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#NSCAGoaches22

Weightlifting Derivatives to Meet your Force-Velocity Profile



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CONFLICT OF INTEREST STATEMENT

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

IN LOVING MEMORY OF
JUD LOGAN
1959 - 2022



Objectives

- Introduce force-velocity profiling and how to visualize it
- Identify weightlifting catching and pulling derivatives
- Discuss the potential of weightlifting derivatives to train an athlete's force-velocity profile
- Provide examples of how best to implement weightlifting derivatives to enhance an athlete's force, velocity, and power characteristics

What is force-velocity profiling?

- The visualization of how an athlete uses both Force and Velocity to produce power
- Charting Force on the X and Velocity on the Y
- Charting Power on an additional Y
- Sometimes load is utilized rather than Force to keep things simple
- Bullet point

Why not just look at power?

- Power is the product of Force and Velocity
 - Power is 500
 - Force can be 10 and velocity can be 50
 - Force can be 50 and velocity can be 10
- By breaking apart the components, you can tell where the athlete is sufficient and deficient
- Force at low velocity and force at high velocity differ

Why?

- Find what the athlete is good in and deficient in
- Only 1-2 extra sets during a 1RM testing session will derive a great amount of information
 - Must use a reliable device that derives force, velocity, and power

How do we do it?

- During 1RM testing
 - Add in 1-2 ballistics before the start of the progression
 - Get true velocity
 - Unloaded (PVC or wooden dowel)
 - Possibly a second set with a light load
 - Get force
 - Continue up to 1RM for force end
 - Record power

How do we do it?

- Loaded jumps
 - 2 Methods
 - 3 Condition: Unloaded, 50%, and 100% bodyweight
 - 6 Condition: Unloaded, 20, 40, 60, 80, and 100% bodyweight
 - Tools
 - MyJump App (Carlos Balsalobre)
 - LPT
 - Optojump
 - Jump mat

Interpreting Power-Force-Velocity Profiles for Individualized and Specific Training

Article in International Journal of Sports Physiology and Performance · December 2015

DOI: 10.1123/ijsp.2015-0638

CITATIONS

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Université Côte d'Azur

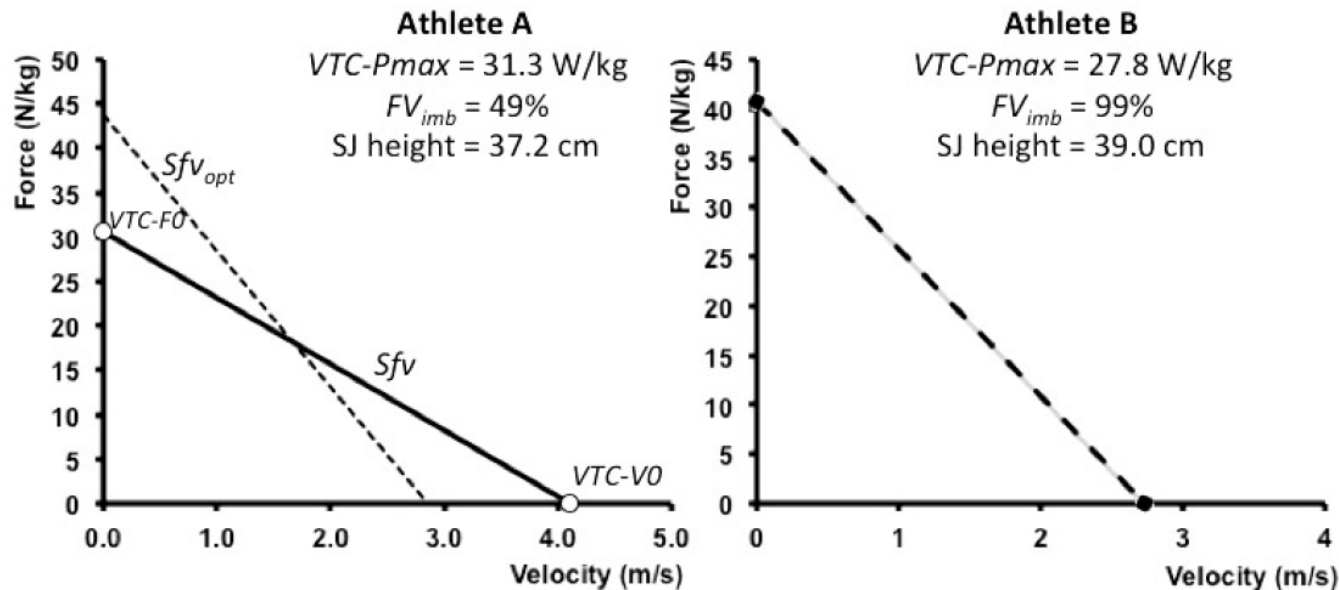
259 PUBLICATIONS 4,887 CITATIONS



Pierre Samozino

Université Savoie Mont Blanc

192 PUBLICATIONS 3,350 CITATIONS



How do we do it?

- Utilize the same metrics for all
 - Mean, peak, or mean propulsive
- Pick the best repetition from the set
- Make sure to use the same repetition for all 3 variables
- Repeat with every subsequent testing session to see how it has changed

Plot

- Use whatever software you prefer
 - Mean, peak, or mean propulsive
- Pick the best repetition from the set
- Make sure to use the same repetition for all 3 variables
- Repeat with every subsequent testing session to see how it has changed

Excel Directions

- Compute velocity by rearranging the power equation (Power = load x velocity):

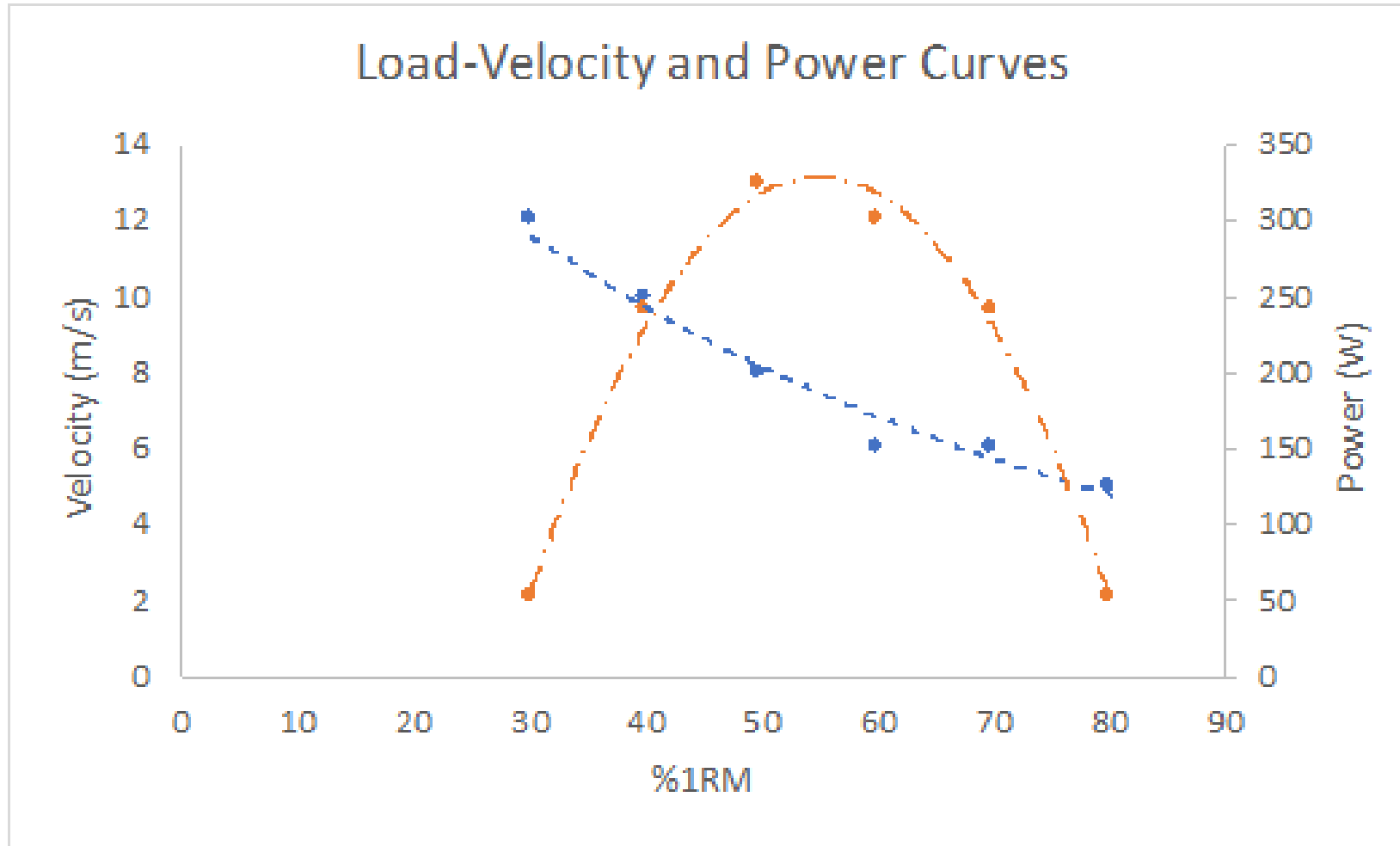
$$\text{Velocity} = \text{power} / \text{load}$$

- In Excel, organize your data so it looks like this (x-axis data should be in first column):

%1RM	Velocity	Power	Load
30	12	50	20
40	10	240	26
50	8	325	33
60	6	300	39
70	6	240	46
80	5	50	51

- Highlight the data for %1RM, Velocity, and Power including headings (load is only needed to calculate velocity).
- Select Insert → select Scatter (there should be two series, one for velocity and one for power)
- Power Curve (Secondary Vertical Axis):
 - Right click on the dots for power (will be higher values), which should select the whole series.
 - Select Format Data Series → under Series Options, select Secondary Axis
 - Right click on dots for power again → select Add Trendline → select Polynomial
- Velocity (Primary Vertical Axis):
 - Right click on one of the dots for load, which should select the whole series.
 - Select Add Trendline → select Exponential
- Delete legend (not necessary for this chart)
- Add Chart Title and Axis Titles including units.
- Select Insert → select Shapes → click on arrow and drag from the highest peak power (data point) down to the x-axis to determine optimal load.

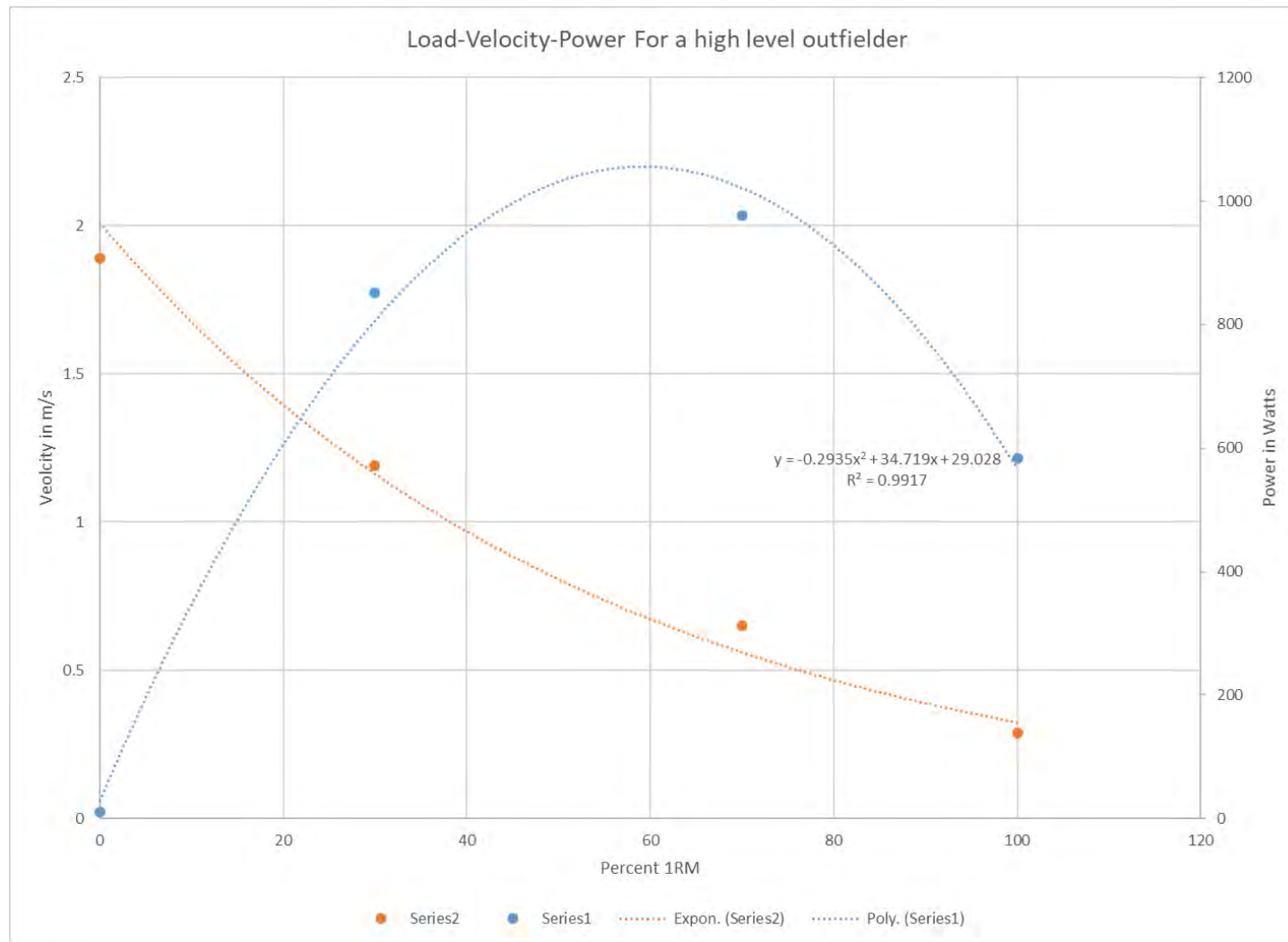
Example Load-velocity and Power Curves



Excel data, Starter in the Outfield

% 1RM	Power	Velocity	Force
0	11.24	1.89	5.93
30	850.92	1.19	752.7
70	976.75	0.65	1532.4
100	583.74	0.29	2042.52

