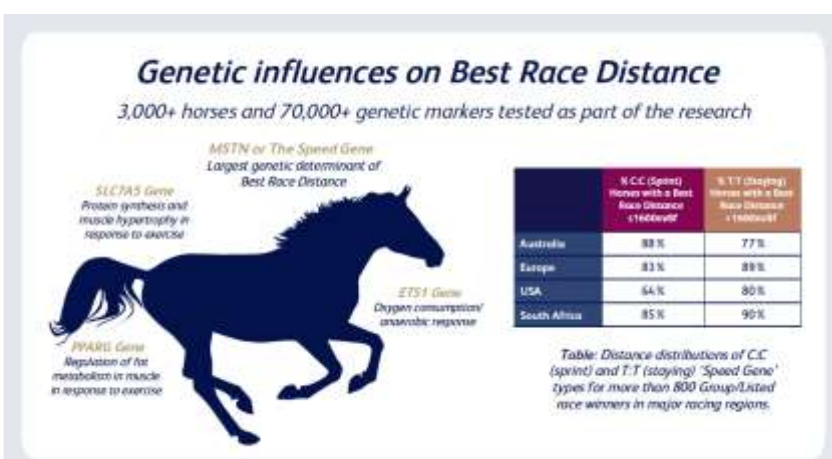
Changing your lens on sprint training

1

A brief history of sprint training

- You either have it or you don't…follow the **money**



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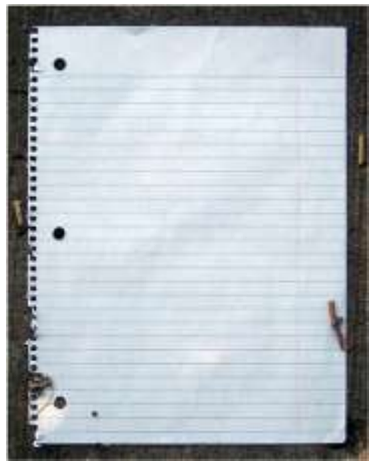
OK…maybe we can build it

3

The basics and the myths

4

Here is the research that correlates Olympic lifts with acceleration



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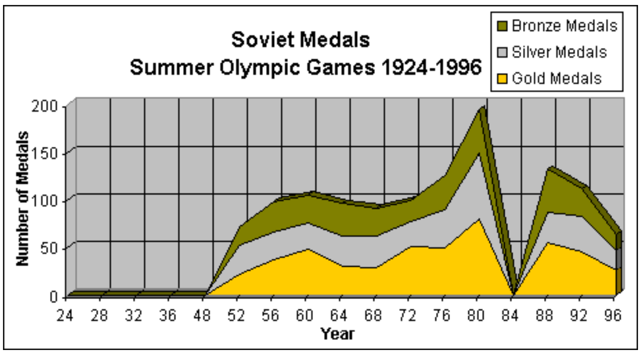
Running drills- Mach drills, Running Dynamics

6

Success of the Eastern Block Countries



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The science

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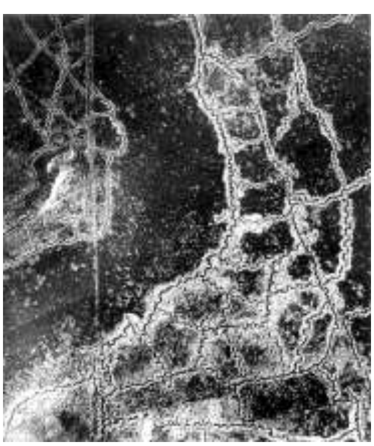
Just like in war, it comes down to logistics, fear and tradition



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The Basics

- Top end speed is important and can be improved
- But needs to be monitored in a short, non-fatigued session.

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How did I change the lens?

- **Look where others haven't**

- Feet
- Front view

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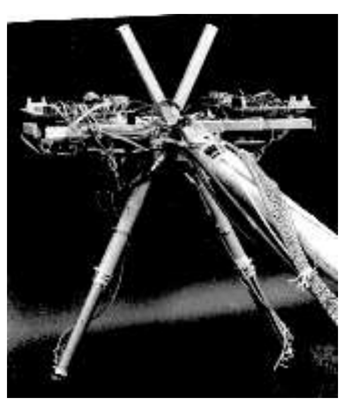
MIT's Planar Bipedal robot 5.9 m/s



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MABEL 6.8 mph

15

Boston Dynamics

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18

Here's the gold…

- If the power is the limitation, then at max velocity, the drag force cancels the thrust force, leaving no thrust to accelerate the system. If the limitation is strength, then at maximum speed the loading on some components equals its strength, and any increase in speed would cause it to break. If the limitation is stability, then at the max speed, some equilibrating mechanisms is at the stability limit, and at a higher speed the system would tumble out of control.

