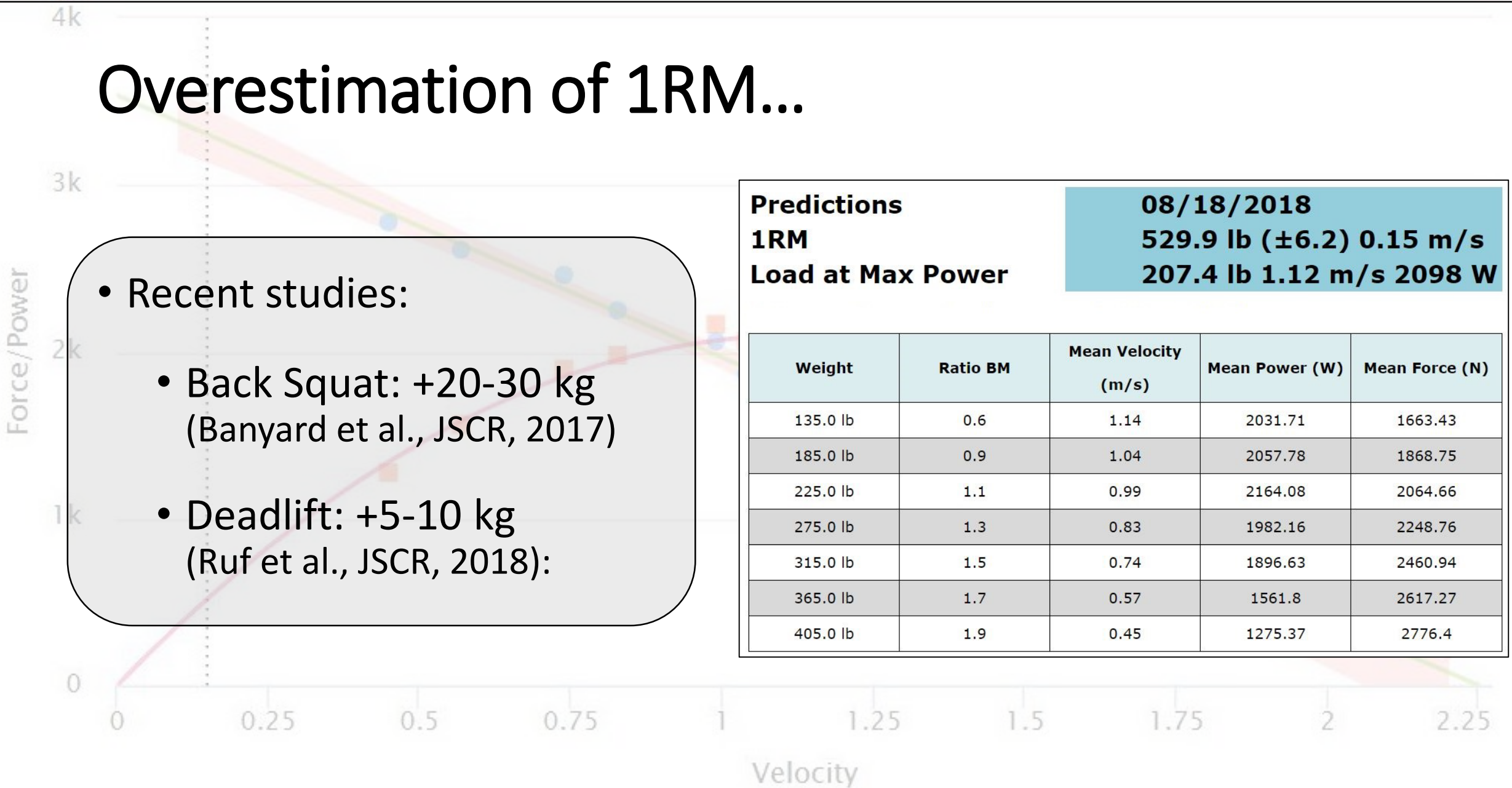
V-Zone	Description	%1RM	Speed (m/s)	Focus	Key Movements
Absolute Strength	Near-Maximal Load / Low Speed	80-100%	< 0.5	Improve Strength (Force Production)	Squat, Deadlift, Bench Press
Accelerative Strength	Acceleration of Moderate-Heavy Load	60-80%	0.75-0.5		
Strength-Speed	Moderate Weight / High Speeds	40-60%	1.0-0.75	Improve Peak Power (RFD / SSC)	Add... Trap Bar / Loaded Jumps, Accommodating Resistance (i.e. Bands, Chains, AEL)
Speed-Strength	Light Weights at Near-Maximal Speeds	20-40%	1.3-1.0		
Starting Strength	Body Weight at Maximal Speed	0-20%	> 1.3	Speed / Quickness	Sprints, Agility, BW Plyometrics