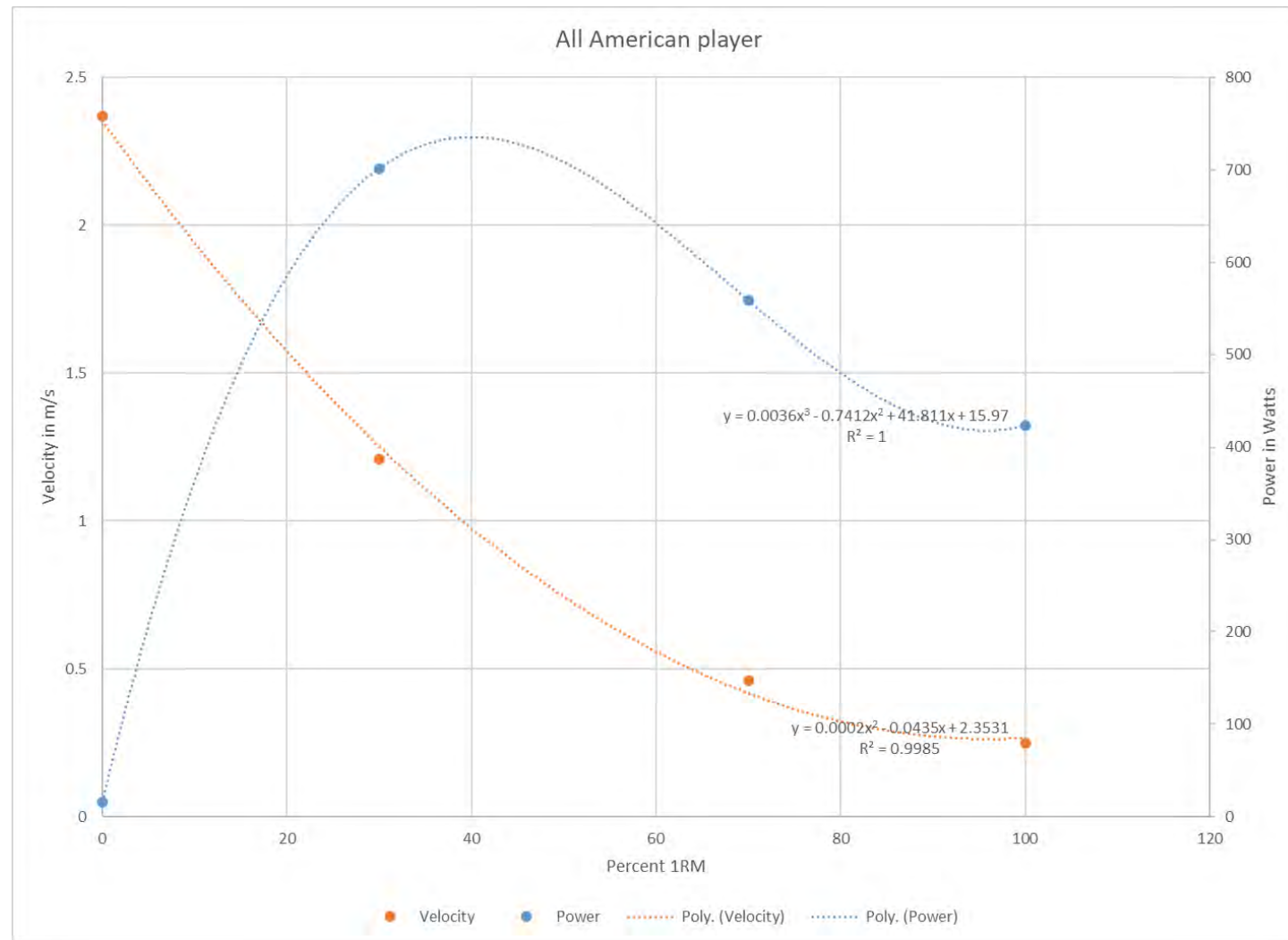
Excel data, Starter in the Outfield



Excel data, All-American Player

% 1RM	Power	Velocity
0	15.97	2.37
30	701.47	1.21
70	558.84	0.46
100	423.44	0.25

Excel data, All-American Player



Comparison

- Power in high level outfield, 60% of 1RM
- Power in All-American, 40% of 1RM
- Both have adequate strength
- What to train?
 - Strength-speed in outfielder
 - Speed-strength in All-American

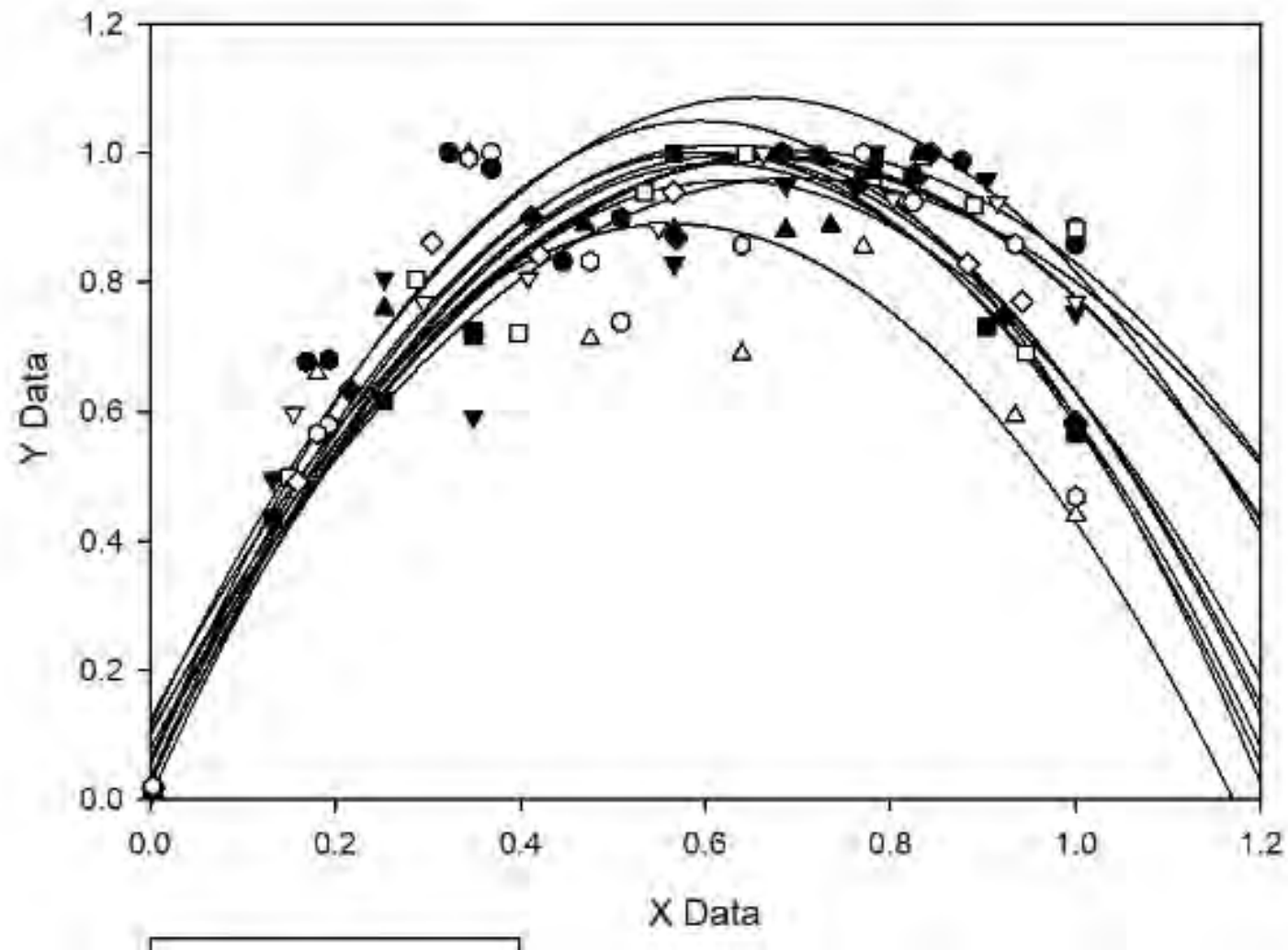
How do the curves look?

- Where is power?
 - How much of it?
 - Is it towards the force or velocity end?

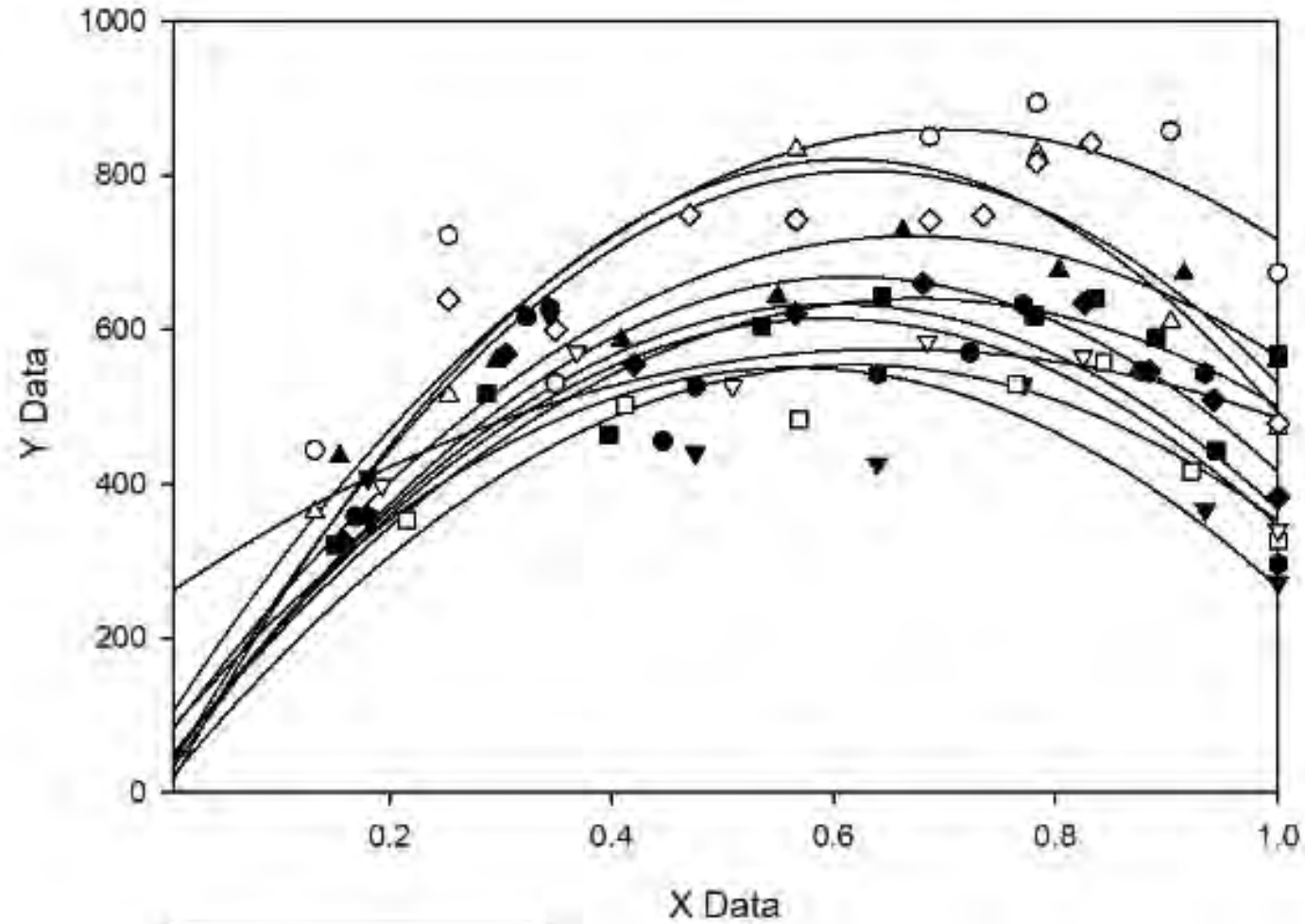
Subsequent Graphs

- Created in Sigmaplot
 - It's quicker and looks prettier
- Spaghetti Plots
 - Entire team
 - Generalizations
- Individual plots
 - Make basic training recommendations

