



# Biomechanics of the Pole Vault

- selected aspects -



I. Introduction

II. Helsinki:  
first results

III. Jump and Plant Complex (JPC):  
theoretical considerations  
new findings



scientific goal: understand movement



scientific approach:

movement = interaction

## project „pole vault“



goal:  
understand interaction  
between athlete and pole



improve pole vault knowledge  
(improve pole vault performance)



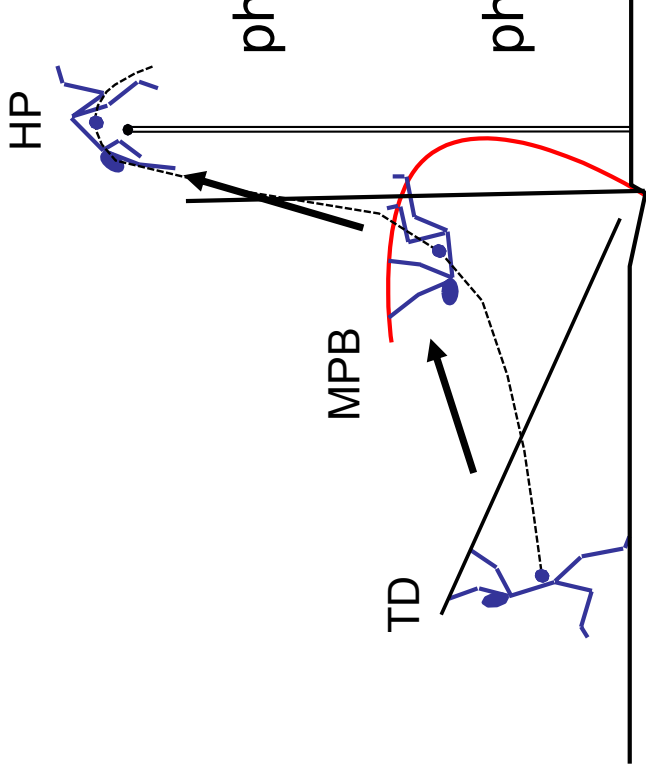
- a) what are elite vaulters doing
- b) experimental studies

## Pole Vault



- first results -

# theoretical considerations:



phase 2 : energy gain = **critterion 2**

phase 1 : energy gain = **critterion1**

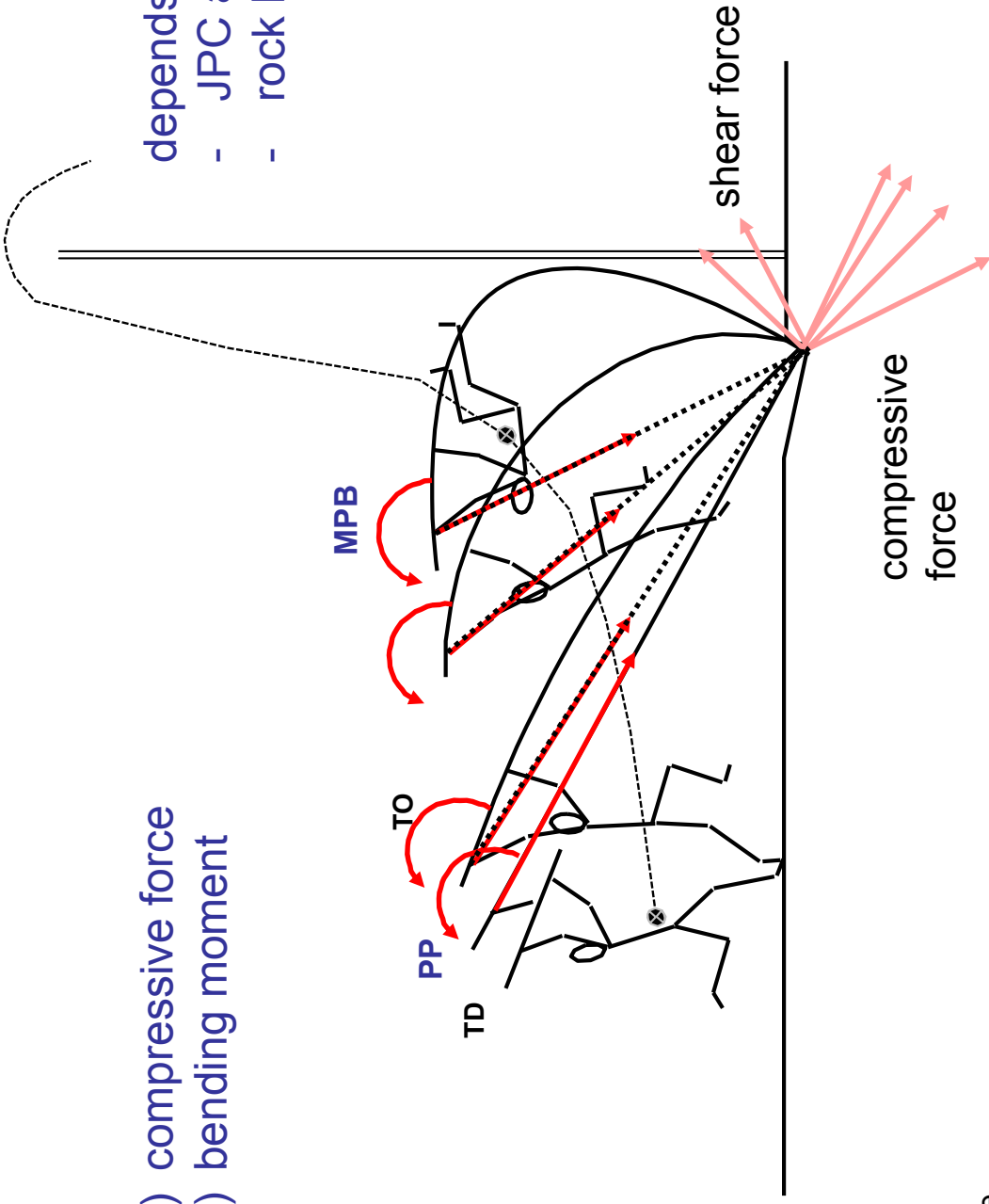
critterion 1 + critterion 2 = total energy gain