- How Fast Can a Robot Run, Jeff Koechling

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Invert

Evert

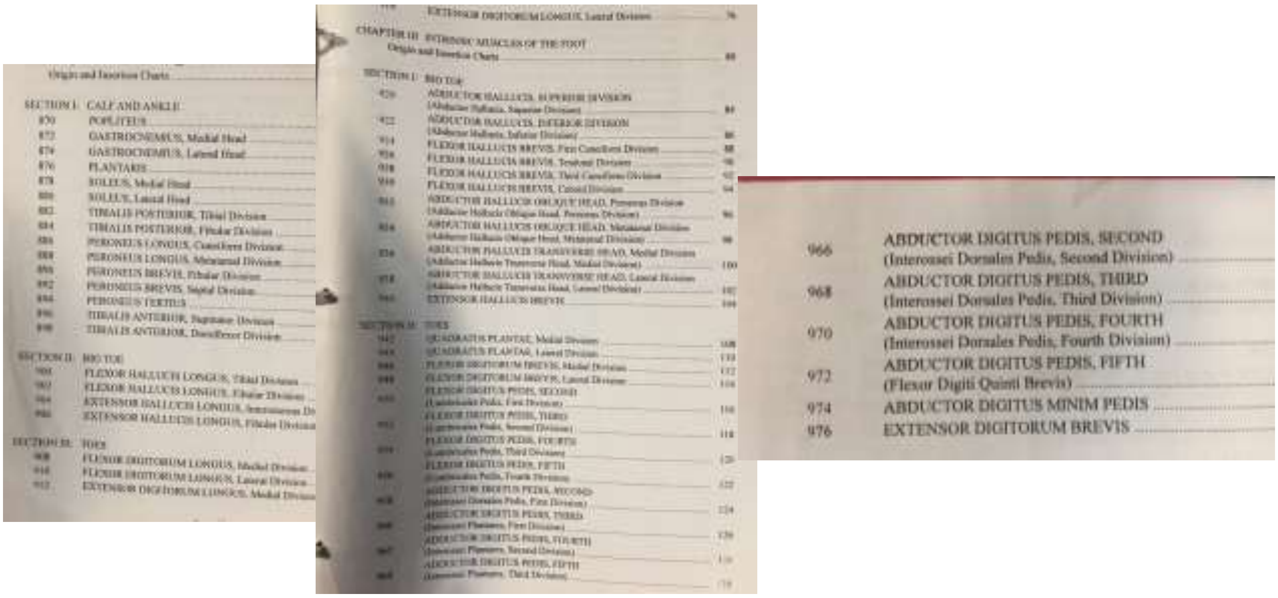
Pronate

Supinate

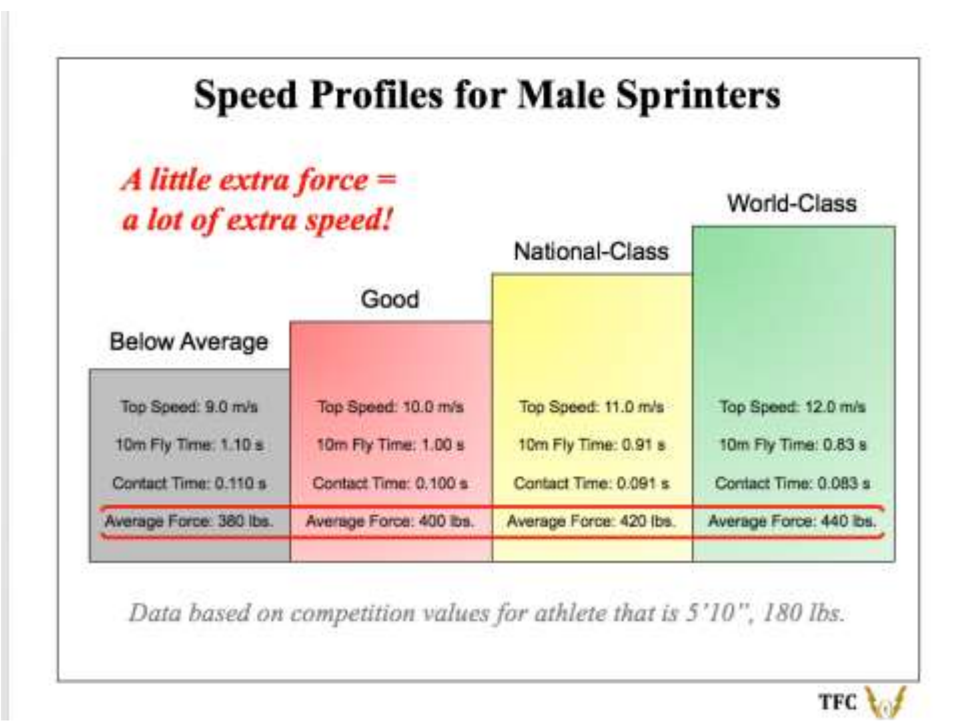
Varus

Valgus

22


966 ABDUCTOR DIGITUS PEDIS, SECOND (Interossei Dorsales Pedis, Second Division)
968 ABDUCTOR DIGITUS PEDIS, THIRD (Interossei Dorsales Pedis, Third Division)
970 ABDUCTOR DIGITUS PEDIS, FOURTH (Interossei Dorsales Pedis, Fourth Division)
972 ABDUCTOR DIGITUS PEDIS, FIFTH (Flexor Digiti Quinti Brevis)
974 ABDUCTOR DIGITUS MINIM PEDIS
976 EXTENSOR DIGITORUM BREVIS

23



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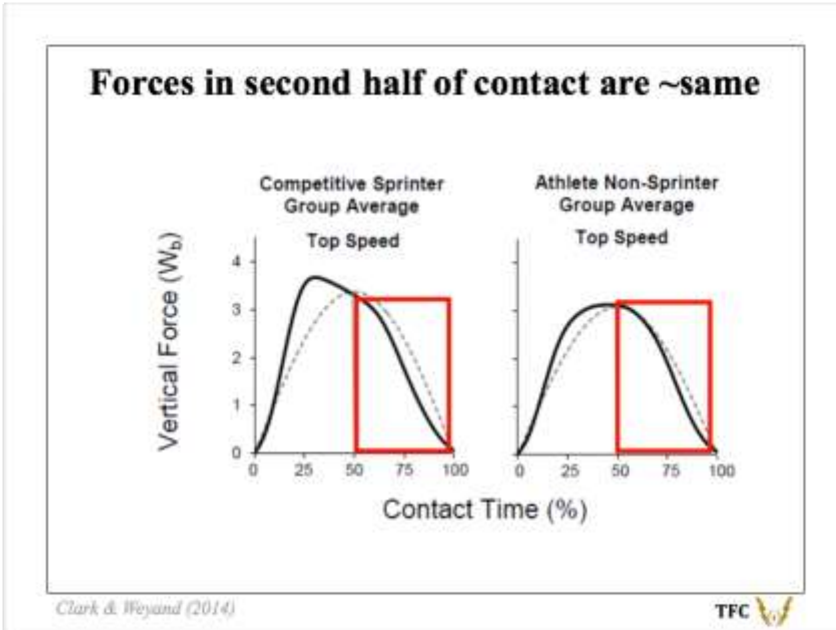
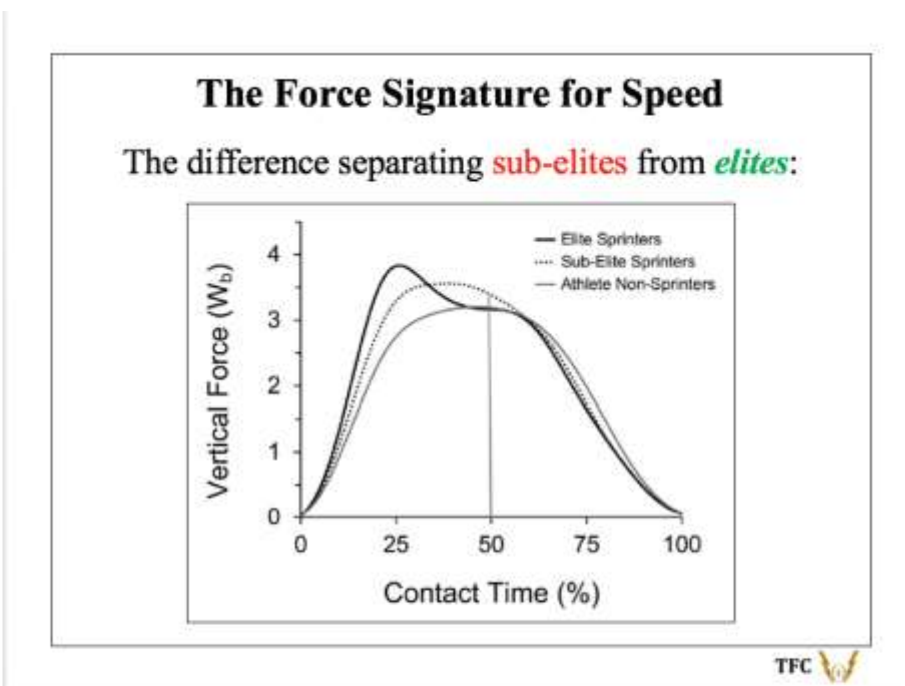


Forces in second half of contact are ~same
Competitive Sprinter
Group Average
Top Speed
Athlete Non-Sprinter
Group Average
Top Speed
Vertical Force (Wb)
Contact Time (%)
Clark & Weyand (2014)
TFC

25



The Force Signature for Speed
The difference separating sub-elites from elites:
Elite Sprinters
Sub-Elite Sprinters
Athlete Non-Sprinters
Vertical Force (Wb)
Contact Time (%)
TFC

26

Understanding the effect of Touchdown distance and ankle joint kinematics on sprint acceleration performance through computer simulation, Bezodis, N., Sports Biomechanics, (2015)

- "Beneficial effects of reducing ankle joint dorsiflexion during early stance on early acceleration performance and identified the need for coaches to increase ankle plantar flexor strength…"

- Slightly greater than 90 degrees

27

THE FOOT

- CONTACT– The stiffer the ankle complex is at contact, the more energy can be transferred up and down the line

- For example, poor big toe function will dissipate 34% of the energy that the foot/ankle complex absorbs which is about 75% of the total energy in a sprint

28

Tendon elastic energy in the human ankle plantar-flexors and its role with increased running speed
Adrian Lai, Anthony, Schache, J of Experimental Biology, 2014