Training Age / Experience Level...

- Helms et al, JSCR (2017):
($n=15$, Competitive Powerlifters)
 - 1RM Back Squat: 0.23 ± 0.05 m/s
 - 1RM Bench Press: 0.10 ± 0.04 m/s
 - 1RM Deadlift: 0.14 ± 0.05 m/s
- Zourdos et al., JSCR (2016):
 - Velocity Differences Between:
 - Experienced Squatters
 - Novice Squatters 

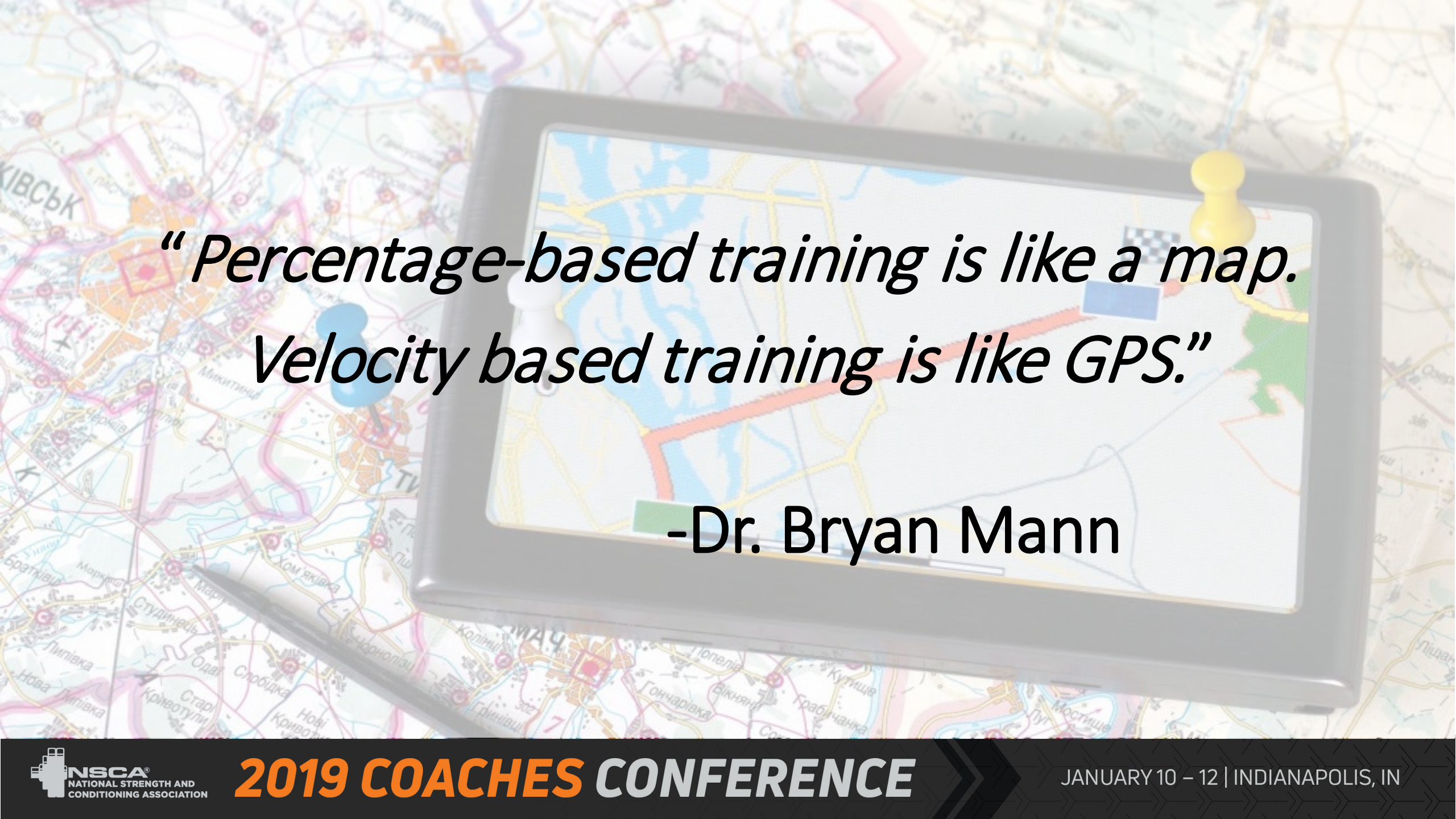


Overestimation of 1RM...



- Recent studies:
 - Back Squat: +20-30 kg (Banyard et al., JSCR, 2017)
 - Deadlift: +5-10 kg (Ruf et al., JSCR, 2018):

Predictions		08/18/2018		
1RM		529.9 lb (±6.2) 0.15 m/s		
Load at Max Power		207.4 lb 1.12 m/s 2098 W		
Weight	Ratio BM	Mean Velocity (m/s)	Mean Power (W)	Mean Force (N)
135.0 lb	0.6	1.14	2031.71	1663.43
185.0 lb	0.9	1.04	2057.78	1868.75
225.0 lb	1.1	0.99	2164.08	2064.66
275.0 lb	1.3	0.83	1982.16	2248.76
315.0 lb	1.5	0.74	1896.63	2460.94
365.0 lb	1.7	0.57	1561.8	2617.27
405.0 lb	1.9	0.45	1275.37	2776.4



*“Percentage-based training is like a map.
Velocity based training is like GPS.”*

-Dr. Bryan Mann

Measures of Velocity...

- Main Variables:
 - Mean Velocity (m/s)
 - Peak Velocity (m/s)
 - Peak Power (W)
- Consider:
 1. Movement
 2. Training goal