# how is the energy transferred into the pole?

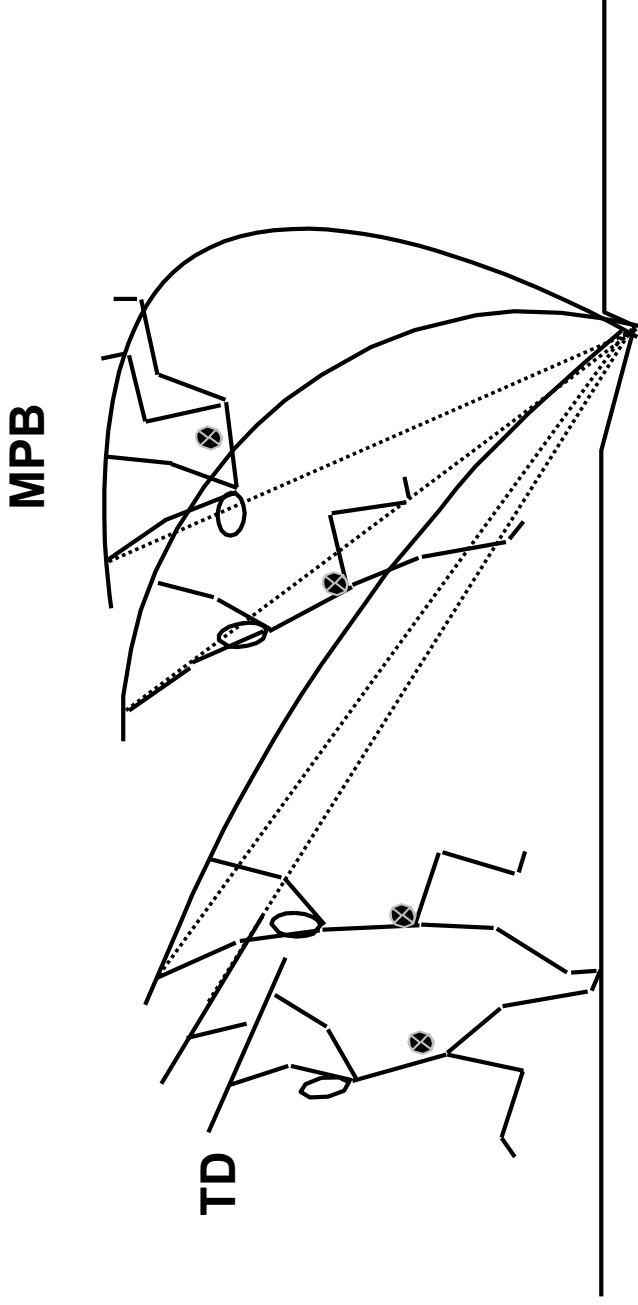
- a) compressive force
- b) bending moment

depends on:

- JPC action
- rock back action



# differentiation of first pole phase - criterion 1 -





# role of arm motion in countermovement jump - a phenomenon -

jump height countermovement jump:

arms only

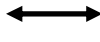
3 cm

legs only

35 cm

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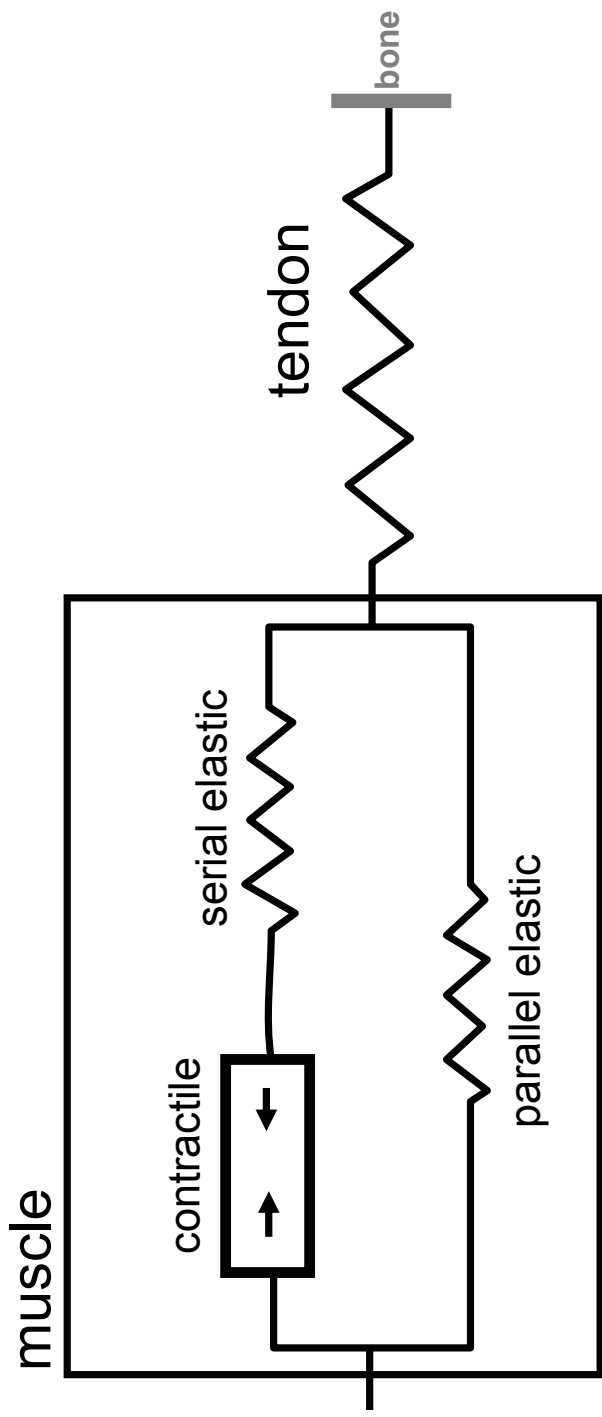
38cm