- MTU of gastroc and soleus was responsible for 75% of positive work at 8 m/s

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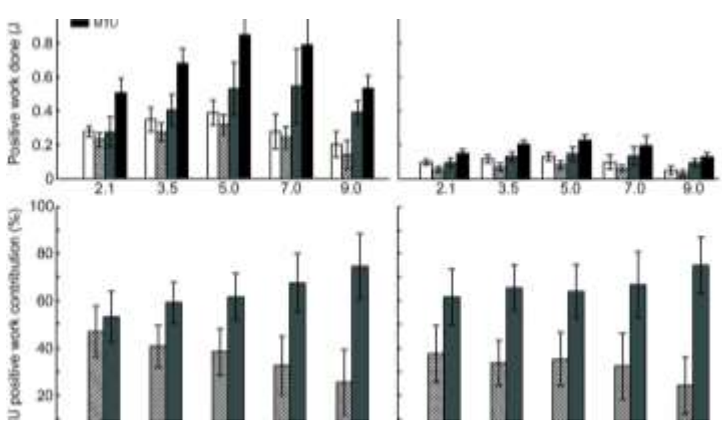
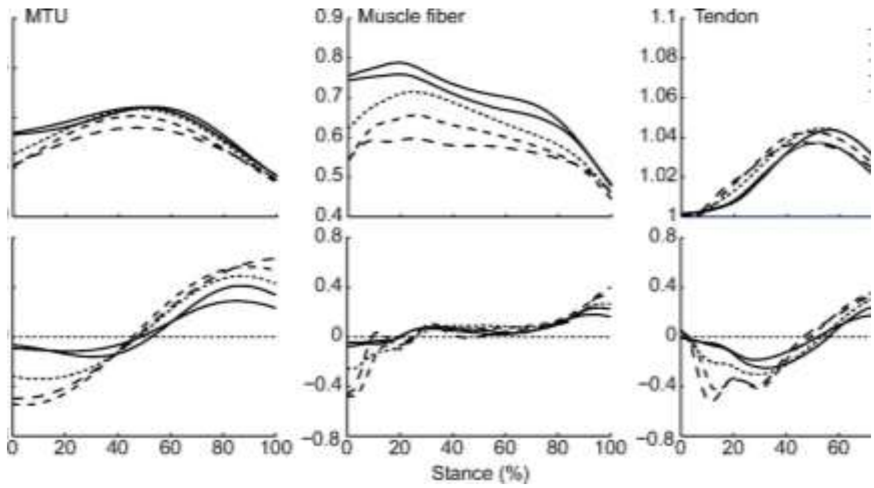
Muscles in Isometric state and MTU active



White muscle fiber stripe fiber with mTU grey tendon black MTU

30

Muscle length changes with velocity



Top normalized length bottom contraction velocity shows as speed picks up- more MTU and Tendon over muscle- big calf distance runner

31

Dynamic contribution analysis on the propulsion mechanism of sprinters during initial acceleration phase, Koike, S., 33rd International conference on Biomechanics in sport, 7/15

- Ankle dorsiflexion torque was the largest contributor to the generation or whole body propulsion

32

Support leg joint contributions to center of mass acceleration during 3 phases of a maximal sprint, von Lieres, H. conference paper

- MTP (metatarsal phalangeal joint) and ankle showed the largest contributions to vertical and horizontal acceleration

33

When account for MPJ…

- Ankle- 35% higher
- Knee- 40% lower
- Hip- 9% higher

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So why not popular?

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Which logo do you want on your shirt?

BENCH PRESS 300 CLUB

Isometric Plantar flexion club for 700 N

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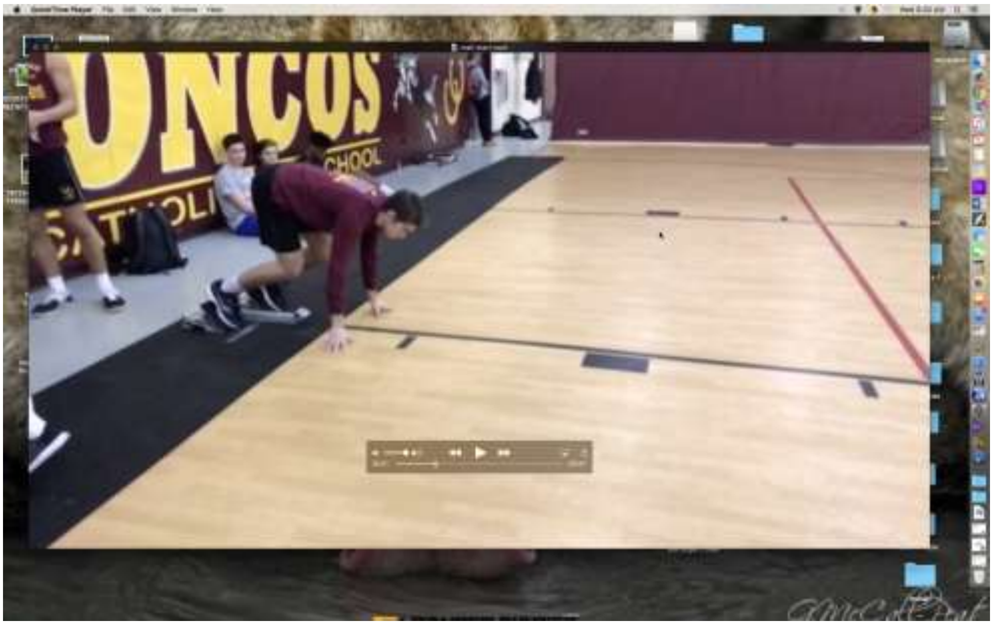

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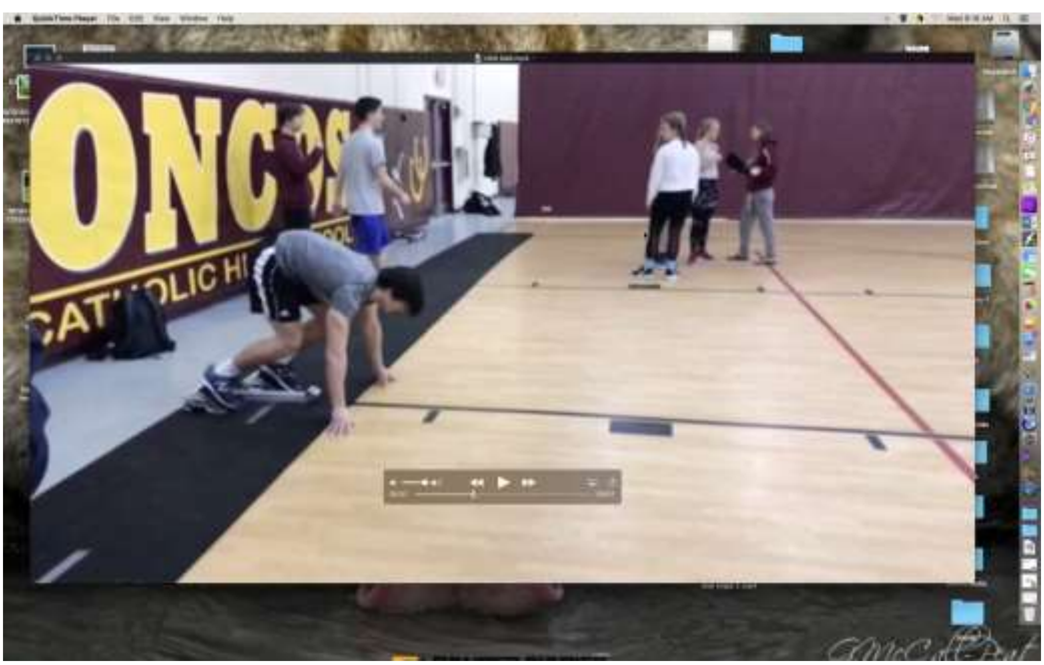