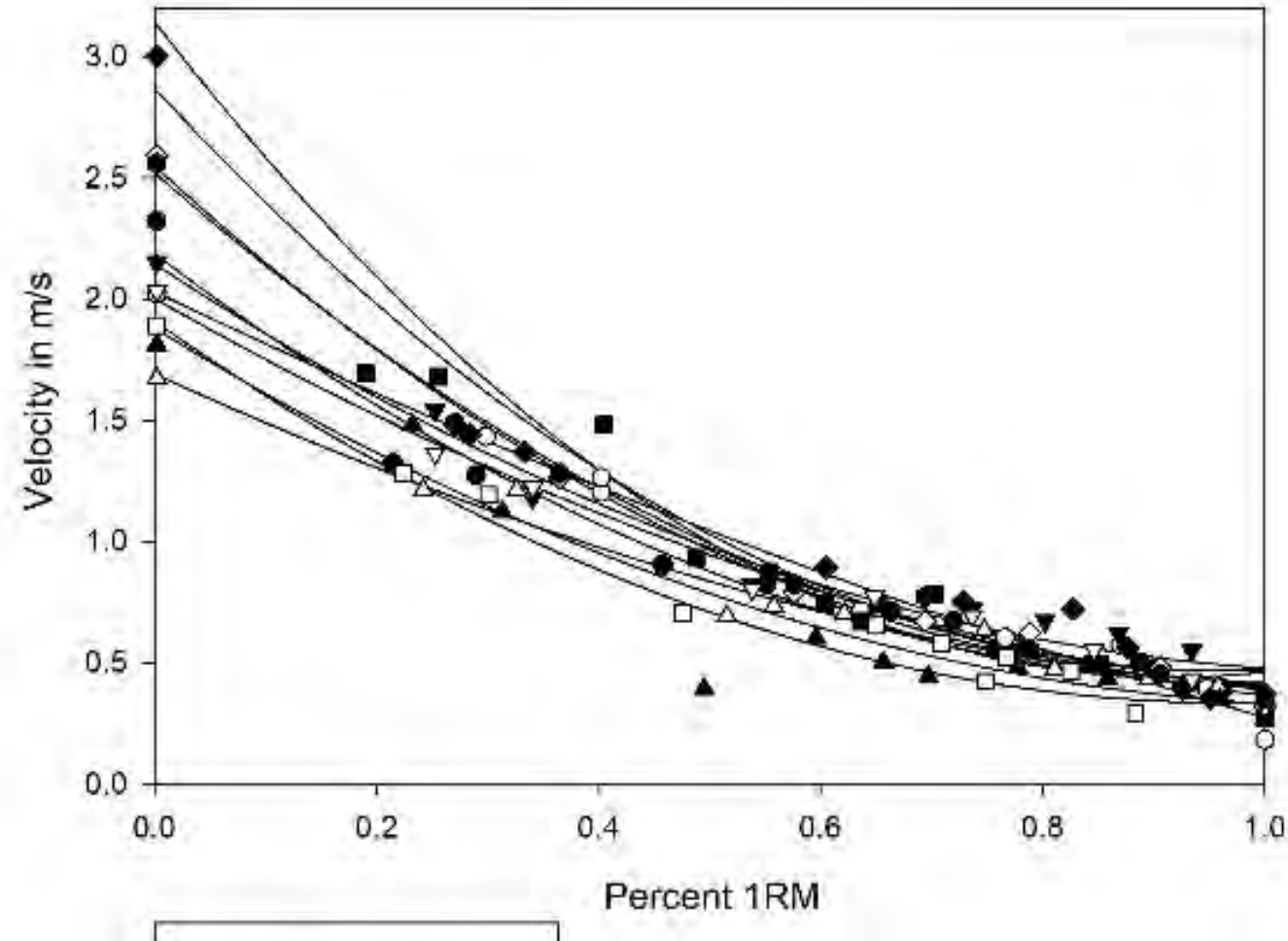
Normalized Squat Power



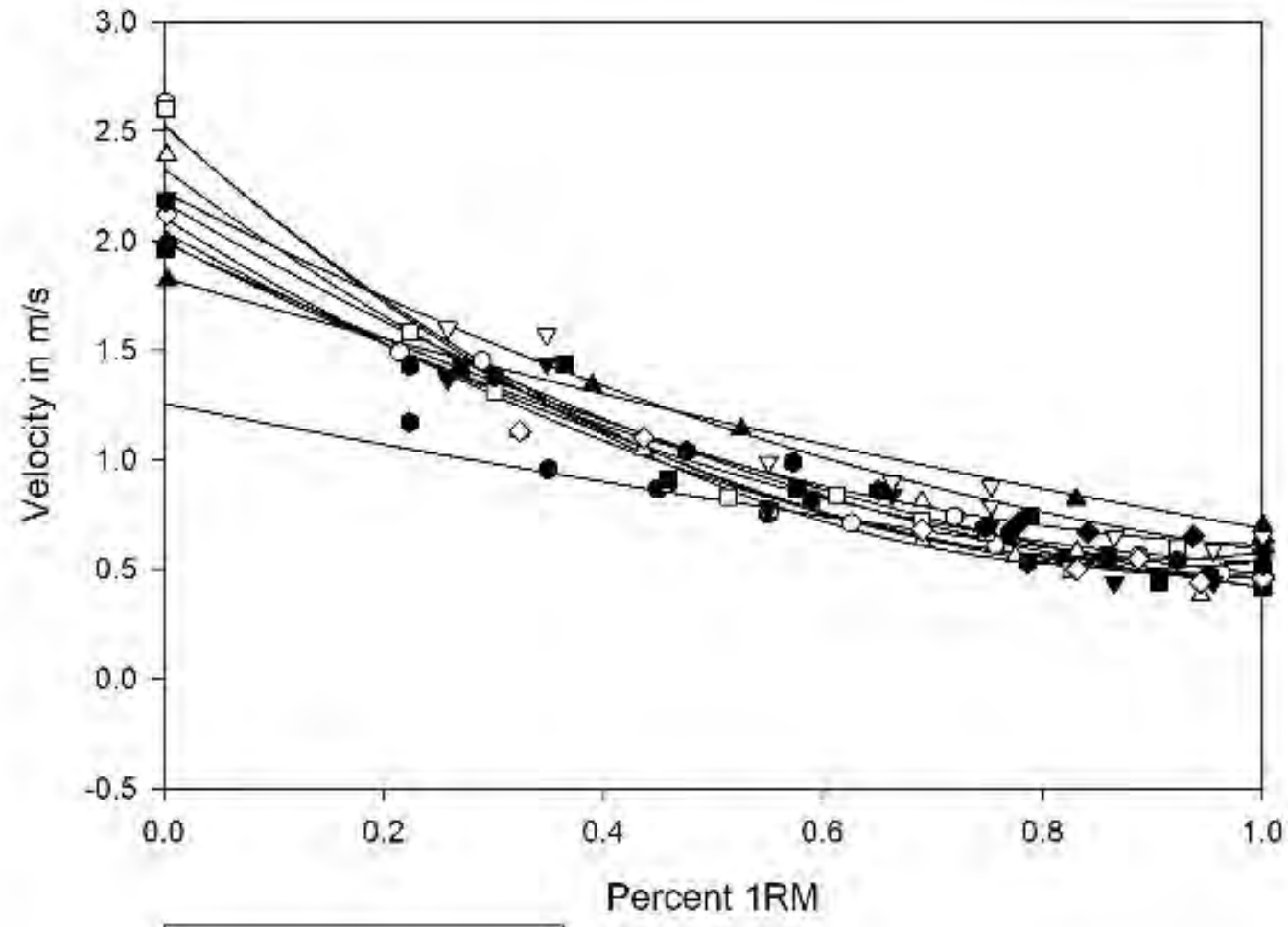
Absolute Squat power



Velocity:load true 1RM



Velocity: Percent 1RM not true



How can we use weightlifting derivatives to train force-velocity characteristics?

What are weightlifting derivatives?

- Derivative: something that is based on another source
- Weightlifting derivatives are based on the traditional weightlifting competition movements (i.e. snatch and clean & jerk)
- Catching derivatives
 - Modified from traditional snatch and clean movements by altering start or catch position
- Pulling derivatives
 - Modified from traditional movements by removing the catch phase and potentially altering the start position

Weightlifting Derivatives

Catching Derivatives

- Most common weightlifting derivatives
 - Examples: power clean, hang power snatch, mid-thigh clean, etc.
- Benefits
 - Coordinated triple extension movement resulting in strength-power development
 - Postural strength adaptations
 - External load acceptance
- Limitations
 - Maximal effort ranges from ~50-100% of 1RM
 - May be a time-consuming teaching and learning process
 - Incomplete triple extension
 - Poor catching technique

Weightlifting Derivatives

Pulling Derivatives

- Examples
 - Clean pull from the floor
 - Countermovement shrug
 - Hang high pull
- Benefits
 - Coordinated triple extension movement resulting in strength-power development
 - Postural strength adaptations
 - External load acceptance
 - Less complex regarding technique
 - Expand loading potential (~20-140% 1RM)
- Limitations
 - Athletes may view pulls as “incomplete” movements

How can we use weightlifting derivatives to train force-velocity characteristics?

Training the F-V Curve with Weightlifting Derivatives

- We are prone to go with what we know and are comfortable with
 - Catching variations are the most used exercises
- Are we limiting ourselves to a small portion of the F-V with only catching variations?
 - Loading range?
 - Maximal effort with light loads?
- How do pulling derivatives compare to catching derivatives?
 - Force
 - Velocity
 - Power

Catch vs. Pull – Cross-sectional Comparisons

Clean variations

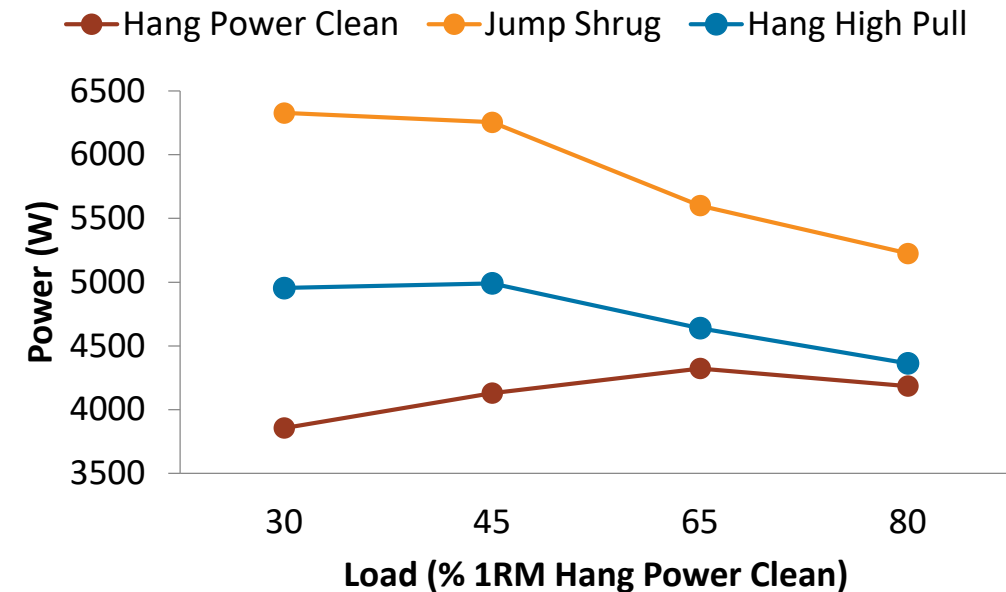
- Comfort et al., 2011a; 2011b
 - Mid-thigh pull > peak force, RFD, and power than hang clean and hang power clean
 - No differences between mid-thigh pull and mid-thigh power clean

- Suchomel et al., 2014



- Kipp et al., 2018
 - Jump shrug > relative power than hang power clean at 30, 50, and 70% 1RM
 - Jump shrug > relative power at knee and ankle joints