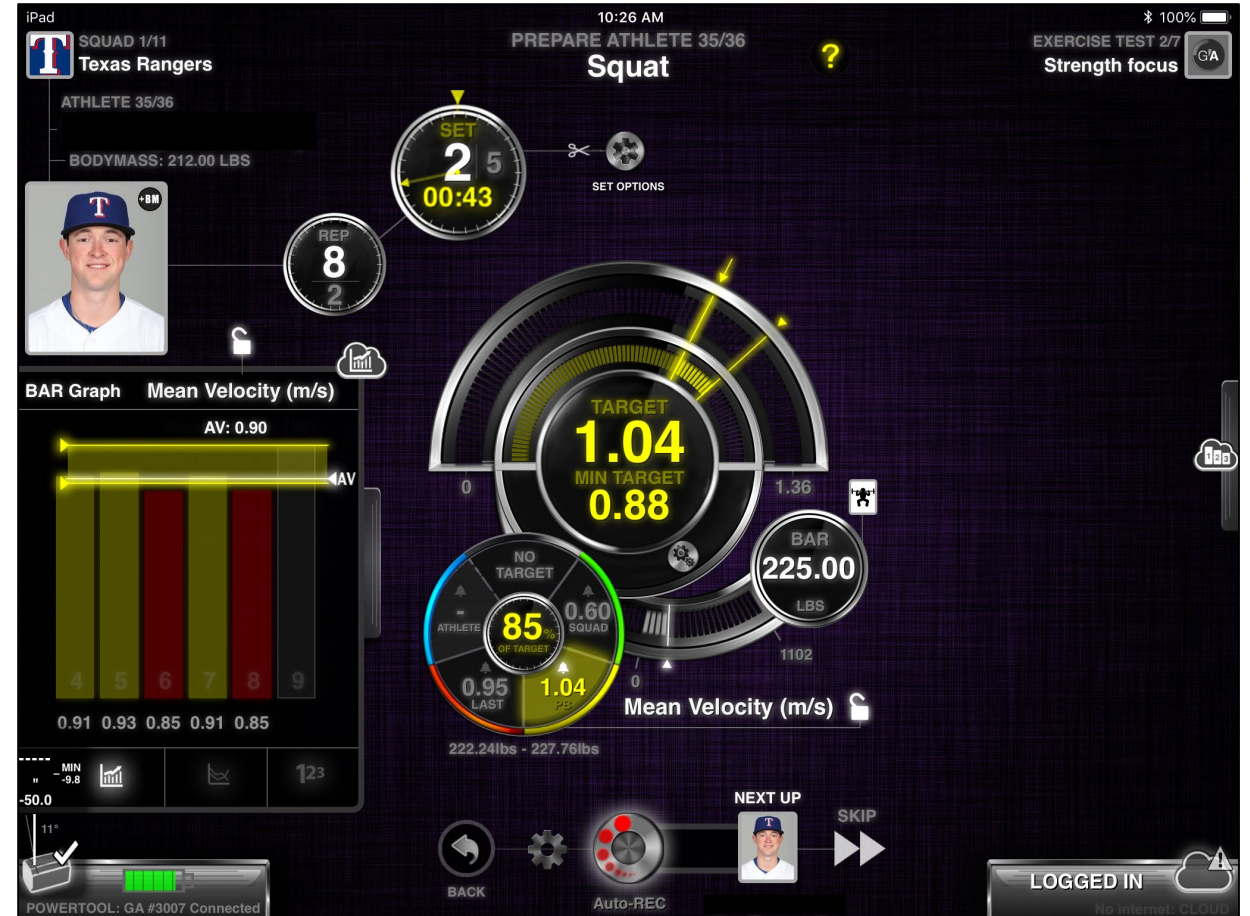


Mean vs. Peak Velocity

Use w/ Mean Velocity	Use w/ Peak Velocity
Back Squat, Squats w/ Bands	Loaded Jump Squat, Trap Bar Jumps, BW Jumps
Deadlift (Trap Bar / BB)	Olympic Variations – e.g. Clean Pull, Hang Clean
Bench Press	Keiser Rotational Press (% Peak Power), Keiser Push-Pull (% Peak Power)

Don't Let VBT Overcomplicate Things...

- Focus on Single a Number