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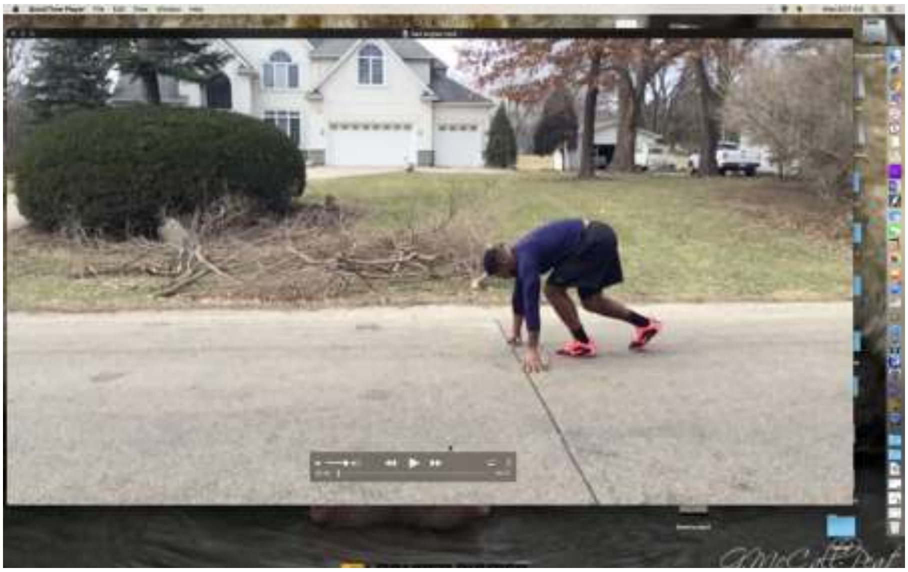

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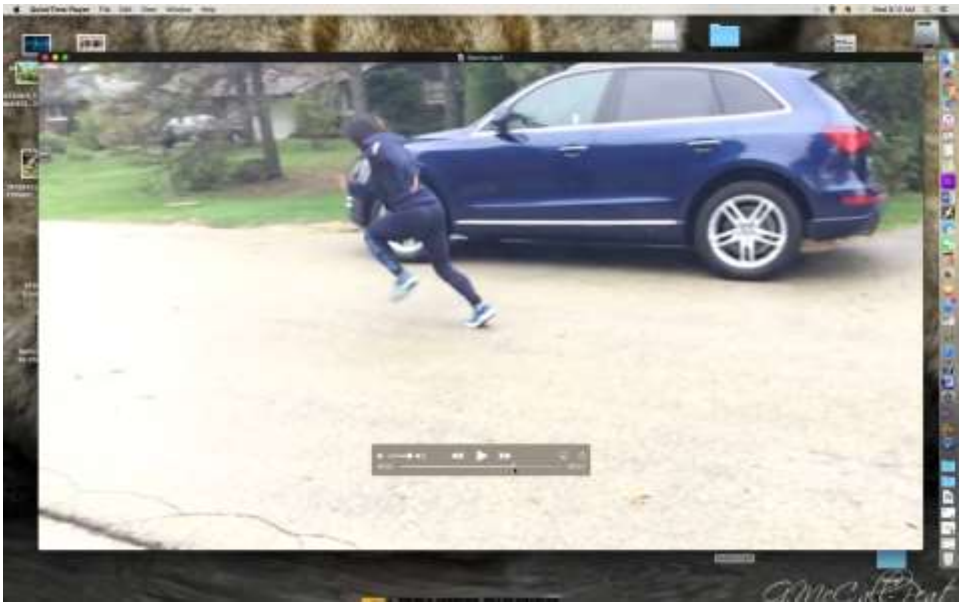

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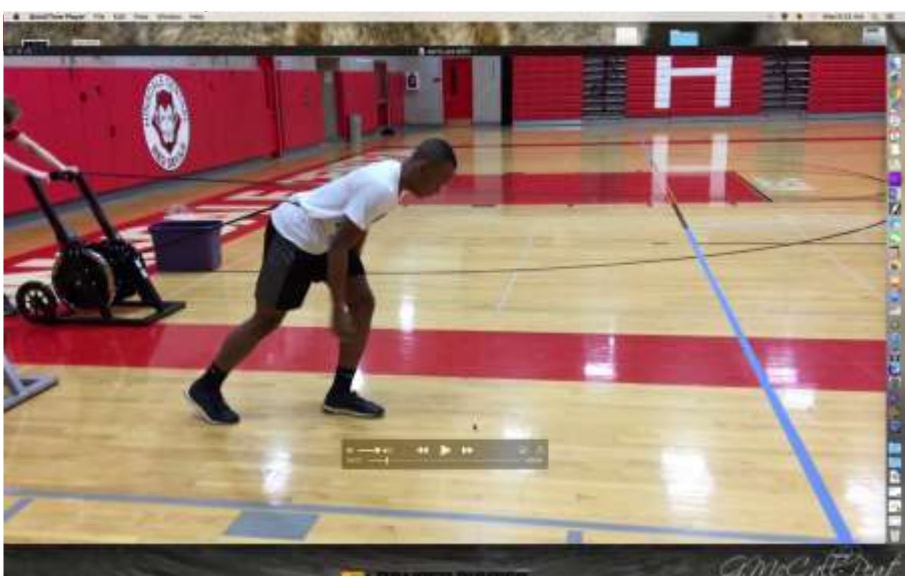

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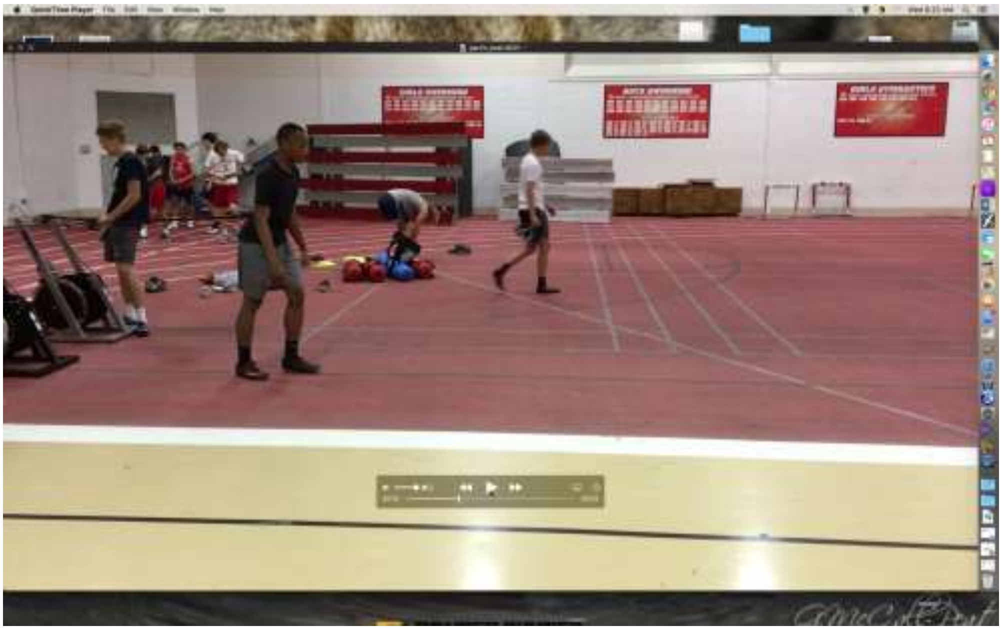

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Let’s move…

- Stand up
- Go into a calf raise
- Which way does your foot break
    - Over 4 toes?
    - Big toe?