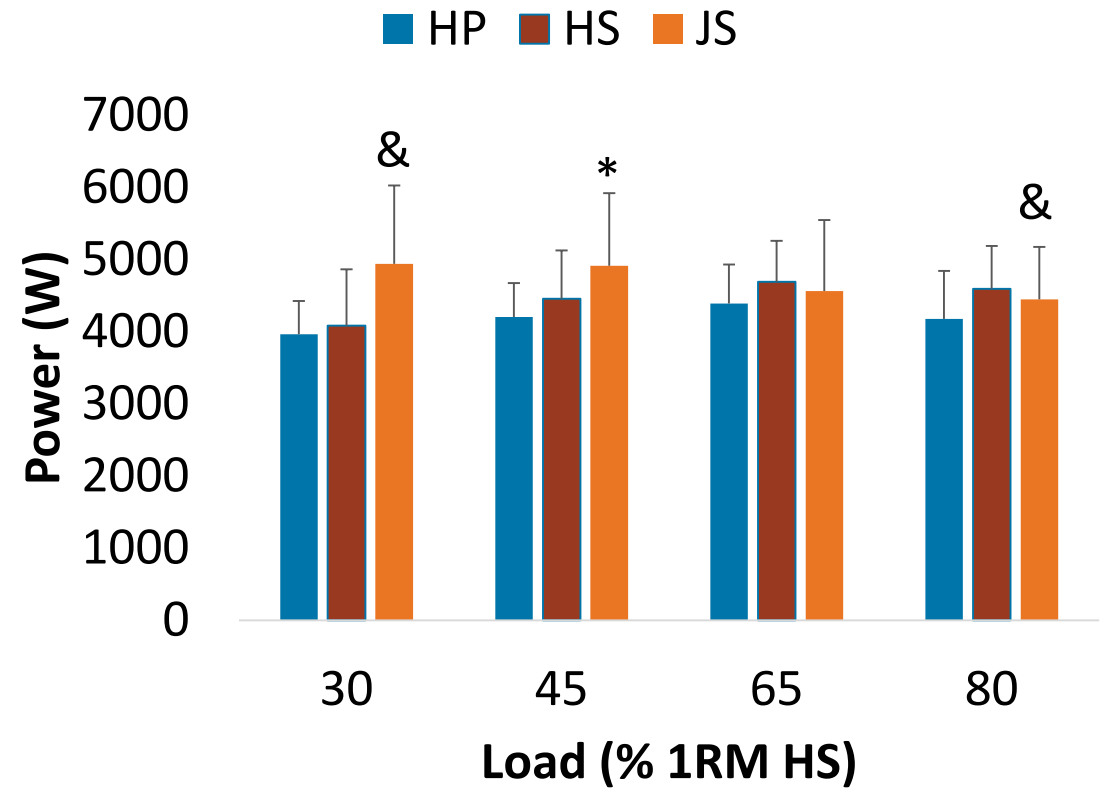
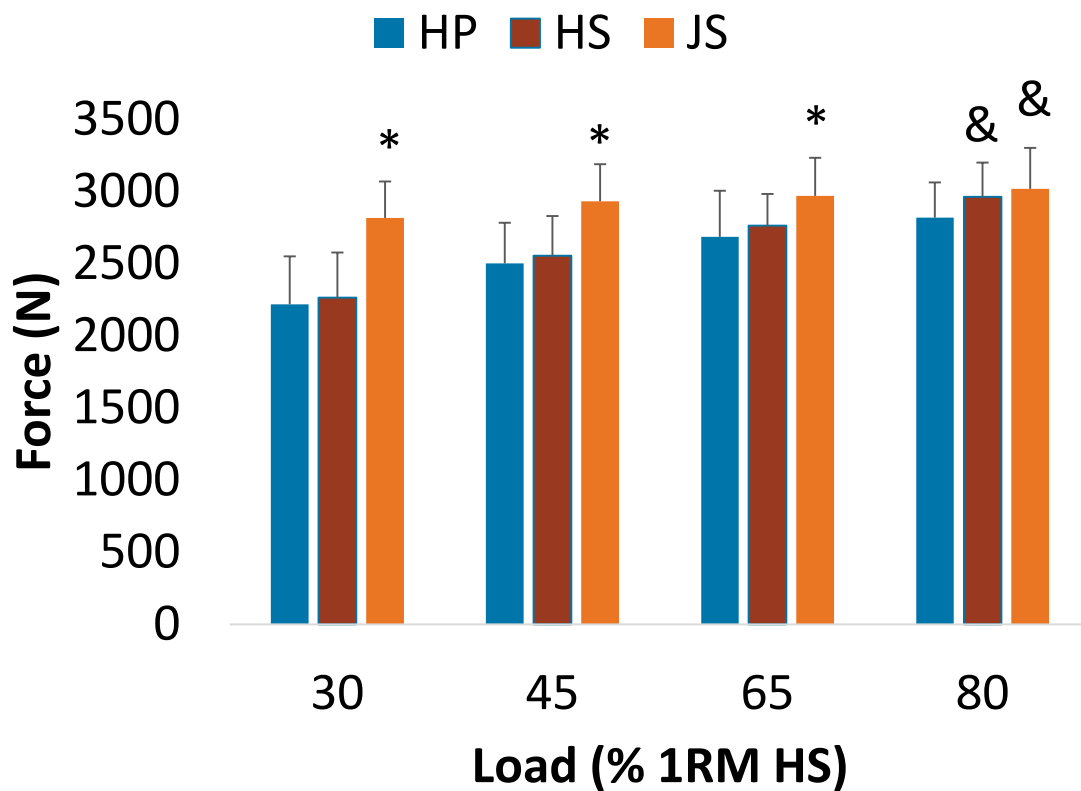
- Takei et al., 2020
 - Hang high pull > force and velocity at peak power than hang power clean at 40, 60, and 70% 1RM with **weightlifters**



Catch vs. Pull – Cross-sectional Comparisons

Snatch variations

- Feimster, 2017 Thesis



Catching vs. Pulling Training Studies

Catch vs. Pull Training Comparison

Comfort et al., 2018

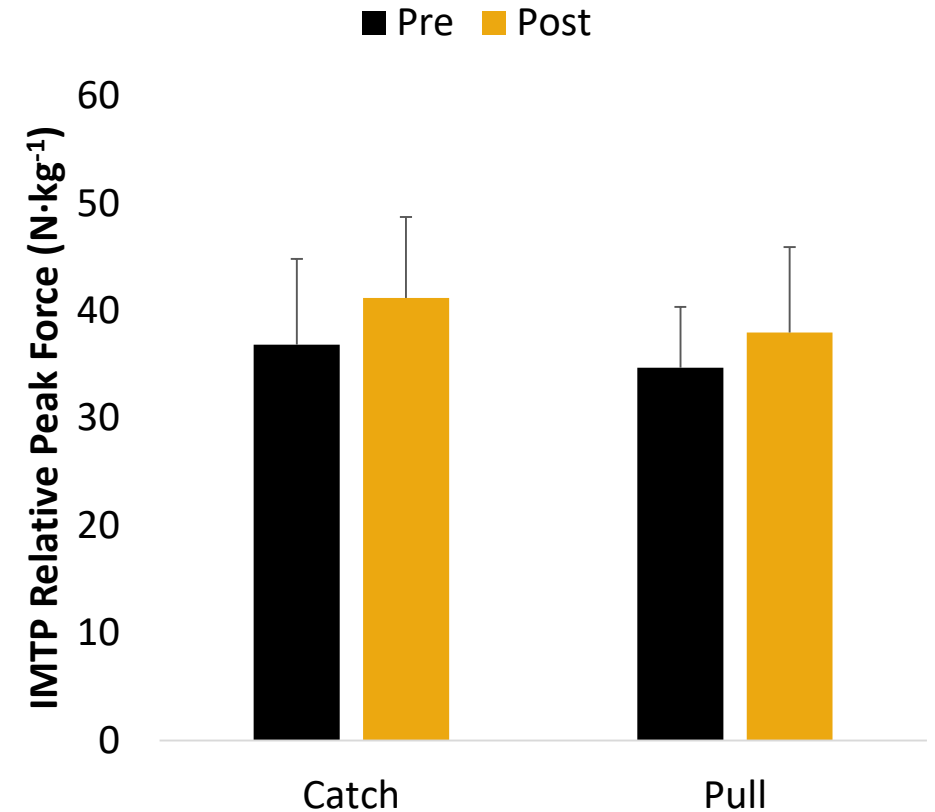
- 8 weeks of in-season training (twice per week)
- Catch group and Pull group
 - All weightlifting movements were performed with the same relative loads
 - Biomechanically similar movements (e.g. Power clean vs. Clean pull from floor)

Mesocycle 1: Day 1					Mesocycle 2: Day 1				
Exercise	Week 1	Week 2	Week 3	Week 4	Exercise	Week 1	Week 2	Week 3	Week 4
Back Squat	3 x 5 @ 75%	3 x 5 @ 80%	3 x 5 @ 82.5%	3 x 5 @ 67.5%	Power Clean /	3 x 3 @ 80%	3 x 3 @ 85%	3 x 3 @ 90%	3 x 3 @ 75%
Power Clean / Clean Pull	3 x 5 @ 75%	3 x 5 @ 80%	3 x 5 @ 82.5%	3 x 5 @ 67.5%	Push Press	3 x 3 @ 80%	3 x 3 @ 82.5%	3 x 3 @ 85%	3 x 3 @ 75%
Push Press	3 x 5 @ 70%	3 x 5 @ 72.5%	3 x 5 @ 75%	3 x 5 @ 60%	Back Squat	3 x 3 @ 82.5%	3 x 3 @ 87.5%	3 x 3 @ 90%	3 x 3 @ 75%
Nordic Lowers	2 x 3 BW	3 x 3 BW	3 x 3 BW	3 x 3 BW	Nordic Lowers	2 x 3 BW	3 x 3 BW	3 x 3 BW	3 x 3 BW
Mesocycle 1: Day 2					Mesocycle 2: Day 2				
Mid-thigh Power Clean / Mid- thigh Pull	3 x 5 @ 60%	3 x 5 @ 65%	3 x 5 @ 70%	3 x 5 @ 55%	Mid-thigh Power Clean / Mid-thigh Pull	3 x 3 @ 80%	3 x 3 @ 82.5%	3 x 3 @ 85%	3 x 3 @ 70%
RDL	3 x 5 @ 70%	3 x 5 @ 75%	3 x 5 @ 77.5%	3 x 5 @ 62.5%	RDL	3 x 3 @ 80%	3 x 3 @ 85%	3 x 3 @ 87.5%	3 x 3 @ 72.5%

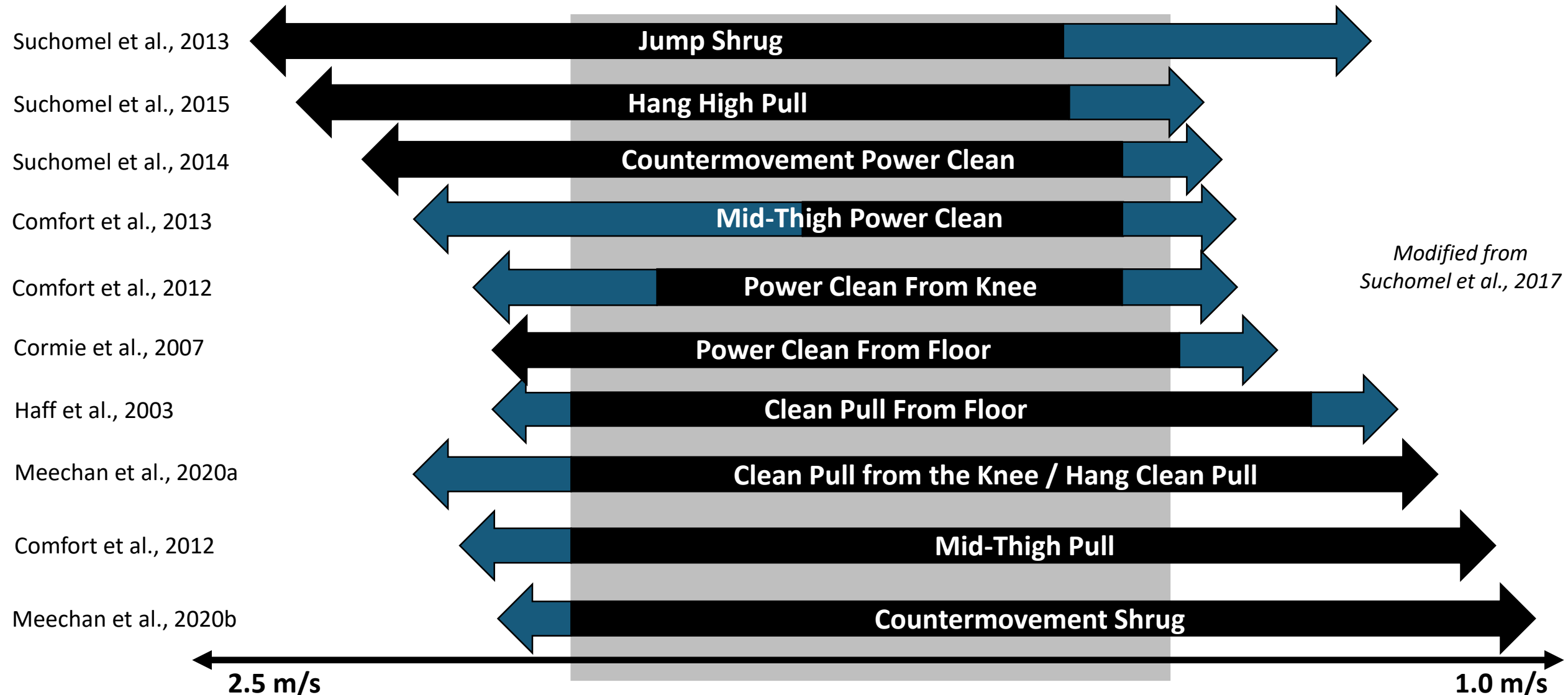
Catch vs. Pull Training Comparison

Comfort et al., 2018

- Isometric mid-thigh pull
 - Relative peak force
 - Relative force at 100, 200, and 250 ms
- Countermovement jump
 - Height
 - Peak power
 - Modified reactive strength index (RSImod)
- Both groups improved IMTP and CMJ performance, but no statistical or practical differences existed between groups