- Coach the Player (Not the iPad)
- Give Immediate Feedback!

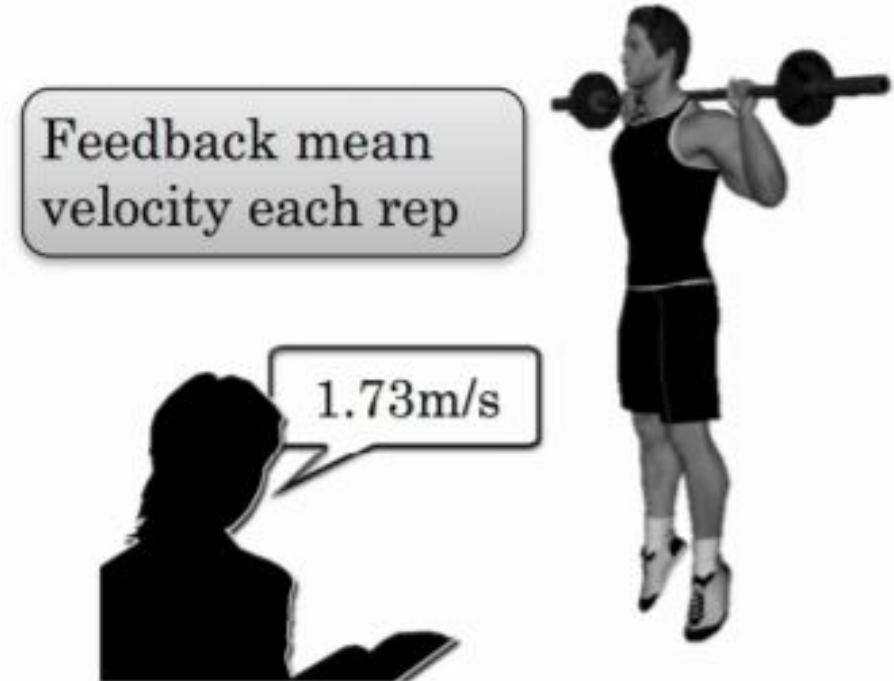


VBT Feedback Improves Performance

(Keller et al., 2014; Nagata et al., JSCR, 2018; Randell et al., JSCR, 2011)

- Immediate velocity feedback improves sprinting and jumping ability.
- It seems, higher frequency velocity feedback, leads to greater benefits in athletic performance.