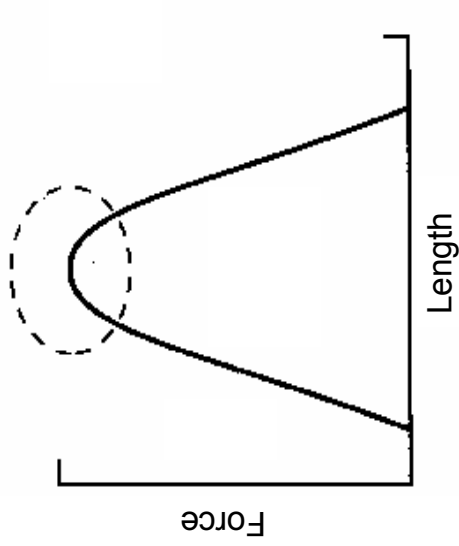
legs+arms

45cm

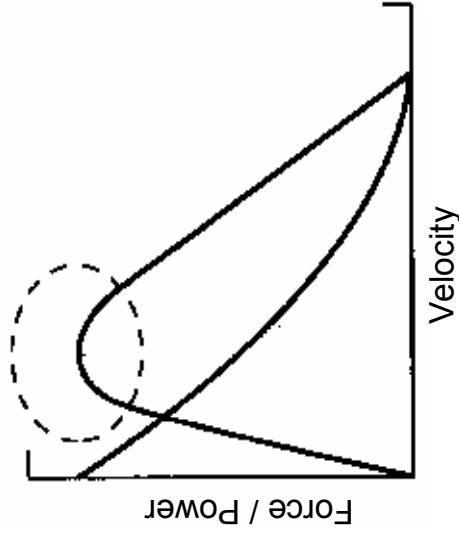
# model muscle-tendon-unit (micro level)



# the work of contractile elements

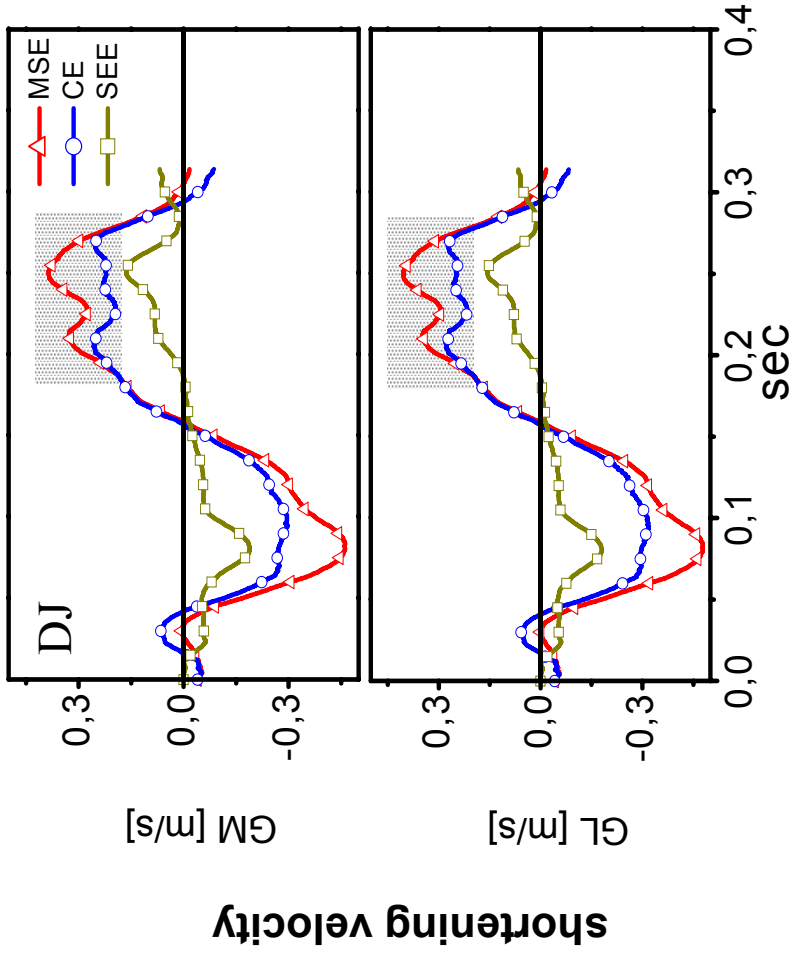


- the force-length-relationship determines maximum force generation



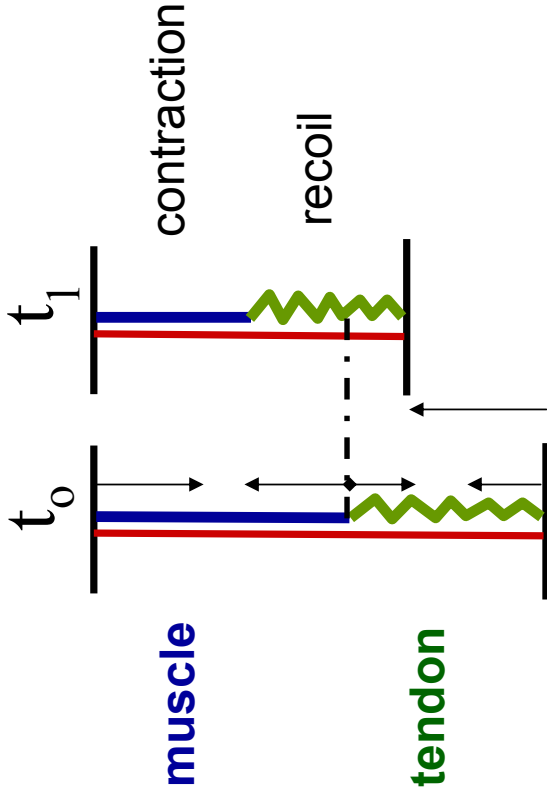
- contraction velocity determines the muscle's maximum power (force-velocity-relationship)