The Gray Area of Weightlifting Derivatives

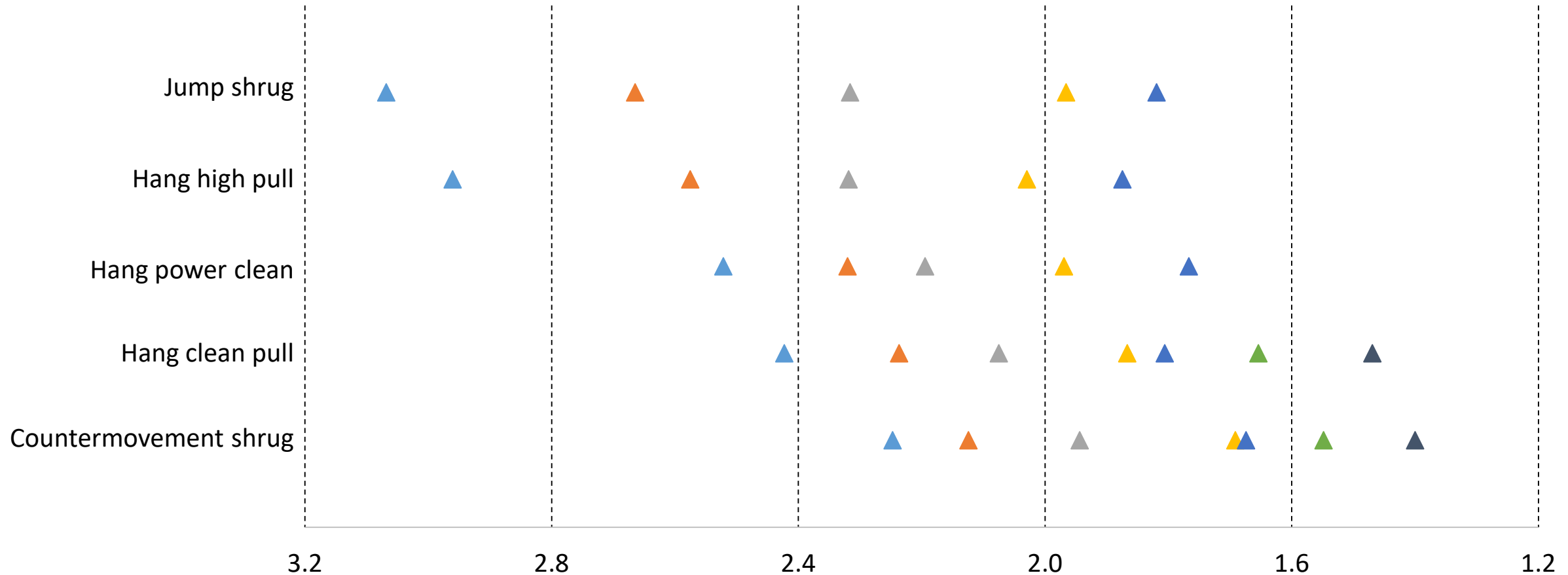


The Gray Area of Weightlifting Derivatives

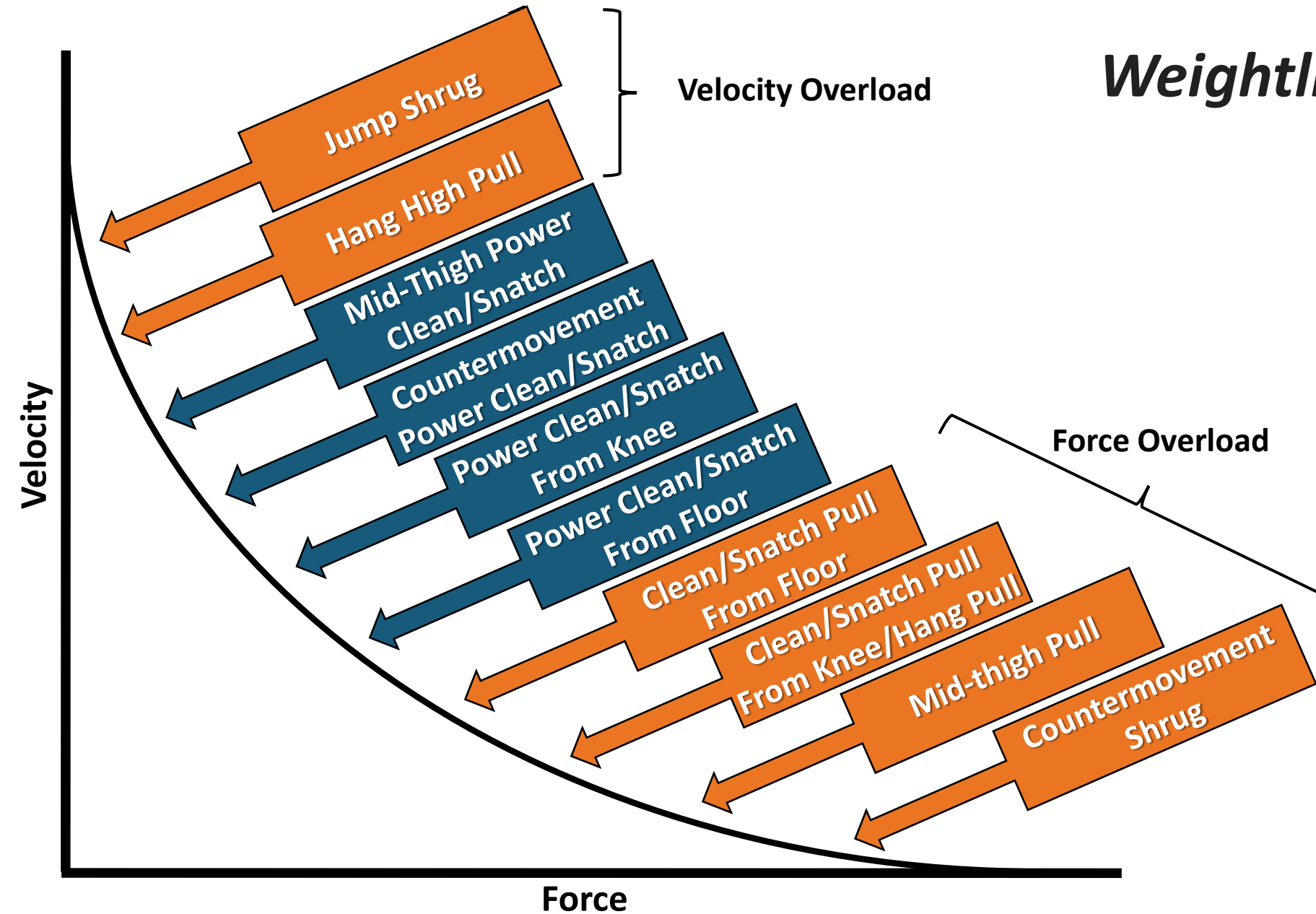
Suchomel et al., In progress – Peak barbell velocities (GymAware)

%1RM Hang power clean

20% 40% 60% 80% 100% 120% 140%



Weightlifting F-V Curve

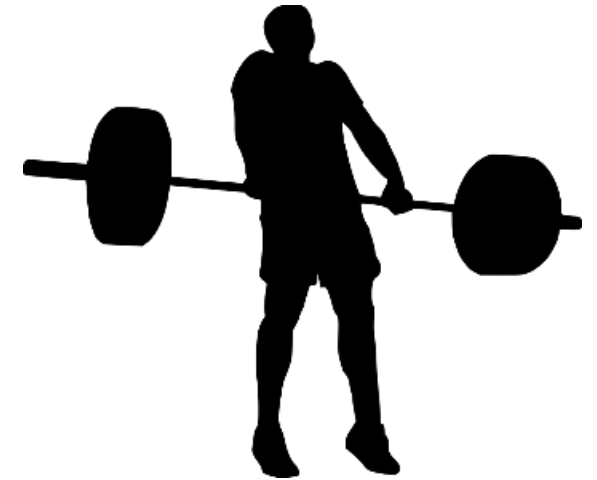


Modified from Suchomel et al., 2017

Catch vs. Pull Training Comparison

Suchomel et al., 2020a; 2020b

- 10 weeks of training
 - Strength-endurance (3 x 10) in Weeks 1-3
 - Strength (3 x 5) in Weeks 4-7
 - Overreach (5 x 5) in Week 8
 - Taper (3 x 3 and 3 x 2) in Weeks 9-10
- 3 different groups
 - Catch (submaximal catching derivatives)
 - Pull (submaximal pulling derivatives)
 - **Overload (pulling derivatives with a force- and velocity-specific loading)**

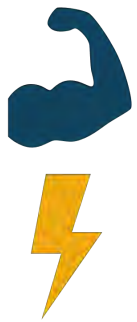


Catch vs. Pull

Training Comparison

Suchomel et al., 2020a; 2020b

- Catch group
 - Power clean: 55-82.5% 1RM
 - Mid-thigh power clean: 53-70% 1RM
 - CM power clean: 55-60% 1RM
 - Hang power clean: 55-75% 1RM
- Pull group (same loading as above)
- Overload group
 - Clean pull from floor: 75-102.5% 1RM
 - Mid-thigh pull: 107-135% 1RM
 - CM shrug: 105-110% 1RM
 - Hang high pull: 35-40% 1RM
 - Jump shrug: 30-40% 1RM

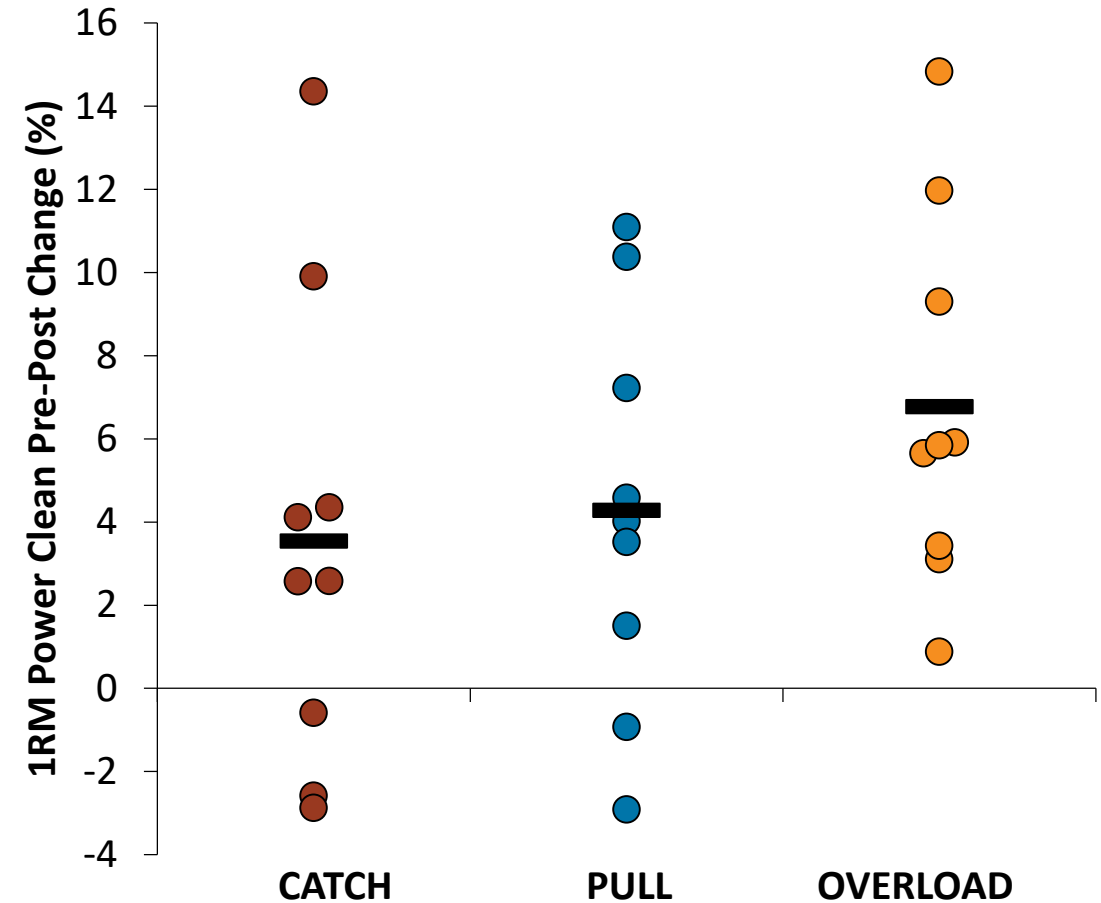


Training Block	Day 1	Day 2	Day 3
Strength-Endurance	Back Squat	Power Clean from Floor	Power Clean from Floor
	Military Press	Stiff-legged Deadlift	Back Squat
	Split Squat	Bent-over Row	Incline Bench Press
	Bench Press	Pull-up	Bent-over Row
Strength + Overreach	Push Press	Mid-thigh Power Clean	Mid-thigh Power Clean
	Back Squat	Power Clean from Floor	Back Squat
	Bench Press	Stiff-legged Deadlift	Incline Bench Press
	Lunge	Pull-up	Dumbbell Row
Speed-Strength	Jerk		Jerk
	¼ Squat + Squat Jump	CM Power Clean	Hang Power Clean
	Bench Press	Hang Power Clean	
Training Block	Day 1	Day 2	Day 3
Strength-Endurance	Back Squat	Clean Pull from Floor	Clean Pull from Floor
	Military Press	Stiff-legged Deadlift	Back Squat
	Split Squat	Bent-over Row	Incline Bench Press
	Bench Press	Pull-up	Bent-over Row
Strength + Overreach	Push Press	Mid-thigh Pull	Mid-thigh Pull
	Back Squat	Clean Pull from Floor	Back Squat
	Bench Press	Stiff-legged Deadlift	Incline Bench Press
	Lunge	Pull-up	Dumbbell Row
Speed-Strength	Jerk		Jerk
	¼ Squat + Squat Jump	CM Shrug	Jump Shrug
	Bench Press	Hang High Pull	