Immediate Feedback (ImFB)



(Nagata et al., JSCR, 2018)



Velocity Focus By Month

In-Season Phases

- April: *Strength* De-Load
- May: *Power*
- June: *Speed* De-Load
- July: *Low Vol. Strength*
- Aug: *Low Vol. Power*
- Sept: *Speed* De-Load
- Oct (MLB): Recovery

Off-Season / Spring Training

- Oct (MiLB): *Hypertrophy* - *Speed*
- Nov: *Hypertrophy* - *Speed*
- Dec: *Strength* De-Load
- Jan: *Strength* - *Power* De-Load
- February: *Power* De-Load
- March: *Speed*

Off-Season vs. In-Season

Similar Concept with Adjusted Volume – e.g. Back Squat, Deadlift, & Bench Press

PHASE	IN-SEASON VOLUME	OFF-SEASON VOLUME	VELOCITY (m/s)
Strength	5 x 2 <i>Cluster Sets</i>	5 x 4-5 <i>Straight Sets</i>	0.5-0.7
Power	3 x 3-4 <i>Straight Sets</i>	6-8 x 3 <i>Complex / Contrast Pairs</i>	0.7-0.9
Speed	2-3 x 5 <i>Adjusted ROM / Dynamic Resistance*</i>	4 x 5 <i>Early Off-Season (Teach Intent) (MLB)</i>	> 0.9
Hypertrophy	3 x 6-8 <i>Based on Individual Need</i>	4 x 8-12 <i>Early Off-Season (MiLB)</i>	0.6 – 0.9

* e.g. Box Squats w/ Bands, Deadlift from Blocks

Catchers (Power Endurance)

- Remain powerful through the lower body late into games, with continued emphasis on mobility and quickness...
- **VBT Goal:** Sustain velocity through each set – **15% Velocity Loss**


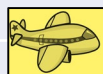

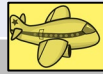





In-Season Strength-Power	Trap Bar Deadlift 3 x 4-6 @ 0.7-0.9 m/s
In-Season Speed (Metabolic Circuit)	Box Squat w/ Bands 3-4 x 5 @ > 0.9 m/s



Photo: Kelly Gavin (2018)

Catchers (Case Study)

- VBT helps us adjust workouts to in-game workload...

	Post-ASB – Wk. 1	Post-ASB – Wk. 2
SUN*	Catcher	3 rd Base 
MON	VBT: Strength *Pinch Ran*	VBT: Speed 
TUE	Catcher	VBT: Strength 
WED	-	Team Off Day 
THU	VBT: Power *Pinch Ran* 	Catcher VBT: Power 
FRI	3 rd Base 	VBT: Speed 
SAT	Catcher	Catcher 

 = Sprints / Agility Session – *Sunday: Day Games



Photo: Kelly Gavin (2018)

Corners (1B, 3B, LF, RF – Peak Power)

- Develop peak power potential while maintaining overall athleticism for their positions....
- **VBT Goal:** Improve speed without sacrificing strength – **20% Velocity Loss**

In-Season Strength	Squat & Deadlift 5 x 2 @ 0.5-0.7 m/s
In-Season Power	Squat & Deadlift 4 x 3-4 @ 0.7-0.9 m/s



Photo: Kelly Gavin (2018)

Corners (Case Study)

- VBT helps us quantify progress...
- Profile:
 - Power Hitter
 - Below Avg. Runner / OF Defense
 - Training to ↑ Speed / Quickness
 - Improving Diet to Lose Weight
- DEXA (Dec 2017 → Dec 2018):
 - +5 lbs LBM
 - -2 % Body Fat