# interaction between muscle and tendon



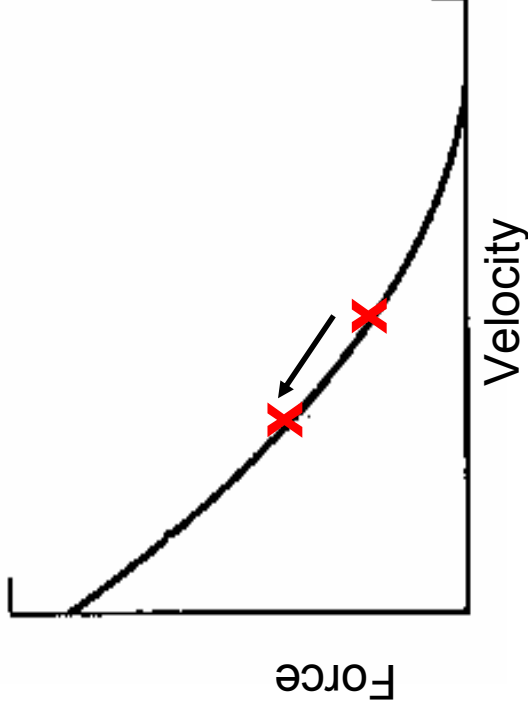
Arampatzis et al. 2001

# interaction between muscle and tendon



interaction increases the force production of the contractile element

## interaction between muscle and tendon



interaction increases the force production of the contractile element

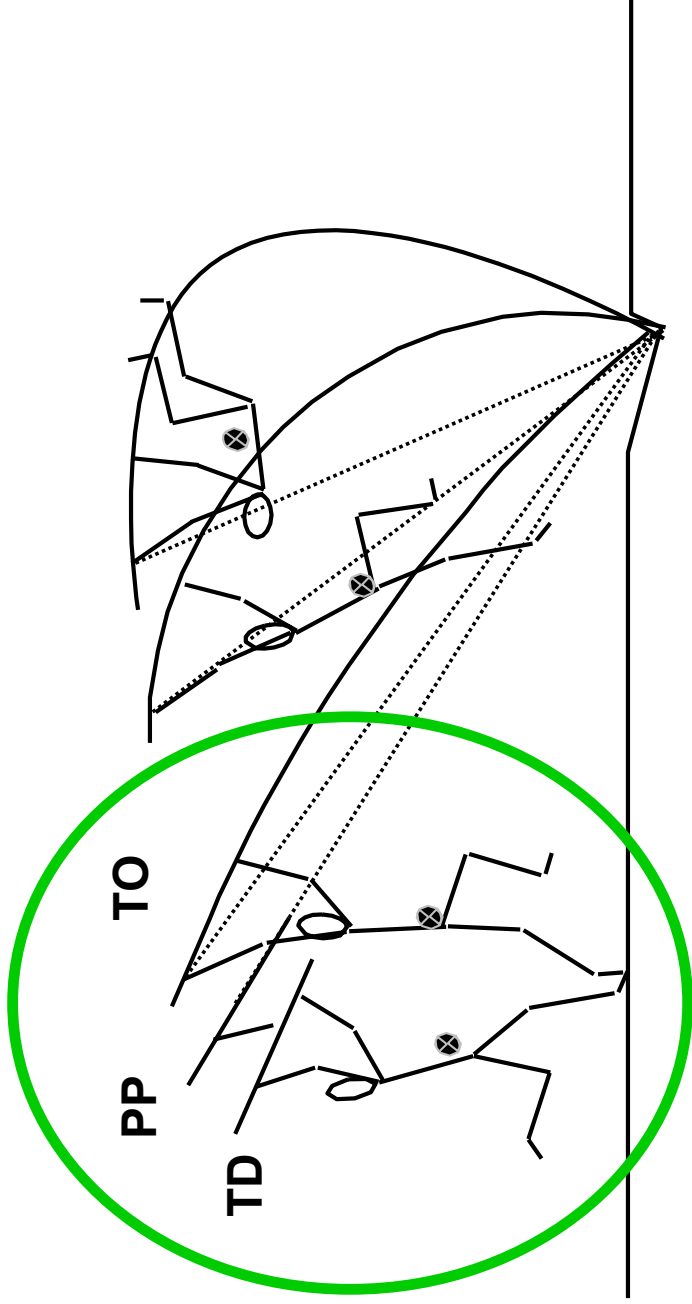
role of arm motion in countermovement jump  
- a phenomenon -

the reason:

