CONFLICT OF INTEREST STATEMENT

I have one potential conflict of interest in relation to this presentation: I have a patent on a hip thrust device.

Force Vector Training

Bret Contreras, PhD, CSCS,*D

What to Expect

I. History of Force Vector Concept
II. Theories
III. Drawbacks
IV. Experiments
   I. Plyos
   II. Resistance Training
V. Conclusion

Force Vector Training

Where did it all begin? The emergence of the hip thrust in 2006…

Force Vector Training

Where did it all begin? A 2009 eBook…

Force Vector Training

Where did it all begin? A 2009 TNation Article…

Force Vector Training

Where did it all begin? A 2010 Blogpost…

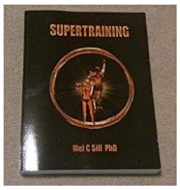
Force Vector Training

Where did it all begin? A 2011 SCJ Article…

Considering that (a) vertical forces tend to plateau after approximately 70% of maximum running velocity is achieved (1), whereas horizontal forces continue to increase as velocity rises, and (b) horizontal force application is significantly correlated to increased acceleration, whereas total and vertical force production are not (9), it seems wise to incorporate strategies to work the hips from a horizontal vector if increased speed and acceleration are sought. Furthermore, because of the increased muscular tension throughout the full range of motion, the hip thrust exercise would theoretically heighten the hypertrophic stimulus for the gluteal muscles (12) and thus increase strength and power potential because of the relationship of these factors to muscle cross-sectional area (3,5,6).

It was, however, observed long before I came around…

Mel Siff & Yuri Verkoshansky, Supertraining



"In some events, such as swimming, inertia plays a major role in the entire process, unlike in running, where the specificity of movement depends on *horizontal thrust* and the vertical oscillation of the athlete's center of gravity."[1]

"To fulfill the criteria of correspondence with respect to the amplitude and direction of movement, it is advisable to select the exact starting position and posture of the athlete, as well as to calculate the direction of action of the forces associated with the working links of the system and the additional load. The line of action of the applied external resistance and of the loaded movement as a whole must also be taken into account."

"For example, in middle-distance running, skiing and skating, a knapsack full of sand or a weight belt are sometimes used as resistance. However, the muscles which bear the load are those which resist the weight of the body. This can increase the ability to cope with vertical loading and develop general strength-endurance, but does not strengthen those muscles which propel the body horizontally."

"Similarly, a skater may execute jumps on one leg on the floor or from a bench. These exercises strengthen the leg muscles supporting the body and the static endurance of the back muscles, but do not fully imitate the working of the muscles for the push-off, where the force is directed backward."

"Skaters should use another method or resisted movement by changing the direction in which the force of resistance is acting. [Figure showing three different towing methods: 1) towing a human, 2) towing a weighted sled, and 3) towing a sled with a human sitting on it while skating] These methods to a large extent match the training exercise to the dynamics of the sport specific actions."[3]

"The strength exercise should not only reproduce the full amplitude of the movement but also the specific direction of resistance to the pull of the muscles."[3]

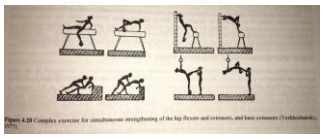


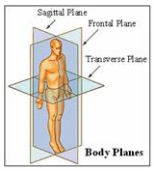
Figure 4.20 Complex exercise for simultaneous strengthening of the hip flexors and extensors, and knee extensors (Verkhoshansky, 1977).

Loaded single leg straight leg hip thrust variations from 1977

Planar Terminology

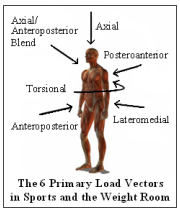
Popular amongst strength coaches

Drawback: Jumping upward, jumping forward, landing from a vertical or broad jump, sprinting forward, decelerating from linear running, and backpedaling are all sagittal plane activities



Vector Terminology

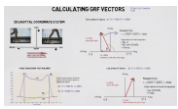
More Specific



A Naming Problem: What to call it?

A force is a vector quantity; it has both magnitude and direction.

- Vector Specificity?
- Force Training?
- Multidirectional Training?
- Force Vector Specificity?
- Load Vector Training?



Theories: Why Would it Work?

Torque Angle Curve Specificity

Are All Hip Extension Exercises Created Equal?