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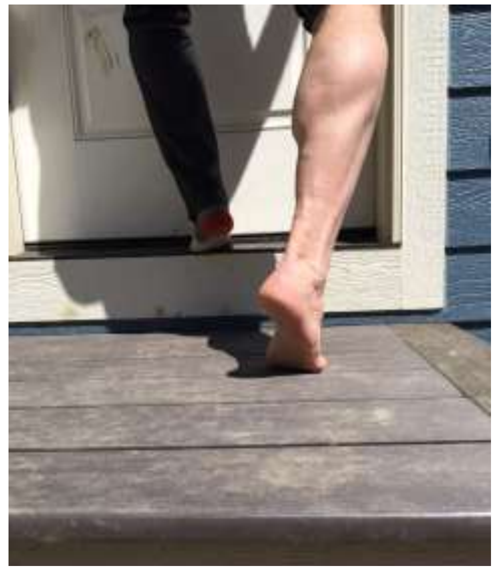
Good foot/bad foot



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ISO foot patterns

- ISO Position has a 15 degree carryover in each direction

- Knee straight
- Knee bent
- Big toe

- Hip position and placement of weight key

46

Can you?

- 1. Stand on 2 feet with pressure on your tripod?
- 2. Do the same on one foot?
- 3. Pull your toes off the ground and balance?
- 4. Close your eyes? Ears?
- 5.Ankle squat and hold that foot position?
- 6. Go up on your big toe

47

The anatomical arrangement of muscle and tendon enhances limb versatility and locomotor performance, Wilson, A., Philosphical transcations of the Royal Society, (2011)

- Tendon stiffness is tuned to optimize fiber shortening velocity and minimize muscle activation
- To role of distal muscles may therefore not be to directly perform work but to modulate the power production of proximal muscles by functioning as a tuneable series of elasticity or tendon-Cocontractions

48

Stumble reflex

- ”At the spinal cord level, there is a coupling between muscle and its antagonist (and an inhibition of one another).” Both in a trip or gait.
-

49

Stumbling corrective reaction: a phase-dependent compensatory reaction during locomotion.

Forssberg H., 1979

- Tripping cats
- Perturbations in the stumble reflex cycle cause ”brisker flexion”
- Making your body think it is going to fall or trip will trick it into tensing

50

- Body organization: The goal the body has is to organize its parts to do the task that has been set out. In an athletic sense, this would incorporate navigation, slack control with co-contractions and a target. In order to challenge this process, we can make things happen faster so body has to prepare faster or fall (managing reflexes). When challenged the body will learn to stiffen faster to prepare for the unexpected. This translates to the actual movement because the body will find that it works better when it is stiffer and stable.

51

SO……..

- Overspeed works because it forces a stiffer spring (which results in higher Ground Reactionary Force) in a manner that the body accepts and assilimilates due to stumble reflexes and motor learning skill development.

52

Even cooler thought of the day…

- The peak forces that occur in a reflexive support during sprinting , such as stumble and crossed extensor, are greater than those that can be created by "maximum voluntary contraction".
- Kyrolainen, H. et al. Changes in muscle activity with increased running speed" J. of Sports Sciences, 2005

53

Overspeed

- Bands
- Unweighted
- Tows
- Elevated surfaces

54

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57

The Acute Kinematic Effects of Sprinting with Motorized Assistance

Kenneth Clark, Micheal Cahill, Christian Korfist

- Theory: assisted sprinting could acutely enhance maximum velocity via mechanisms normally observed with swifter running, and without causing aberrant changes to the runner’s gait, this mode of training may have potential to elicit long term improvements in top speed.
- -assisted max velocity would increase due to stride length rather than rate
- - assisted run would have decreased contact times and increased measure of vertical force but no appreciable changes in flight times, swing times or contact lengths

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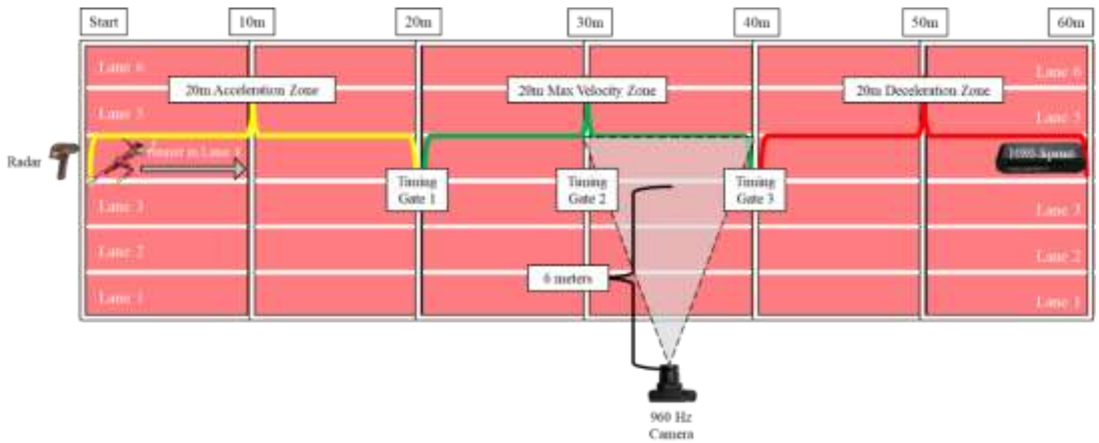

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	Velocity (m/s)	Contact Time (s)	Flight Time (s)	Step Time (s)	Swing Time (s)	Step Rate (Hz)	Step Length (m)	Contact Length (m)	Flight Length (m)	Vertical Force (BW)
Unassisted Mean	10.0	0.100	0.112	0.213	0.325	4.72	2.11	1.00	1.12	2.13
Unassisted SD	0.3	0.011	0.007	0.013	0.018	0.29	0.09	0.09	0.06	0.14
Assisted Mean	10.9*	0.095*	0.116†	0.211	0.328	4.75	2.30*	1.03*	1.26*	2.24*
Assisted SD	0.4	0.010	0.006	0.014	0.019	0.32	0.09	0.09	0.05	0.13
% Difference	9.4%	-5.2%	3.4%	-0.6%	0.8%	0.7%	8.7%	3.7%	13.1%	4.8%
Effect Size *(interpretation)*	3.28 *(v. large)*	0.49 *(small)*	0.58 *(small)*	0.10 *(trivial)*	0.15 *(trivial)*	0.11 *(trivial)*	2.04 *(v. large)*	0.40 *(small)*	2.62 *(v. large)*	0.76 *(moderate)*

60

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62

- **<u>Faster max velocities were achieved due to increased stride length and improved vertical forces</u>**
  - **Shows minimal changes in contact times and postural changes**
  - **Mean vertical forces was larger when towed than when unassisted**

63

Conclusion

- Although step rate did not change, there were small but significant decreases in contact time, indicating ***<u>increased vertical force</u>*** and decreased duty factor ratio during the assisted conditions. This is consistent with normal mechanics of increased max velocity,

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Toe pop exercises

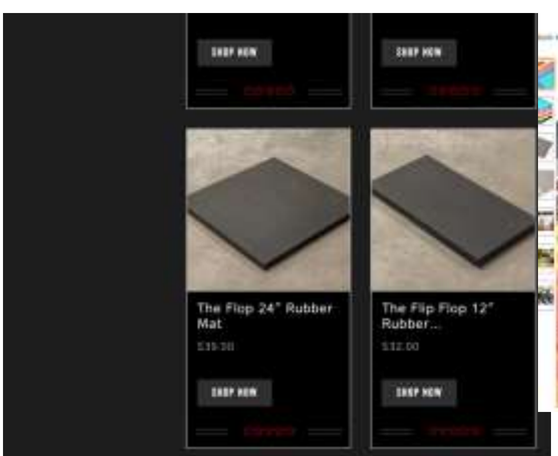
- Needs to be alternating or else no stumble reflex and becomes bag hop exercises