- energy transfer
- reflexes
- energy storage
- force-velocity relationship

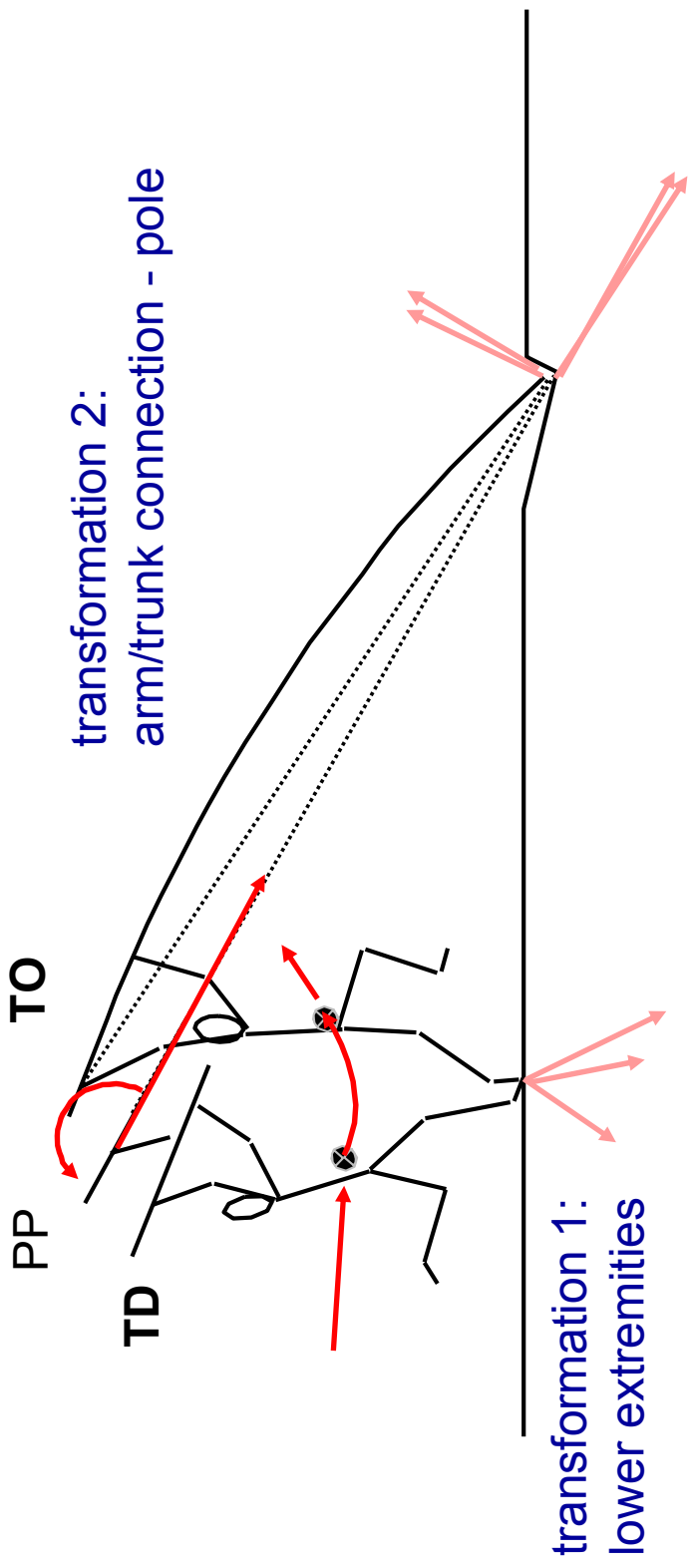
→ principle valid for each muscle-tendon-unit (even the arms?)

# differentiation of first pole phase - criterion 1 -





# energy balance of JPC - TD to TO -





kangaroos would never jump with their arms



.....➔ pole planting is like jumping on our arms

we have to train our arms for something  
they are not made for

# generate knowledge – transfer knowledge