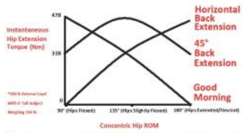


Figure 3. Graph of instantaneous hip extension torque at selected ranges of motion in 3 different hip extension exercises.

Theories: Why Would it Work?

Torque Angle Curve Specificity

A COMPARISON OF HIP JOINT KINETICS DURING THE BARBELL HIP THRUST, DEADLIFT AND BACK SQUAT

Ian Bezodis, Laurie Needham and Adam Brazil
School of Sport & Health Sciences, Cardiff Metropolitan University, Cardiff, UK

The barbell hip thrust, deadlift and back squat are all exercises designed to strengthen the hip extensor muscles. The aim of this study was to directly compare hip joint kinetics in the lifting phase of the barbell hip thrust with those in the deadlift and back squat. Six resistance-trained men performed one set of three repetitions at 90% 1RM of each exercise. Kinematic (250 Hz) and kinetic data (1000 Hz) were used to calculate hip angle and moment throughout each lifting phase. Analysis of continuous data revealed that the hip extensor moment was significantly greater early in the lifting phase in the deadlift and later in the lifting phase in the hip thrust. All three exercises clearly facilitate the strengthening of the hip extensors, and careful consideration of the specific desired adaptation is recommended when selecting exercises for this purpose.

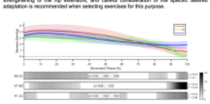


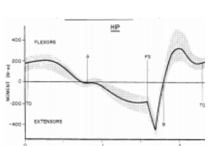
Figure 2: Mean ± standard deviation of hip moment throughout the lifting phase for hip thrust (HT, blue), deadlift (DL, red) and back squat (BS, green). Shaded bars represents the SnPM{t} output statistic for each comparison. Intensity of shaded areas indicate the extent to which the critical threshold (t*) was exceeded during the lifting phase.

Hip Extension Moment Angle Curve in Sprinting

KINETICS OF SPRINTING

Ralph Mann
Biomechanics Laboratory
206 Seaton Building; University of Kentucky; Lexington, Kentucky 40506

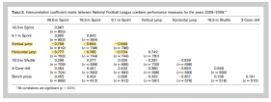
Paul Sprague
Biomechanics Laboratory
University of Kentucky
Lexington, Kentucky 40506



NFL Correlations Jumping & Sprinting

Relationships Between National Football League Combine Performance Measures

Daniel W. Robbins
Faculty of Health Sciences, School of Physiotherapy, University of Sydney, Lidcombe, Australia



Jumping Upward vs. Jumping Forward

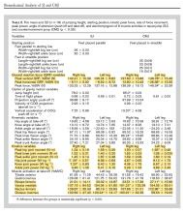
Biomechanical Analysis of Squat Jump and Countermovement Jump From Varying Starting Positions

Krzysztof Mackala,[1] Jacek Stodółka,[1] Adam Siemieński,[2] and Milan Coh[2]
Department of [1]Track and Field and [2]Biomechanics, University School of Physical Education in Wrocław, Poland; and [2]Department of Biomechanics, Faculty of Sport, University of Ljubljana, Slovenia

Biomechanical Analysis of Standing Long Jump From Varying Starting Positions

Krzysztof Mackala,[1] Jacek Stodółka,[1] Adam Siemieński,[2] and Milan Coh[2]
[1]Department of Track and Field; [2]Department of Biomechanics, University School of Physical Education in Wrocław, Wrocław, Poland; and [2]Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia

Jumping Upward vs. Jumping Forward



Jumping Upward vs. Jumping Forward

ORIGINAL RESEARCH

Kinetics of Standing Broad and Vertical Jumping

D.G.E. Robertson[1] and D. Fleming[2]
[1]Kinanthropology Department
University of Ottawa, Ottawa, Ontario
[2]School of Physical Education and Recreation
University of British Columbia
Vancouver, British Columbia

Percentage contributions of the leg joints to the total work done in the propulsive phases of standing broad and vertical jumps

Joint	*Standing broad jump* n = 8	*Vertical jump* n = 3
Hip	45.9 ± 8.3%	40.0 ± 9.6%
Knee	3.6 ± 3.4%	24.2 ± 7.3%
Ankle	50.2 ± 6.1%	35.8 ± 2.1%
Total / Total Change in Energy	89.0 ± 9.3%	94.0 ± 10.1%