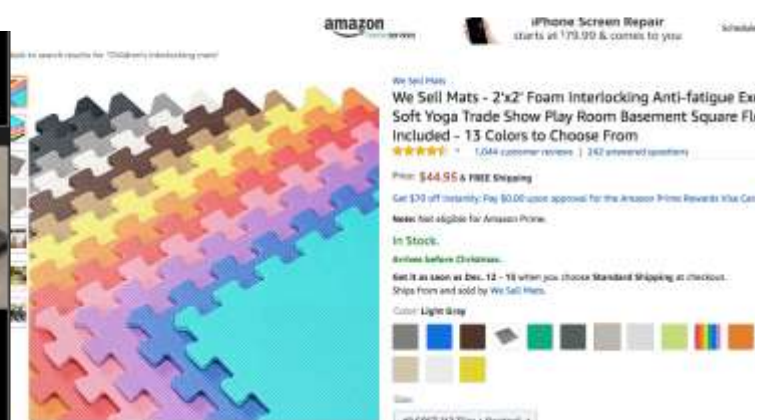
68

Raise the ground with **mats**

69

mats





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Once energy is absorbed, it needs a direction

- Ankle rocker or its 8 ugly sisters give it direction

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Ankle Rocker

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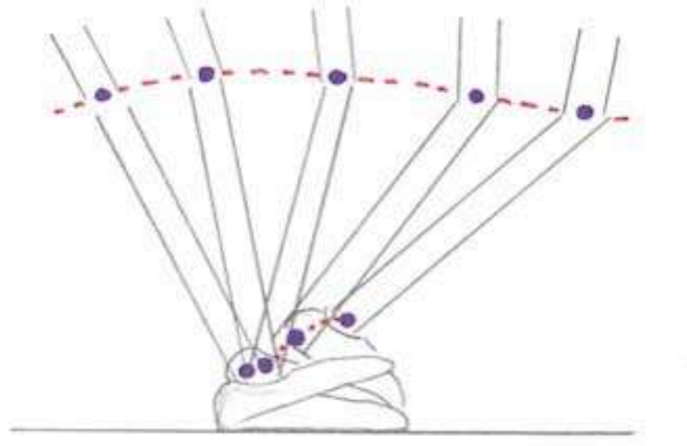


73

Common cheat patterns

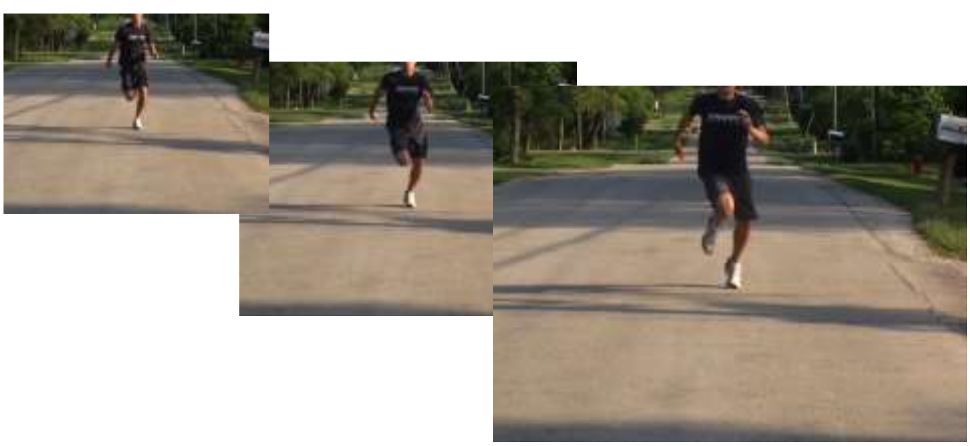
- Turn foot in
- Turn foot out
- Bounce over the top– bouncy gait
  Collapse arch
  Swing hips
  Outside of foot
  Throw body weight forward

74

Turn foot in

75

out



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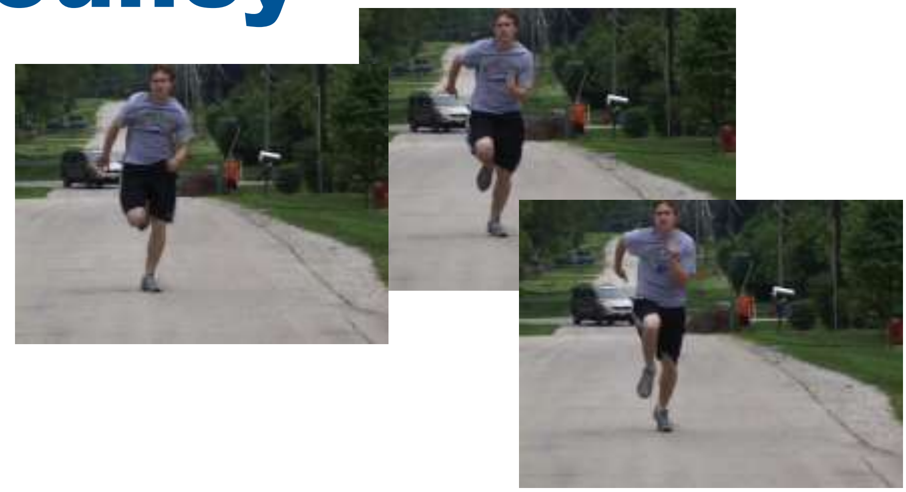
Bouncy



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Spin out through big toe

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Anterior tilt

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Hips or knees swing wide

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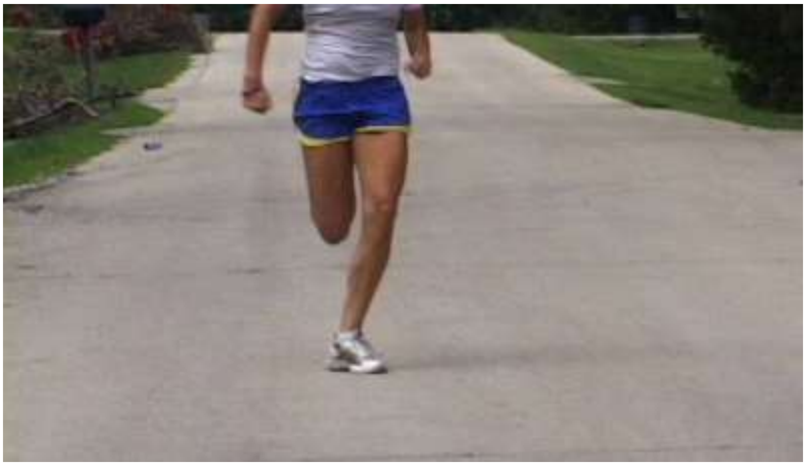

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Throw weight forward

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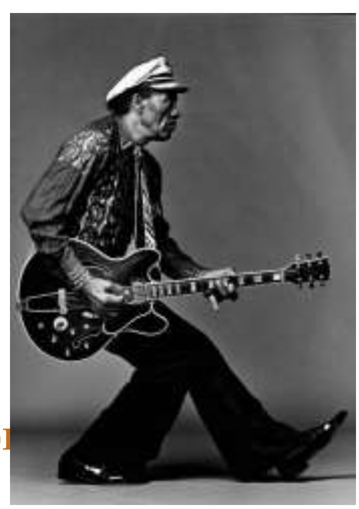
Exercises

- Wind shield wipers
- Single leg squats
- Shuffle walks
- Ankle jumps
- Overspeed/French Contrast
- Uphill Toe pops

- Add to all exercises in weight roo
- (Squats, lunges)



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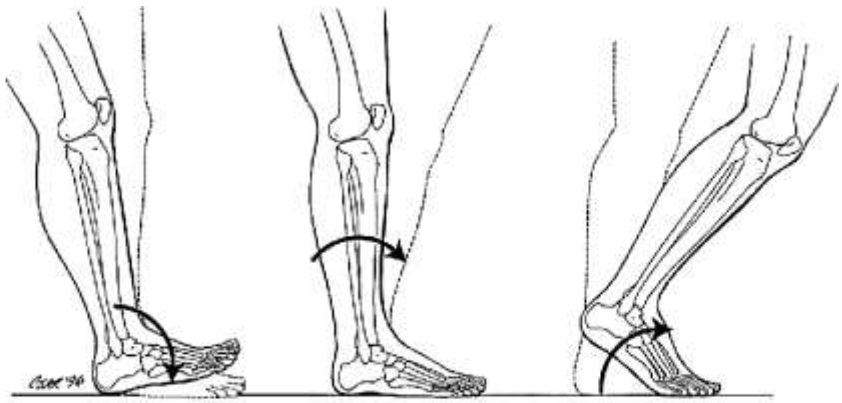
Once ankle rocks, goes to forefoot rocker