Catch vs. Pull Training Comparison

Suchomel et al., 2020a

- Dynamic strength (1RM power clean)
- Isometric strength (Relative IMTP peak force)
- 30 m sprint performance
 - 10 and 20 m splits
- 505 change of direction performance
 - Right and left legs

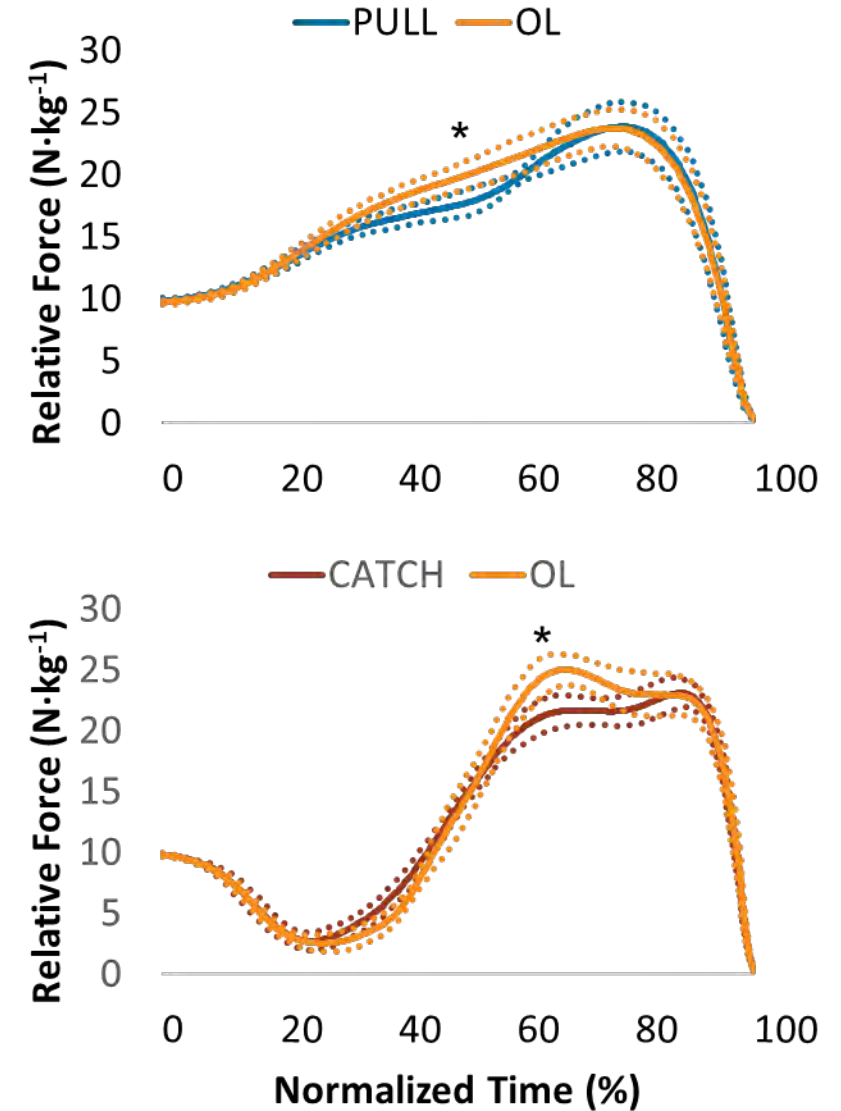


- The greatest 1RM power clean, IMTP peak force, 10-, 20-, and 30-m sprint, and 505 change of direction improvements were produced by the **overload group**

Catch vs. Pull Training Comparison

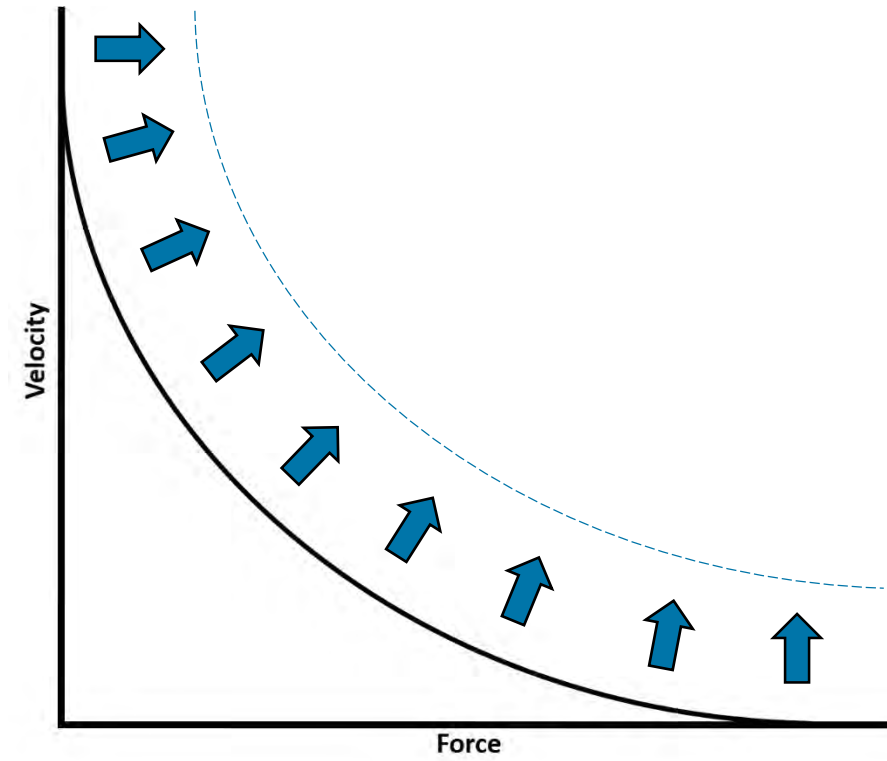
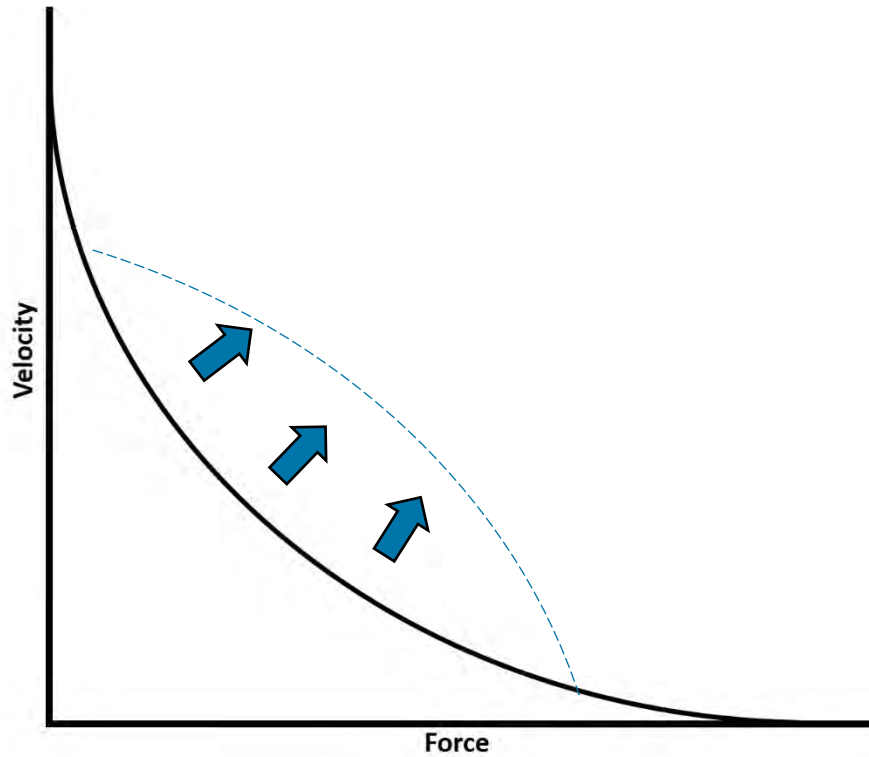
Suchomel et al., 2020b

- Squat jump (SJ) and countermovement jump (CMJ)
 - Height
 - Propulsion mean force
 - Propulsion time
 - Time-normalized force-time curves
- The **overload** and **pull** groups produced the greatest SJ and CMJ adaptations, respectively
- The **overload** group produced greater SJ propulsive force than the **pull** group and greater braking force than the **catch** group