Horizontal jump – more hip and ankle work, less knee

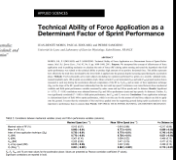
Horizontal Force in Sprinting

Effects of Running Velocity on Running Kinetics and Kinematics

Matt Brughelli,[1] John Cronin,[1,2] and Alan Chaouachi[3]
[1]School of Exercise, Biomedical and Health Science, Edith Cowan University, Joondalup, Western Australia, Australia; [2]Institute of Sport and Recreation Research New Zealand, AUT University, Auckland, New Zealand; and [3]National Center of Medicine and Science in Sport, Tunisian Research Laboratory "Sport Performance Optimization" (NCMSS), Tunis, Tunisia

ORIGINAL RESEARCH

Technical Ability of Force Application as a Determinant Factor of Sprint Performance



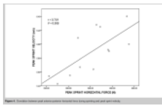
Sprint Acceleration Mechanics: The Major Role of Hamstrings in Horizontal Force Production

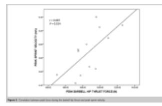
Jean-Benoît Morin[1†], Philippe Gimenez[2], Pascal Edouard[3,4], Pierrick Arnal[5], Pedro Jiménez-Reyes[1], Pierre Samozino[6], Matt Brughelli[7] and Jordan Mendiguchia[8]
[1]Laboratory of Human Motricity, Education Sport and Health (EA6312), Faculty of Sport Sciences, University of Nice Sophia Antipolis, Nice, France; [2]Laboratory Culture Sport Health Society (EA 4660), University of Franche-Comté, Besançon, France; [3]Laboratory of Exercise Physiology (EA4338), University of Lyon, Saint-Etienne, France; [4]Sports Medicine Unit, Department of Clinical and Exercise Physiology, Faculty of Medicine, University Hospital of Saint-Etienne, Saint-Etienne, France; [5]Faculty of Physical Sciences and Sport, Catholic University of San Antonio, Murcia, Spain; [6]Laboratory of Exercise Physiology and Biomechanics (LPBEM), University of Savoie, Le Bourget du Lac, France; [7]School of Sport and Recreation, Sport Performance Research Institute New Zealand, Auckland University of Technology, Auckland, New Zealand; [8]Department of Physical Therapy, ZENTRUM Rehab and Performance Center, Barakaldo, Spain

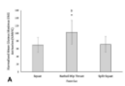
Recent literature supports the importance of horizontal ground reaction force (GRF) production for sprint acceleration performance. Modelling and clinical studies have shown that the hip extensors are very likely contributors to sprint acceleration performance. We experimentally tested the role of the hip extensors in horizontal GRF production during short, maximal, treadmill sprint accelerations. Torque capabilities of the knee and hip extensors and flexors were assessed using an isokinetic dynamometer in 14 males familiar with sprint running. Then, during10 s sprints on an instrumented motorized treadmill, horizontal and vertical GRF were synchronized with electromyographic (EMG) activity of the vastus lateralis, rectus femoris, biceps femoris, and gluteus maximus averaged over the first half of support, entire support, entire swing and end-of-swing phases. No significant correlations were found between isokinetic or EMG variables and horizontal GRF. Multiple linear regression analysis showed a significant relationship ($R^2 = 0.024$) between horizontal GRF and the combination of biceps femoris EMG activity during the end of the swing and the knee flexors eccentric peak torque. **In conclusion, subjects who produced the greatest amount of horizontal force were both able to highly activate their hamstring muscles just before ground contact and present high eccentric hamstring peak torque capability.**

Activation of the *Gluteus Maximus* During Performance of the Back Squat, Split Squat, and Barbell Hip Thrust and the Relationship With Maximal Sprinting

Michael J. Williams, Neil V. Gibson, Graeme G. Sorbie, Ukadike C. Ugbolue, James Brouner, and Chris Easton







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RESEARCH ARTICLE

Vertically and horizontally directed muscle power exercises: Relationships with top-level sprint performance

Irineu Loturco[1]*, Bret Contreras[2], Ronaldo Kobal[1], Victor Fernandes[3,4], Neilton Moura[3], Felipe Siqueira[4,5], Ciro Winckler[6], Timothy Suchomel[7], Lucas Adriano Pereira[1]