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Toe-off

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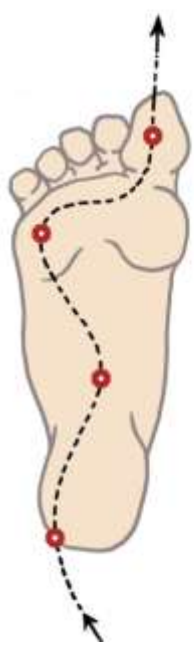


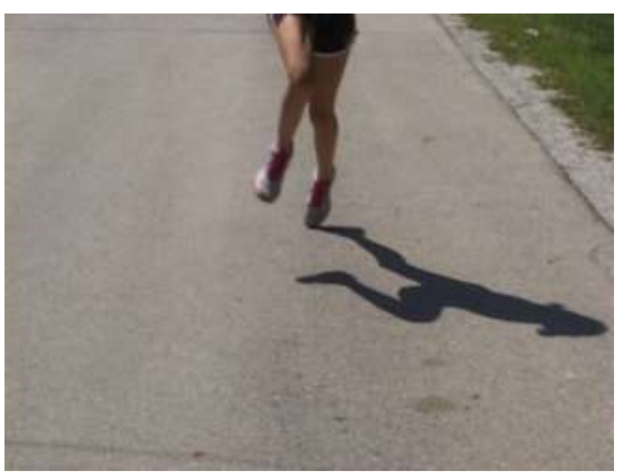
90

The potential of toe flexor muscles to enhance performance, Goldmann, J. Journal of Sports Science, 2013

- Toe flexors transmit energy produced by hip/leg extensors
- No impact on top end speed or vertical jumps but big impact on horizontal jumps and acceleration

91

If missing big toe…



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Drill for toe off

- ISO toe holds
- Stair walks
- No arm runs
- Single leg cleans
- Single leg hops down a line with stick on back

93

To sum up

- The more functional the foot is, the more power the brain will allow it to have

- Can squat 1000lbs, but if foot doesn't function properly, brain will protect it and limit the power so you can get away from the grizzly bear

94

The Lateral Chain/toe off

95

Lateral Chain

96

Crossover Gait

97

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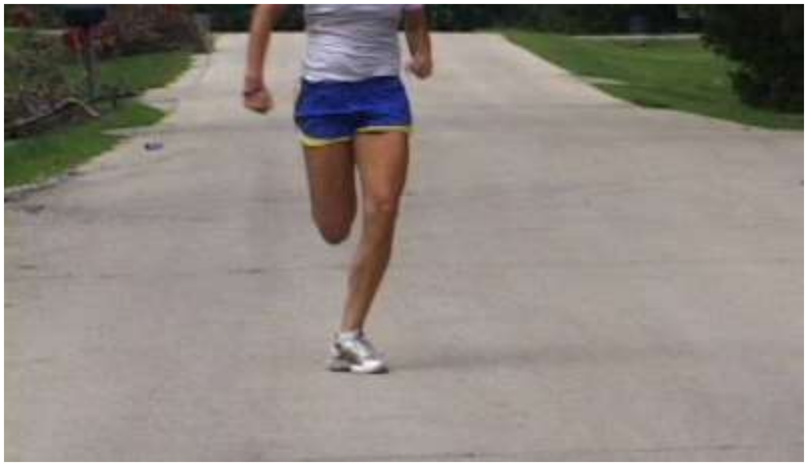

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Possibly add coordination to weight room

- 4 way hip machine- properly
- Hip tips
- Steps
- Swiss ball complex

100

Swiss Hip Hike

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Unstable surface

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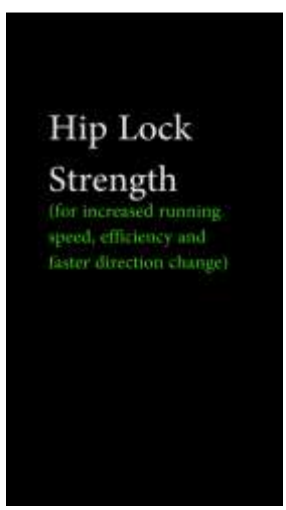
Bad Foot/ Good foot

103

More weight room lateral chain work



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Add complexity

105

4 WAY

106

107

- Hip proprioceptive feedback influences the control of mediolateral stability during human walking.

  Roden-Reynolds DC1, Walker MH1, Wasserman CR1, Dean JC2.
- J Neurophysiol. 2015 Oct;114(4):2220-9. doi: 10.1152/jn.00551.2015. Epub 2015 Aug 19.

- Instability on ground in fast fashion

108

109

OVERLOAD

co-ordination

•Concepts to apply

- Time/pressure- forces better co-contractions which result in stiffer contacts and more power (overspeed, uneven surfaces)
- Reflex patterns (scissoring action, toe off)
- Perturbations (Waterbags, hanging weight, hanging banded weight, uneven surfaces)

110

Association of Step Width with Accelerated Sprinting Performance and Ground Reaction Force

Ryu Nagahara, Et al (2017)

- Steps 1-4 12”
- Steps 5-8 8”
- Steps 9-12 5”
- Steps 13-16 4”
- Steps 17-22 3”

- Ranges 10.5-10.9

111

My Bad algebra and overspeed

- (Motor Learning Skills x Stumble Reflex)
- +
- (Ken Clark’s 2 Mass model to determine Ground Reactive Force
- +
- Hypothesis based off overspeed research)
- ____

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Basic Motor Learning Skills

101

- Complexity of the body make it necessary to restrict degrees of movement. We cannot handle all of the possibilities of movement (unless you are Dontae Fowler).
- We deal with all of the possibilities we divide movement into attractors and fluctuators

113

Too much for a weekend!!! Where are the Margaritas??

- **Attractors**- basic movement patterns that stay the same regardless of situation

- +

- **FLUCTUATORS**- movement that responds and changes to specific situations or environments

- The sum…equals…drum roll please

114

Wait for it

- The brain can command control through the attractor patterns without having to micromanage (*fast brain, slow brain*)- these are the basics of movement that can be broken down to **apply to all individuals**. To strengthen the attractors, you can change the ENVIRONMENT, ORGANISM or intensity (controlled fluctuators).
- Finished, shot, throw, punch kick, etc

115

- The more usable the attractor is, the more willing the brain is to use it. It will eventually override previous attractor that are not as efficient.

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So, what does this do for me and where is the overspeed stuff?

- If we challenge environment, the body has to respond in a more perfect manner. **Making things happen faster is the ultimate in challenging the environment or else…**

117

118

Sorry, Charlie Francis fans… at the right speed, no deceleration

- “No one fast trains this way. This is not an argument and there have been some improvements in technology. And know, a lot of people are using…quite a bit
- Foot strike out in front with increased contact times
  - We didn’t find that t be the case with out 14 sprinters ranging from 11.0 -10.39

119

To sum up

- Motor skill- challenge environment to force body to react in more efficient manner
- Stumble reflex challenge the body to stiffen faster with the knowledge that it could fall
- Clark- lower limb responsible for a lot of the work going on in sprinting and going faster improves power output or GRF in applicable fashion

120

- Body organization: The goal the body has is to organize its parts to do the task that has been set out. In an athletic sense, this would incorporate navigation, slack control with co-contractions and a target. In order to challenge this process, we can make things happen faster so body has to prepare faster or fall (managing reflexes). When challenged the body will learn to stiffen faster to prepare for the unexpected. This translates to the actual movement because the body will find that it works better when it is stiffer and stable.