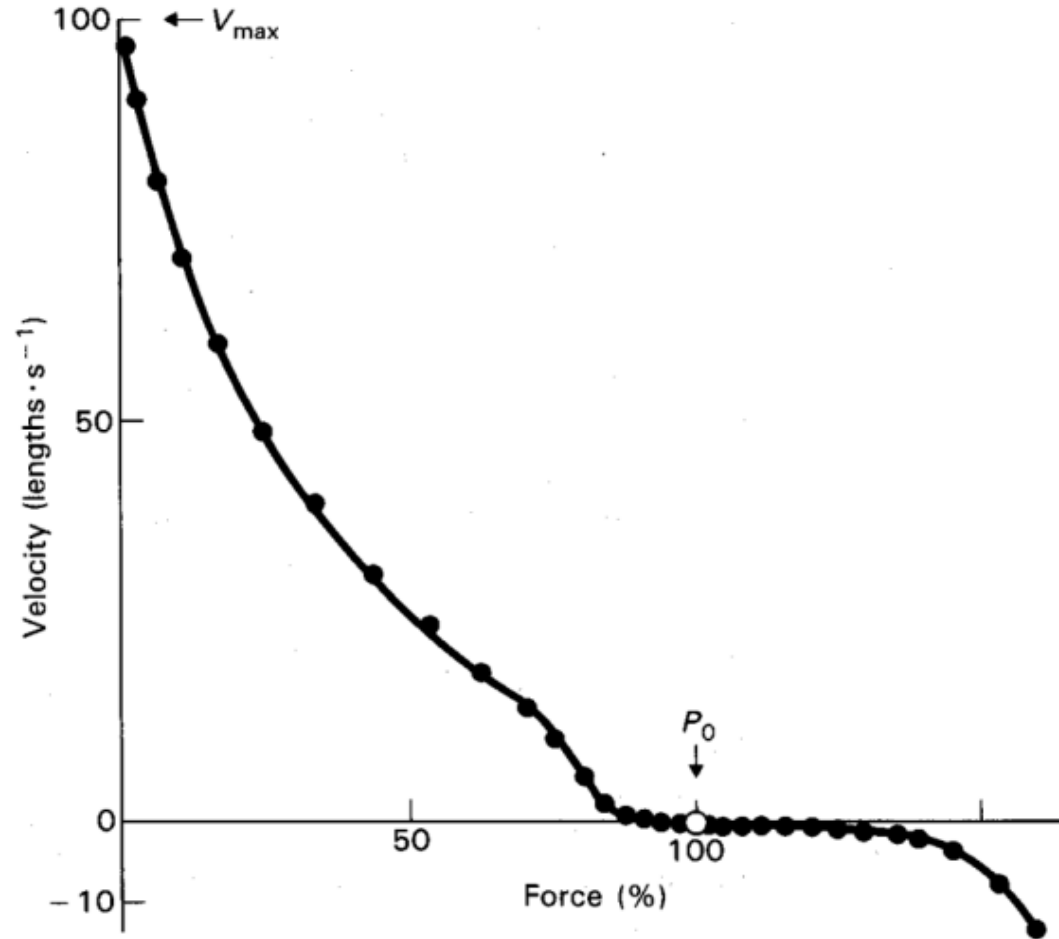
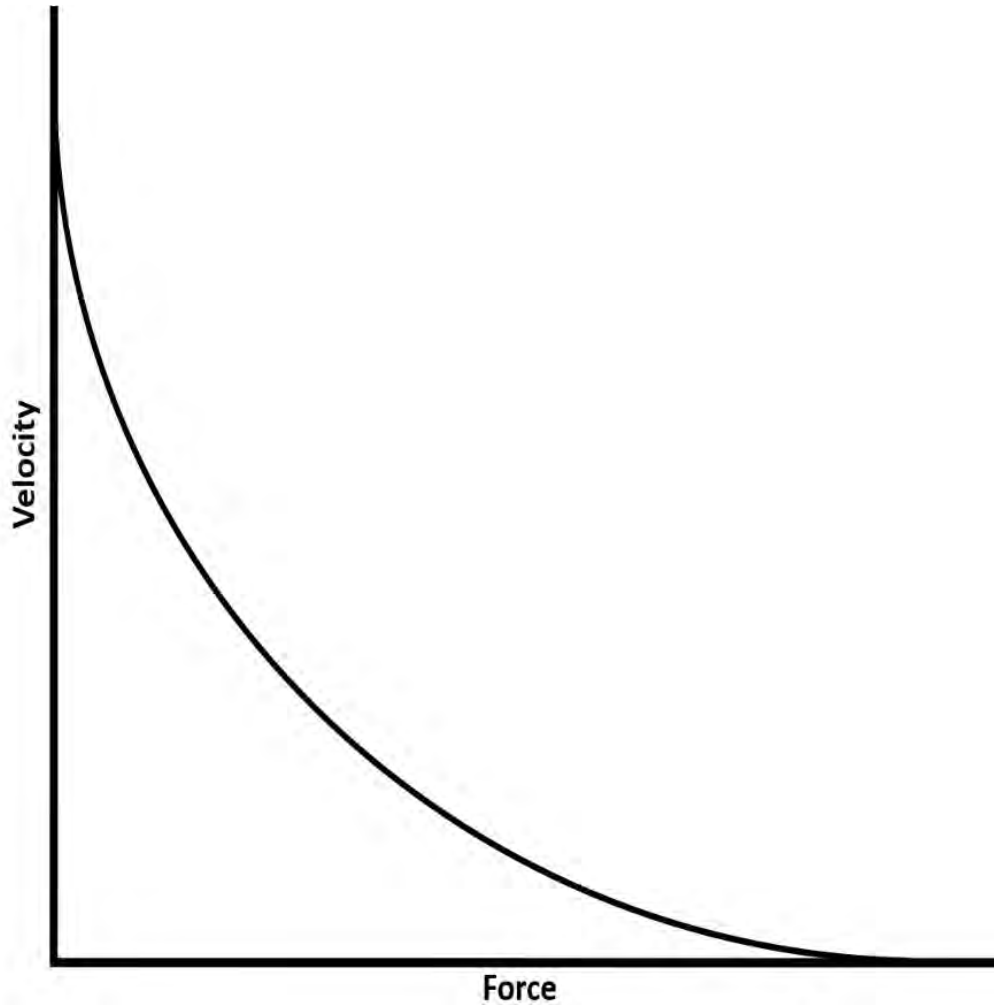


Catch vs. Pull Training Comparison

F-V Curve Adaptations

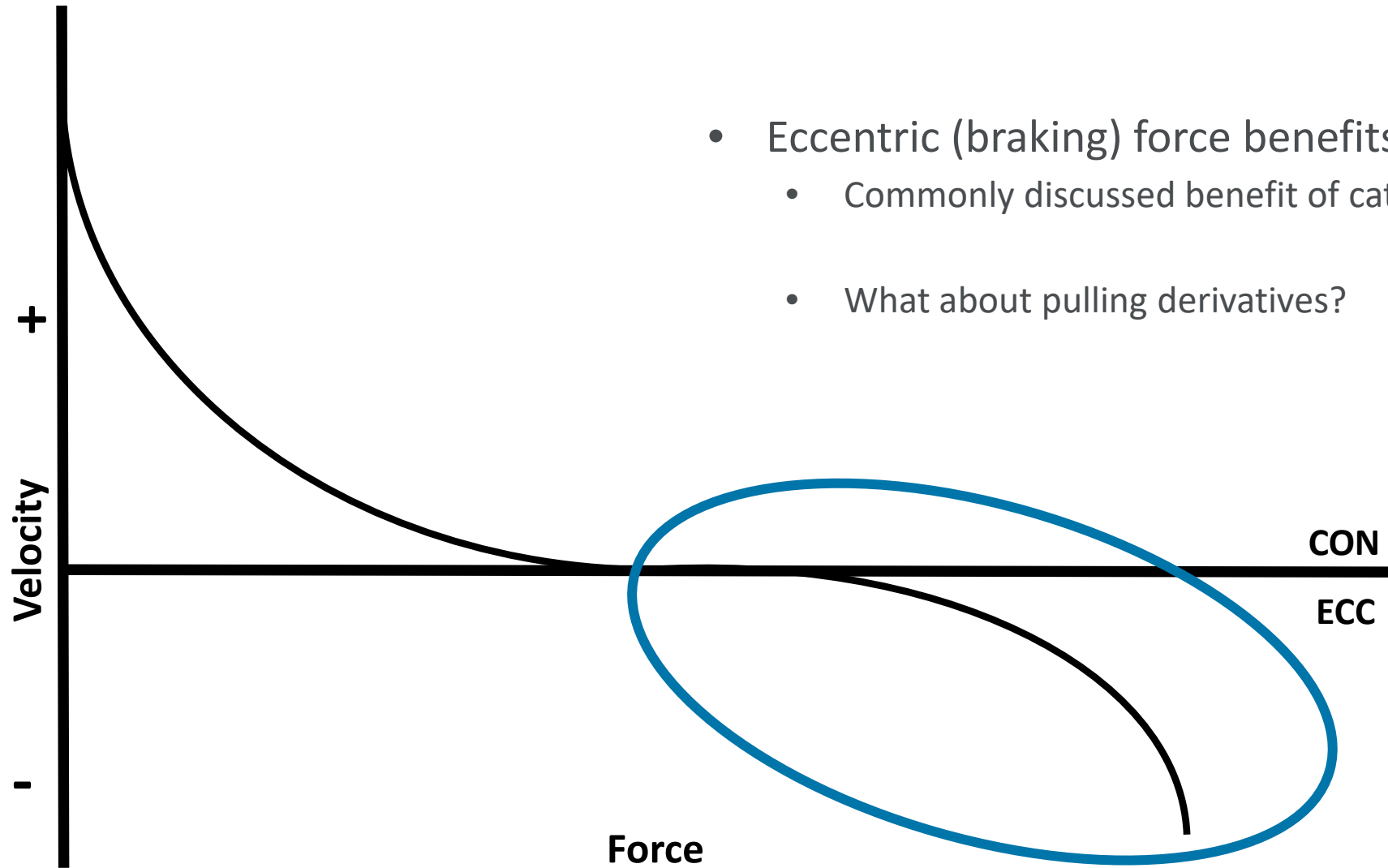


F-V Curve Revisited



Edman et al., 1988

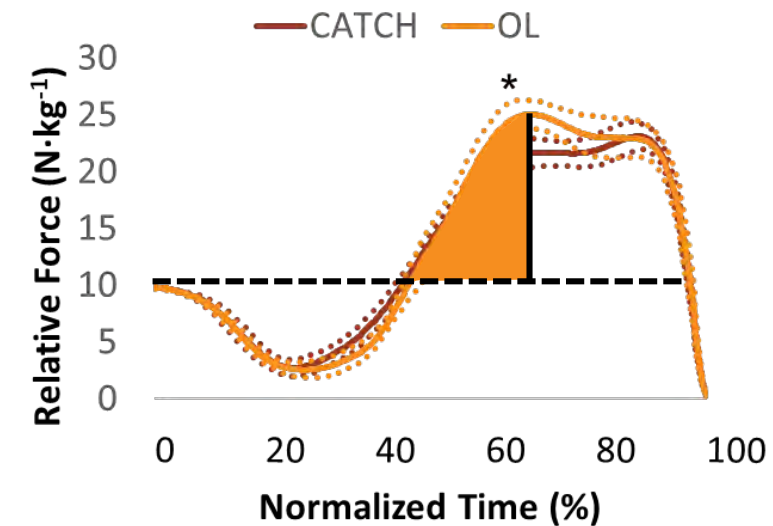
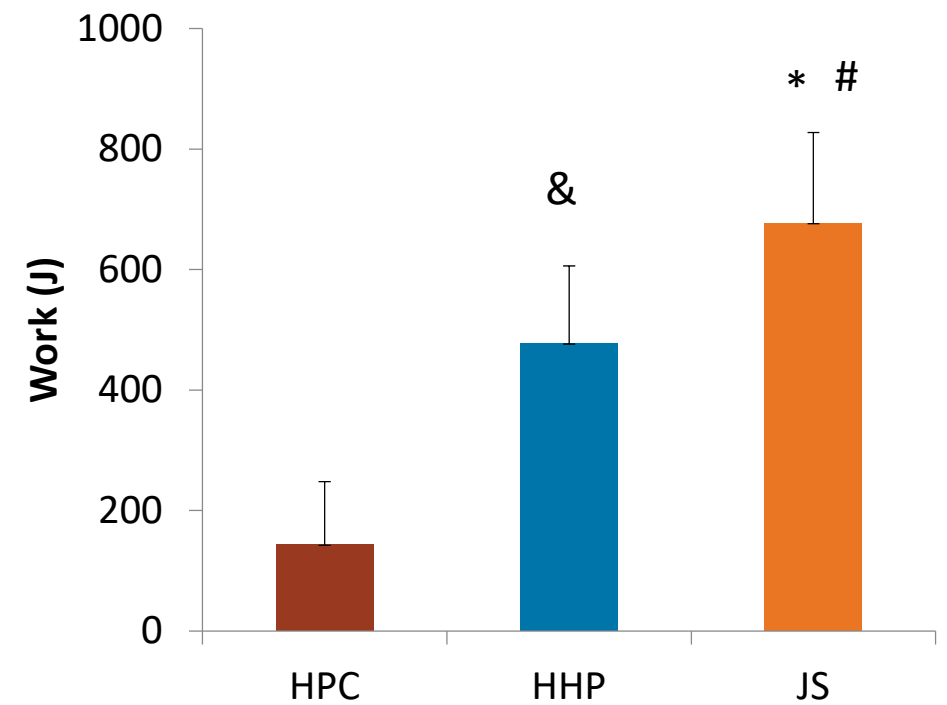
F-V Curve Revisited