1 NAR—Nucleus of High Performance in Sport, São Paulo, Brazil, 2 Auckland University of Technology, Sport Performance Research Institute New Zealand, Auckland, New Zealand, 3 B3 Track & Field Club, São Paulo, Brazil, 4 ADAPT—Association of High-Performance Training & Sports Development, São Paulo, Brazil, 5 Pinheiros Sport Club, São Paulo, Brazil, 6 Brazilian Paralympic Committee, São Paulo, Brazil, 7 Department of Human Movement Sciences, Carroll University, Waukesha, WI, United States of America

Table 2. Shared variance (R^2) of the relationships among the sprint velocities and the vertical jumps and the maximum mean propulsive power (MPP) in the different exercises in top-level sprinters and jumpers.

	Sprint velocities					
	10 m	20 m	40 m	60 m	100 m	150 m
SJ	0.60	0.86	0.86	0.92	0.88	0.86
CMJ	0.60	0.85	0.90	0.86	0.86	0.81
MPP HS	0.82	0.93	0.91	0.87	0.76	0.74
MPP JS	0.75	0.90	0.92	0.89	0.79	0.77
MPP HT	0.86	0.91	0.91	0.89	0.72	0.74

Note:SJ: squat jump; CMJ: countermovement jump; HS: half-squat; JS: jump squat; HT: hip-thrust.

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Transference of Strength and Power Adaptation to Sports Performance—Horizontal and Vertical Force Production

Aaron D. Randell, MSc, John B. Cronin, PhD, Justin W.L. Keogh, PhD, and Nicholas D. Gill, PhD
Sport Performance Research Institute New Zealand, AUT University, Auckland, New Zealand; and School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Perth, Western Australia, Australia

Importance of Horizontally Loaded Movements to Sports Performance

Michael Zweifel, MS, CSCS
Building Better Athletes, Dubuque, Iowa

Bret Contreras, PhD, CSCS,*D
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Biggest Drawback of FV Model

Must Be a Highly Effective Exercise

- Example: Full Squat vs. Band Pull Through

Another Drawback

Overly Simplistic

- Is a landmine cross-body single leg RDL axial, anteroposterior, lateromedial, or torsional?

Another Drawback

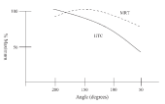
Overly Simplistic

- Squats will likely transfer well to every vector (axial, torsional, anteroposterior, lateral)

Another Drawback

Overly Simplistic

Forms of Variable Resistance Training



- Implies that isokinetics and machines would trump free weights for sports performance

Another Drawback

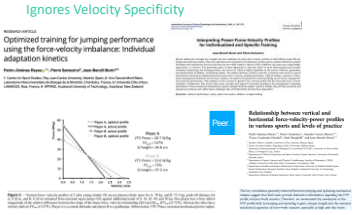
Overly Simplistic

1. Muscle action (eccentric or concentric)
2. Velocity (fast or slow)
3. Repetition range (maximum strength or muscular endurance)
4. Range of motion (full or partial)
5. Degree of stability (stable or unstable)
6. External load type (constant load or accommodating resistance)
7. Force vector (vertical or horizontal)
8. Muscle group

- It's just one of 8 types of specificity in strength training

Another Drawback

Ignores Velocity Specificity



- Ignores force-velocity profiling

The Twin Experiment

Not Published; Part of My PhD Thesis

	1RM Squat	1RM Hip Thrust	Maximum Horizontal Pushing Force	Upper Gluteus Maximus Thickness	Lower Gluteus Maximus Thickness
Squat Twin	↑ 63%	↑ 16%	↑ 20%	↑ 20%	↑ 21%
Hip Thrust Twin	↑ 42%	↑ 54%	↑ 32%	↑ 28%	↑ 28%

Published Research

Does Theory Match Experiments?