Month	Weight	Back Squat	Bench Press
Dec	208 lbs ↓6%	5 x 225 lbs 0.71-0.76 m/s (3721 W) ↑21%	6 x 175 lbs 0.51-0.67 m/s (924 W) ↑30%
Nov	212 lbs ↓5%	5 x 185 lbs 0.74-0.87 m/s (3406 W) ↑11%	6 x 175 lbs 0.46-0.57 m/s (795 W) ↑12%
Oct	214 lbs ↓4%	5 x 225 lbs 0.7-0.74 m/s (3386 W) ↑10%	6 x 175 lbs 0.37-0.54 m/s (709 W) ***
Sept	215 lbs ↓3%	3 x 225 lbs 0.63-0.69 m/s (3342 W) ↑9%	-
Aug	218 lbs ↓2%	5 x 225 lbs 0.58-0.68 m/s (3104 W) ↑1%	-
July	222 lbs ***	5 x 225 lbs 0.61-0.69 m/s (3073 W) ***	-

Speed (CF, SS, 2B – Force Production)

- Develop strength / durability for the high wear-and-tear positions

• **Undersized / Strength-Deficient:** Build Foundational Strength / Hypertrophy

-or-

• **Developed Athlete / Ideal Weight:** Maintain optimal build for speed



Photo: Kelly Gavin (2018)

Speed (Case Study – CF Comparison)

Ideal Weight (example):

- **Age:** 26
- **HT:** 5'9 | **WT:** 185 lbs (6.6% BF)
- **1RM Back Squat:** 465 lbs
- **Elite Speed** (Plus Baserunner)
- **Goal:** Maintain Strength / Speed
- **VBT:** Selective Hypertrophy

10% Velocity Loss

Undersized (example):

- **Age:** 22
- **HT:** 6'2 | **WT:** 170 lbs (8.2% BF)
- **1RM Back Squat:** 275 lbs
- **Plus Speed** (Avg. Baserunner)
- **Goal:** Improve Overall Strength
- **VBT:** ???

20-30% Velocity Loss

Selective Hypertrophy

- Maximum Power Output → **Type II Muscle Fibers** → Recruited at higher loads → Fatigue more quickly...
- By limiting velocity loss in our sets (e.g. 10-20% vs. 30-40%) we can preferentially recruit fast twitch muscle, improve power and prevent failure.

© Micronaut / Martin Deggerli 2009

Velocity Loss & Selective Hypertrophy

(Pareja-Blanco et al., 2017)

- Compared VL 20% and VL 40% during an 8-Week VBT Program:
 - Similar Gains in Back Squat
 - VL20%: Greater ↑ CMJ (Power)
 - VL40%: Greater ↑ Hypertrophy

- **However...**

VL 40% resulted in ↓ Type II heavy chain myosin percentage...

- Velocity Loss Ranges:

- **Selective Hypertrophy: 5-10%**
- **General Strength-Power: 10-20%**
- **General Hypertrophy: 20-30%**

Speed (CF, SS, 2B) Continued...

- **Ideal Weight (example):**

In-Season Strength-Power	Back Squat 4 x 3 @ 0.6-0.8 m/s
In-Season Speed	Squats w/ Bands, Chains, or AEL 2 x 5-6 @ > 1.0 m/s

- **Undersized (example):**

In-Season Hypertrophy-Strength	Squat & Deadlift 3 x 6-8 @ 0.7-0.9 m/s
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Photo: Kelly Gavin (2018)

Starting Pitchers (Power Endurance)

- Durable and conditioned to last deep in games – Lower body, back and core focus; Flexibility / mobility...
- **VBT Goal:** Maximize workload within a given velocity range – **20% Velocity Loss**

In-Season Strength-Power	Back Squat 3-5 x 5 @ 0.6-0.8 m/s
In-Season Power-Speed	Squats w/ Bands 3 x 4-6 @ 0.9-1.1 m/s



Photo: Kelly Gavin (2018)