121

SO……..

- Overspeed works because it forces a stiffer spring (which results in higher Ground Reactionary Force) in a manner that the body accepts and assilimilates due to stumble reflexes and motor learning skill development.

122

How can we apply it to our 3 day workout?

123

1080 tow video

124

125

Great! I want to stay married so I don't have a 1080 Sprint.

126

Extreme *overspeed*

- No 1080 needed.

- So… to challenge the reflexes we can do a bunch of things:
- Overspeed
- Raise the ground
- Soften the ground

- Can apply to hurdling and jumping as well

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Glenn Messemer

- #1 Tues 8/29 1.31 // 1.29 // 1.30 // AVG 1.30 **1.29 was starting point**
- #2 Tues 9/5 1.31 // 1.26 // 1.29 // 1.27 // 1.27 // AVG 1.28
- #3 Tues 9/12 1.26 // 1.26 // 1.25 // 1.24 // 1.25 // AVG 1.25
- #4 Mon 9/18 1.29 // 1.29// 1.23 // 1.21 // 1.28 // AVG 1.26 **These are not overspeed pulls**
- The first four sessions had 0 out of 18 reps at 1.20 or below
- **1/18 reps at 1.22 or below**
- 2/18 reps at 1.23 or below
- PR 1.21
- #5 Wed 9/20 OVERSPEED 1.20 // 1.16 // 1.16 // UNRESISTED 1.20
- #6 Sun 9/24 1.21 // 1.19 // 1.17 // 1.19 // AVG 1.19
- #7 Sun 10/8 1.21 // 1.22 // 1.19 // AVG 1.21
- #8 Fri 10/13 1.19 // 1.20 // 1.23 // 1.19 // 1.16 // AVG 1.19
- #9 Wed 10/18 1.20 // 1.22 // 1.22 // 1.19 // 1.16 // AVG 1.20
- The next four sessions (and including our one unresisted rep following overspeed) had 12 out of 18 reps at 1.20 or below
- **17/18 reps at 1.22 or below**
- 18/18 reps at 1.23 or below
- **2 reps at a new PR of 1.16**!

129

Toe pop exercises

- Needs to be alternating or else no stumble reflex and becomes bag hop exercises

130

Raise the ground with mats

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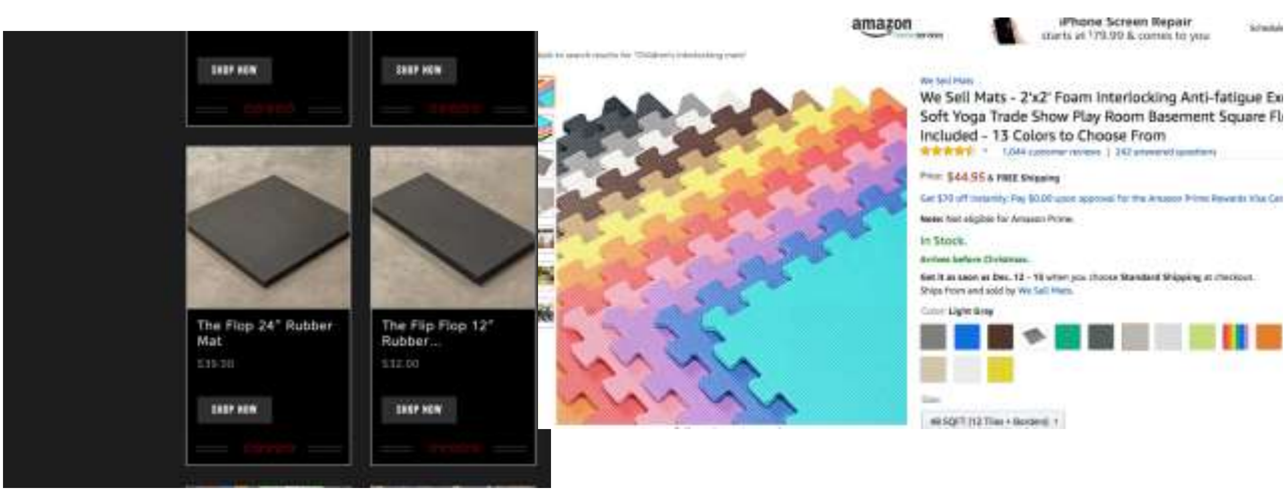
mats



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Cool stuff…but we are just football and Catapult research shows there is no need for top end speed

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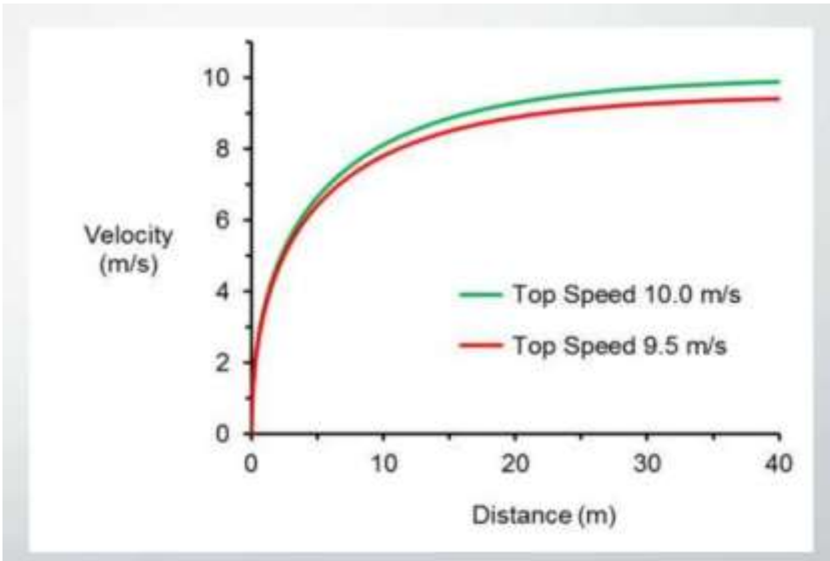

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Top End Speed

- Fly 10,20,30
- Overspeed training
- Sum of all parts- how to eliminate faulty movement patterns on Sat

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What can we do? How can we change our athletes?

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OVERLOAD
the system with weight?

- Can’t really match pressure body takes in weight room
- Calves 7x’s
- Hamstrings 5x’s
- 2.5xs bodyweight on impact in all less than .1 sec

- Biomechanical loading of the Achilles Tendon during normal locomotion
- PV Komi, S Fukashiro, 1992

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Effect of Single vs. Multiple joint ballistic resistance performance upon Vertical Jump

Terjre Dalen, et al., 2013

Table 1. Performance variables at the pre- and post test for the multi and single joint training group (Mean±SD).

Group	Multi joint training group (n=7)		Single joint training group (n=6)	
	pre-test	post test	pre-test	post test
Jumping height (cm)	37.9±5.6	39.8±4.7*†	41.1±4.8	40.6±4.5
1-RM weight (kg)	119±36	136±36*	130±30	156±34*
Peak force (N)	1790±437	1924±442*	1983±348	2002±351
Peak velocity (m/s)	3.18±0.25	3.30±0.30	3.33±0.26	3.39±0.26
Peak power (W)	3197±933	3440±907*	3736±947	3818±985
Time to peak force (s)	0.137±0.047	0.159±0.022*	0.108±0.022	0.166±0.038
Time to peak velocity (s)	0.293±0.058	0.234±0.024*	0.254±0.042	0.243±0.030
Time to peak power (s)	0.204±0.048	0.087±0.016*	0.171±0.023	0.100±0.034

Note: *Significantly different from pre-test, $p<0.05$. †Significantly different from single joint training group, $p<0.05$.

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No Calf raises, leg extension , leg curls

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