Plyometric Studies

Lateral vs. Vertical

COMPARING PRESEASON FRONTAL AND SAGITTAL PLANE PLYOMETRIC PROGRAMS ON VERTICAL JUMP HEIGHT IN HIGH-SCHOOL BASKETBALL PLAYERS

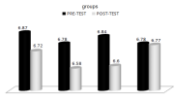
The Effects of Frontal- and Sagittal-Plane Plyometrics on Change-of-Direction Speed and Power in Adolescent Female Basketball Players

Brian T. McCormick, James C. Hannon, Marta Newton, Barry Shultz, Nicole Detling, and Warren B. Young

Vertical better for jumping, lateral better for lateral agility

Plyometric Studies

Vertical vs. Horizontal



VP – vertical depth jump group, HP – horizontal depth jump group, CP – vertical and horizontal depth jump group, CG – control group.
Figure 2. Pre-test and post-test running speed means (s) of the experimental and control

Effects of vertical, horizontal, and combination depth jump training on long jump performance

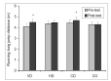
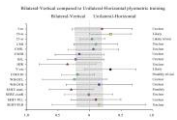


Fig. 2. The mean and standard deviation values for moving long jump performance obtained in studied groups during pre- and posttest

Both groups good for jumping and sprinting but vertical better for jumping and horizontal better for sprinting

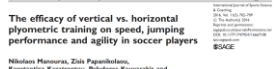
Unilateral horizontal superior for 10m sprint and multiple COD

Influence of force-vector and force-application plyometric training in young elite basketball players



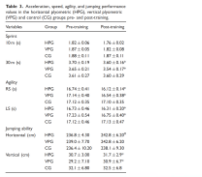
Bilateral Vertical compared to Unilateral Horizontal plyometric training

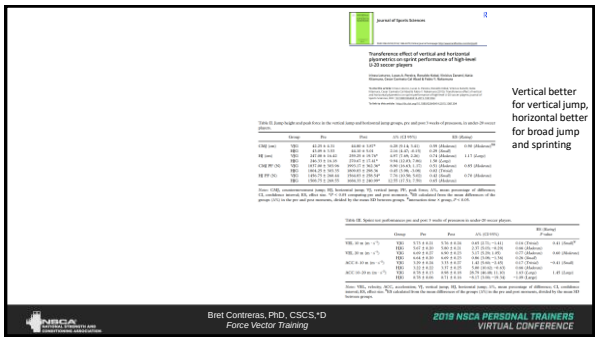
Both groups great for sprint, agility, and jumping, but horizontal better for broad jump



The efficacy of vertical vs. horizontal plyometric training on speed, jumping performance and agility in soccer players

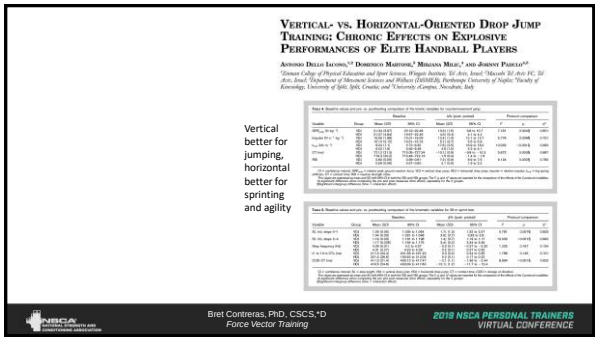
Nikolaos Manouras, Zisis Papanikolaou, Konstantina Karatrantou, Polydoros Kouvarakis and Vassilis Gerodimos





Transference effect of vertical and horizontal plyometrics on sprint performance of high-level U-23 soccer players

Vertical better for vertical jump, horizontal better for broad jump and sprinting



Vertical- vs. Horizontal-Oriented Drop Jump Training: Chronic Effects on Explosive Performances of Elite Handball Players

Vertical better for jumping, horizontal better for sprinting and agility

Resistance Training Studies

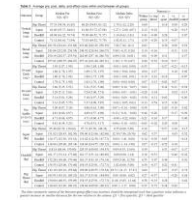
Squat vs. Hip Thrust

Effects of a Six-Week Hip Thrust vs. Front Squat Resistance Training Program on Performance in Adolescent Males: A Randomized Controlled Trial

Short Communication

Effects of 6-week squat, deadlift, or hip thrust training program on speed, power, agility, and strength in experienced lifters: A pilot study

Michael B. Zwetsloot, Andrew D. Vigotsky, Bret Contreras, Wycliffe W. Njoroge Sinuya



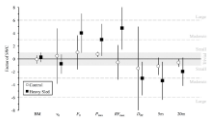
International Journal of Sports Physiology and Performance – 2016