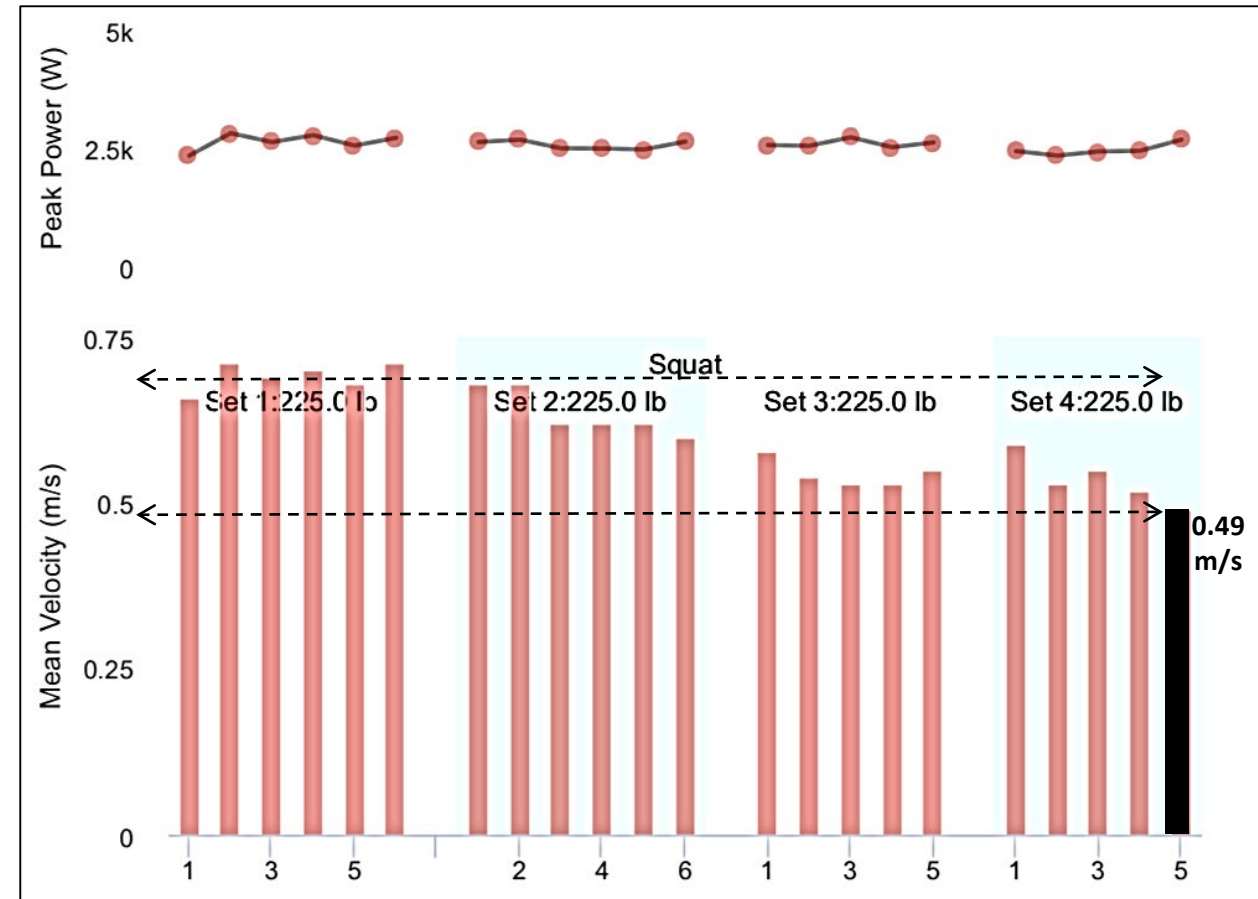
Starting Pitchers (Case Study)

- Established ML Starter
- Performing 225 lbs Back Squats

 ? Sets x 5-6 Reps

25 Total Rep Maximum

Cutoff Velocity: **< 0.5 m/s**



Relievers (Peak Power)

- Develop and maintain peak power (PP) potential, while focusing on arm health and mobility....
- **VBT Goal:** Maximize PP in a controlled volume range – **15% Velocity Loss**

In-Season Strength-Power	Back Squat 4 x 2-4 @ 0.7-0.9 m/s
In-Season Power-Speed	Squats w/ Bands 3 x 4-6 @ 0.9-1.1 m/s



Photo: Kelly Gavin (2018)

Relievers (Case Study)

- Comparing intra-set fatigue trends with jump profiling data...
- Example 1 – Reliever / Closer:
 - Vertec: **38.5"**
 - Force Plate (Drop Jump): **2.96 RSI**
 - CMJ Peak Power: **7200 W**



Relievers (Case Study)

- **Example 2 – Reliever / Closer:**
 - Vertec: **35.5"**
 - Force Plate (Drop Jump): **1.86 RSI**
 - CMJ Peak Power: **5565 W**
- **Force-Deficient vs. Velocity-Deficient Athletes...**



Optimizing the Force-Velocity Curve...