Load Acceptance Comparisons

Cross-sectional Comparisons

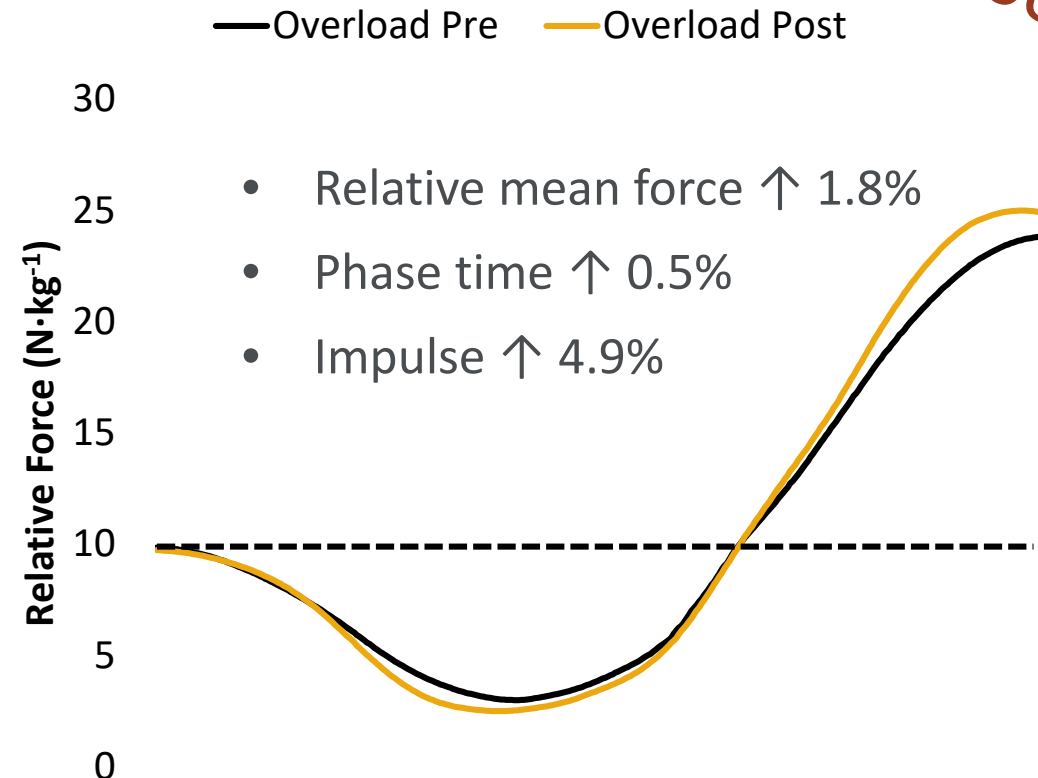
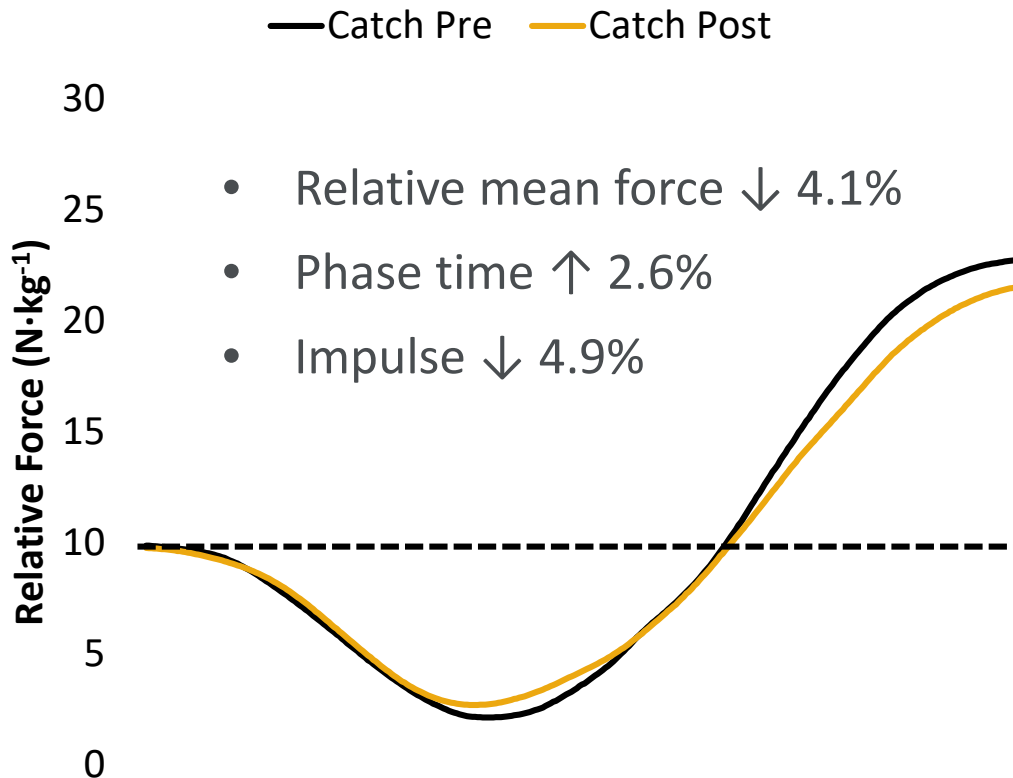
- Suchomel et al., 2017
- Comfort et al., 2017
 - Greater work performed during pull from the knee and hang clean compared to power clean from the knee
- Suchomel et al., 2018
 - Greater hip, knee, and ankle joint work during the jump shrug compared to hang power clean
- Suchomel et al., 2020b



Load Acceptance Comparisons

Suchomel et al., Unpublished Data

20 and 40%
bodyweight loads
coming soon!



Load Acceptance Comparisons

Technique and Competency

- Stimulus modified by catch technique
- Less experienced athletes may “overpull” the bar
- More experienced athletes catch the bar at peak height
 - Decreased downward displacement of load, which limits the influence of gravity
- Pulling derivatives may include a larger downward displacement of load following the pull
 - Emphasis is placed on maximizing bar height

Weightlifting Derivatives Load Acceptance

Summary

- Catching and pulling derivatives may both offer unique eccentric (braking) stimuli
 - Catching derivative stimulus may decrease as an athlete improves their technique
 - May also be modified by exercise, load, and range of motion during the catch
 - Pulling derivatives may provide a similar or greater stimulus due to maximizing bar displacement during every repetition
 - Challenges previous mentalities, but all exercises are tools in the toolbox
- Important to consider the phasic training goals
 - Exercise selection
 - Load
 - Volume
 - Etc.

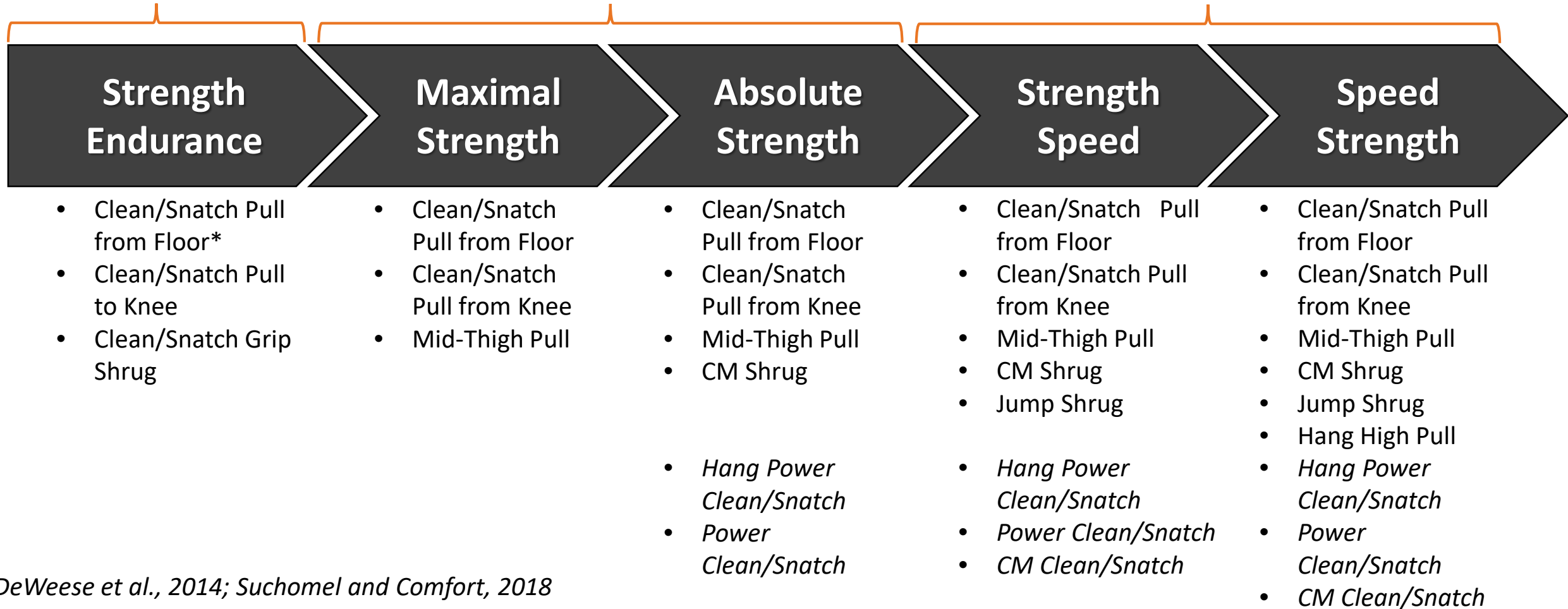


Training Progression and Exercise Selection

Work Capacity &
Hypertrophy

Peak Force Production &
Rate of Force Development

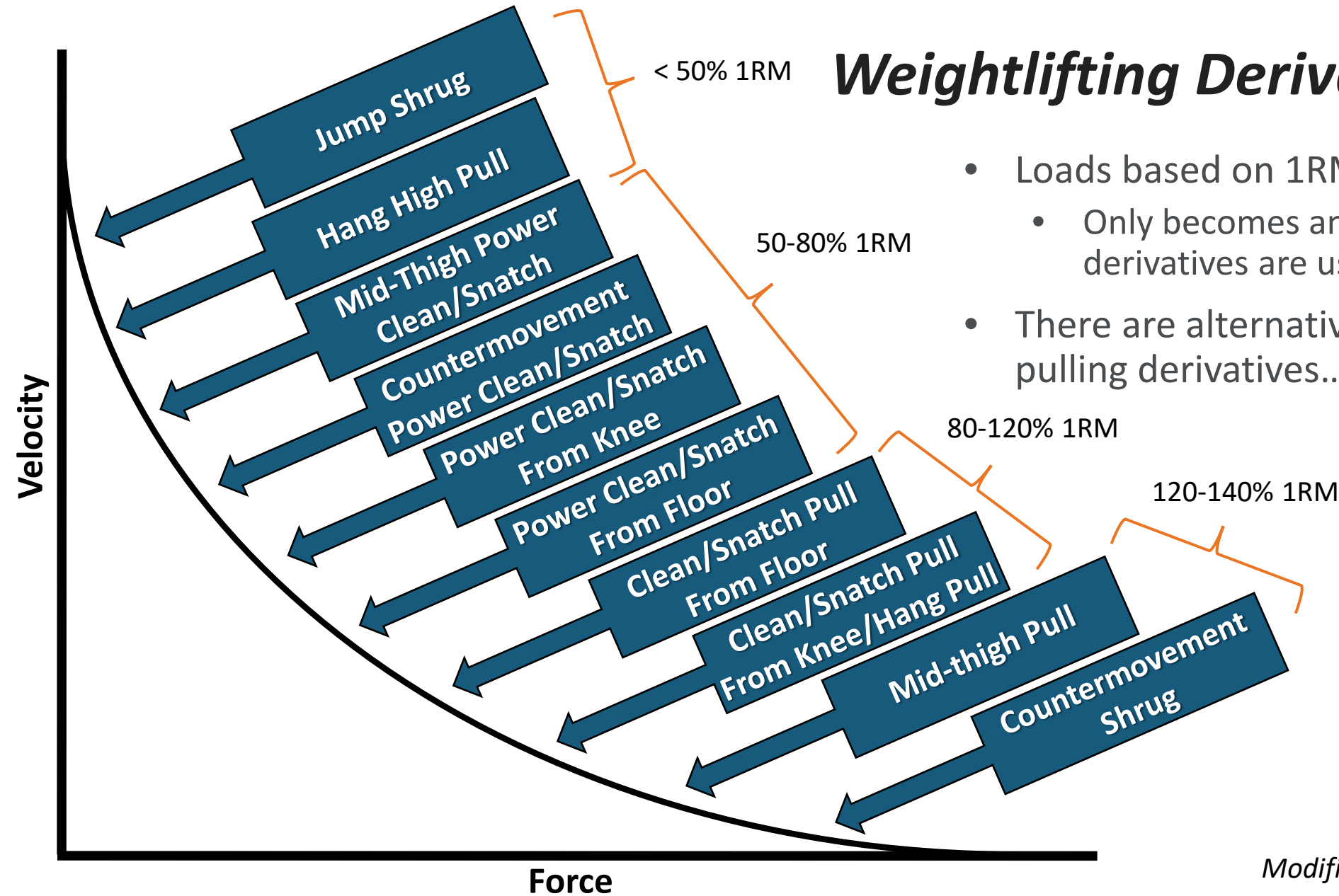
Rate of Force Development &
Peak Power



DeWeese et al., 2014; Suchomel and Comfort, 2018

Weightlifting Derivative Loading

- Loads based on 1RM catching derivative
 - Only becomes an issue if no catching derivatives are used to base load on
- There are alternatives for loading pulling derivatives...



Modified from Suchomel and Comfort, 2018

Alternative Pulling Derivative Loading Methods

- Set-repetition best
 - Estimating a “1RM” and the percentages based on what is performed in training
 - May work best for force-dominant exercises (e.g. mid-thigh pull, countermovement shrug, etc.)
- % of body mass or back squat 1RM
 - May work best for velocity-dominant exercises (e.g. jump shrug, hang high pull, etc.)
 - “Optimal load” range may vary based on relative strength
- Peak barbell velocity zones
 - Exercise and load combinations may train specific fitness characteristics

Exercise	% BM	% BS
Jump Shrug	20-50	10-25
Hang High Pull	45-70	20-35
Hang Clean Pull	120-145	60-70
CM Shrug	120-145	60-70

Suchomel et al., In Progress

Summary

- The use of F-V profiling as a means to determine exercise selection and potential insight into what matters in sport
- Weightlifting catching and pulling derivatives are both effective training stimuli for force and velocity characteristics
- Weightlifting pulling derivatives may provide a greater force and velocity overload stimulus due to the nature of the exercises and loading potential
- The exercise and load combination should be chosen based the athlete's technical competency and the goals of the training phase
- Weightlifting derivatives are part of a holistic training program (e.g. sprints, jumps, etc.)

Thank you!

- Questions?

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