BRIEF REPORT

VERY-HEAVY SLED TRAINING FOR IMPROVING HORIZONTAL FORCE OUTPUT IN SOCCER PLAYERS

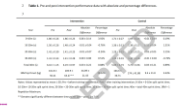
Morin JB[1,2*], Petrakos G[3], Jiménez-Reyes P[1], Brown SR[4], Samozino P[5], Cross MR[6]

[1] Université Côte d'Azur, LAMHESS, Nice, France
[2] School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, United Kingdom
[3] Faculty of Physical Education and Sport, Catholic University of San Antonio, Murcia, Spain
[4] Sports Performance Research Institute New Zealand (SPRINZ), Auckland University of Technology, Auckland, New Zealand
[5] Université Savoie Mont Blanc, Laboratoire Interuniversitaire de Biologie de la Motricité, EA 7424, F-73000 Chambéry, France



Hip Thrust Gains with no Speed Gains?

Effects of Hip Thrust Training on the Strength and Power Performance in Collegiate Baseball Players



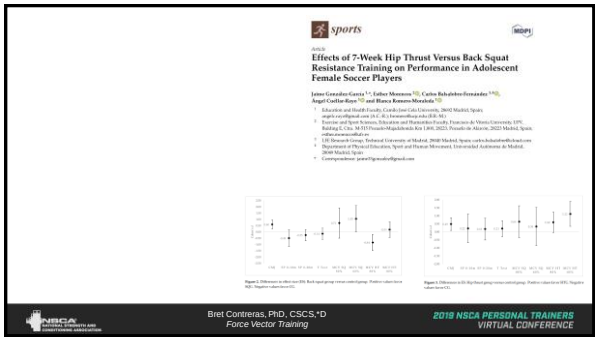

sports

MDPI

Article

The Magical Horizontal Force Muscle? A Preliminary Study Examining the "Force-Vector" Theory

David A. Fitzpatrick, Giuseppe Cimadoro and Daniel J. Cleather

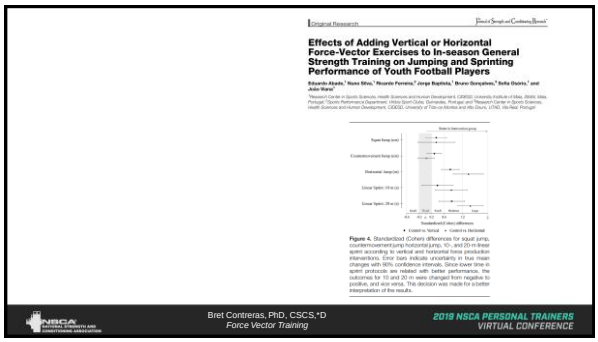

sports

MDPI

Article

Effects of 7-Week Hip Thrust Versus Back Squat Resistance Training on Performance in Adolescent Female Soccer Players

Jaime González-García *, Esther Morenas, Carlos Rubalcabo-Fernández and Angel Cuellar-Rayo


Original Research

Effects of Adding Vertical or Horizontal Force-Vector Exercises to In-season General Strength Training on Jumping and Sprinting Performance of Youth Football Players

Eduardo Abade, Nuno Silva, Ricardo Ferreira, Jorge Baptista, Bruno Gonçalves, Sofia Owen, and Aldo Marques

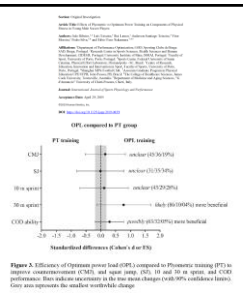


Figure 3. Efficiency of Optimum power load (OPL) compared to Plyometric training (PT) to improve countermovement (CMJ), and squat jump. (SJ). 10 and 30 m sprint, and COD performance. Bars indicate uncertainty in the true mean changes (with 90% confidence limits). Grey area represents the smallest worthwhile change

Conclusion

- Force Vector Theory is Legit but Just One of Many Forms of Specificity
- Vertical Plyos and Squats are Better for Jumping
- Horizontal Plyos and Hip Thrusts are Better for Sprint Acceleration
- Hip Thrusts May Work Better on Younger and Lesser Developed Athletes
- Do it All For Maximal Performance Improvements