- The slope of the force-velocity curve should be used to identify specific areas of mechanical deficiency (Samozino et al., 2012).



Practical Considerations for VBT

- What does the player do well?
Need to improve?
- Appropriate starting point for each player...
- Train a narrow velocity range on a given day (e.g. 0.55-0.6 m/s)
- Progress Slowly...



Challenges with VBT

- More Technical than Using Percentages
- Working with Large Groups
- Use at our Minor League Affiliates
- Managing the Data...
- MLB / MLBPA
- “Cheating the System”
- Changing Our Thinking...



Why we like VBT...

1. Objective feedback on performance
2. Fuels intent and competitiveness by our players
3. Deeper focus and understanding of the big lifts
4. Valuable data and information about our players

Wrapping up VBT... Summary

- Evidence-based approach
- Drives loading parameters in training
- Helps us target specific strength qualities
- Real-time data makes us better coaches



What's Next?

What's Next for VBT in Baseball?

- VBT: Readiness Assessment...
- Monitor In-Season Power:
 - Week-to-Week Changes
 - Long-term Trends

“Week to week fluctuation of increasing or decreasing as an indicator of the current state of the neuromuscular system.”

- (Mann, 2016)

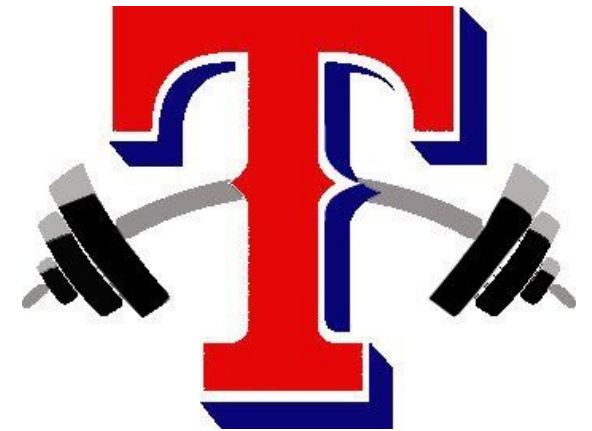
Exercise	Weight	Best Result		Worst Result		Best Result		Worst Result	
		Peak Power (W)	Best Rep	Peak Power (W)	Best Rep	Mean Velocity (m/s)	Best Rep	Mean Velocity (m/s)	Best Rep
Squat	135.0 lb	2800	11/26/2018			0.84	11/26/2018		
	185.0 lb	2597	11/26/2018			0.72	11/26/2018		
	225.0 lb	3761	05/01/2018	2097	08/13/2018	0.84	05/01/2018	0.53	08/13/2018
	245.0 lb	3559	12/17/2018	3025	06/16/2018	0.72	12/17/2018	0.69	11/26/2018
	255.0 lb	3912	12/17/2018			0.69	12/17/2018		
	265.0 lb	4039	12/17/2018			0.67	12/17/2018		
	275.0 lb	3590	05/01/2018	2891	07/30/2018	0.69	06/25/2018	0.55	11/26/2018
	315.0 lb	3690	05/01/2018	2982	09/03/2018	0.60	08/13/2018	0.52	05/01/2018

Future Research...



Any Questions...

- Email: elmcmahon@gmail.com
- Follow   [@RangerStrength](https://www.instagram.com/RangerStrength)
- Or...  [@EricMcMahonCSCS](https://twitter.com/EricMcMahonCSCS)



Thank you...



- **My Family:**
*Meredith, Colin (6),
Amelia (3), Claire (8mo)*
- **Texas Rangers**
- **Scott Caulfield**
- **NSCA**



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