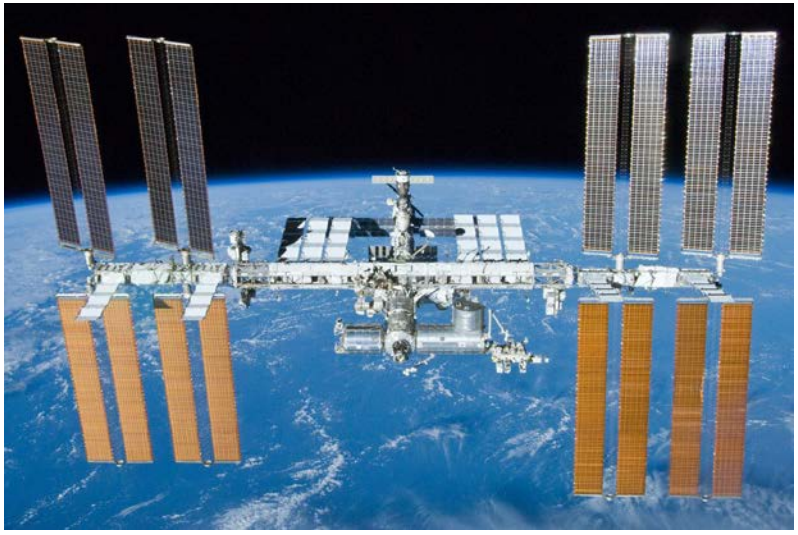
TO G OR NOT TO G: THAT IS THE QUESTION

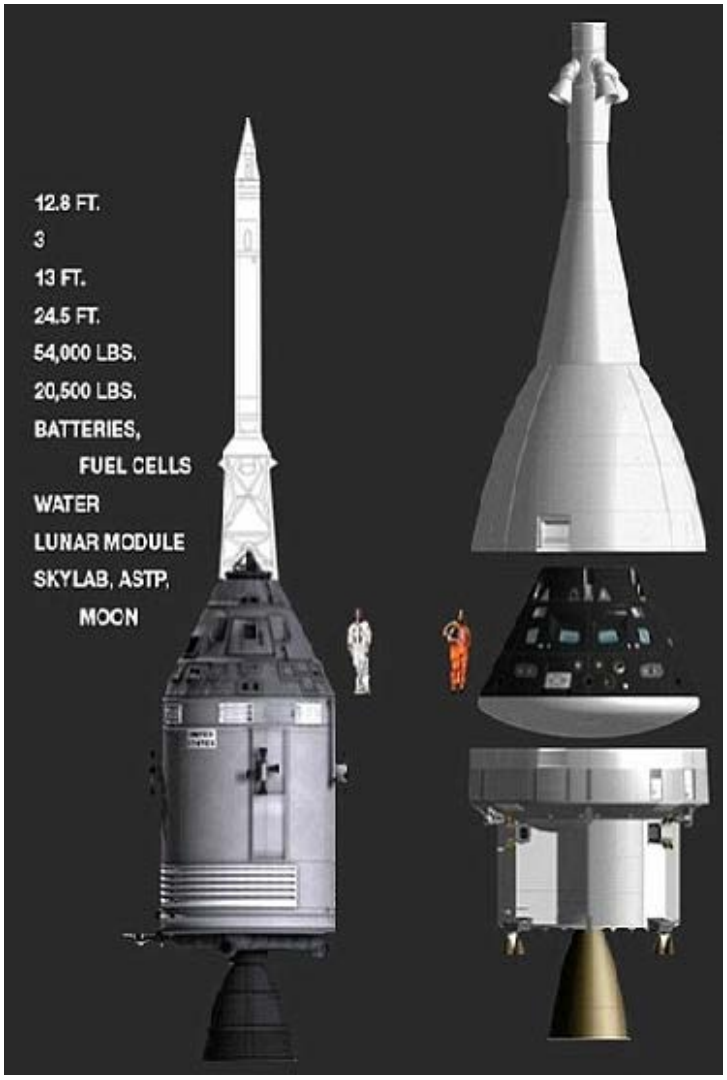
TO G OR NOT TO G: THAT IS THE QUESTION

Accomplishments of the US Space Program have been …

Out of this world ☺

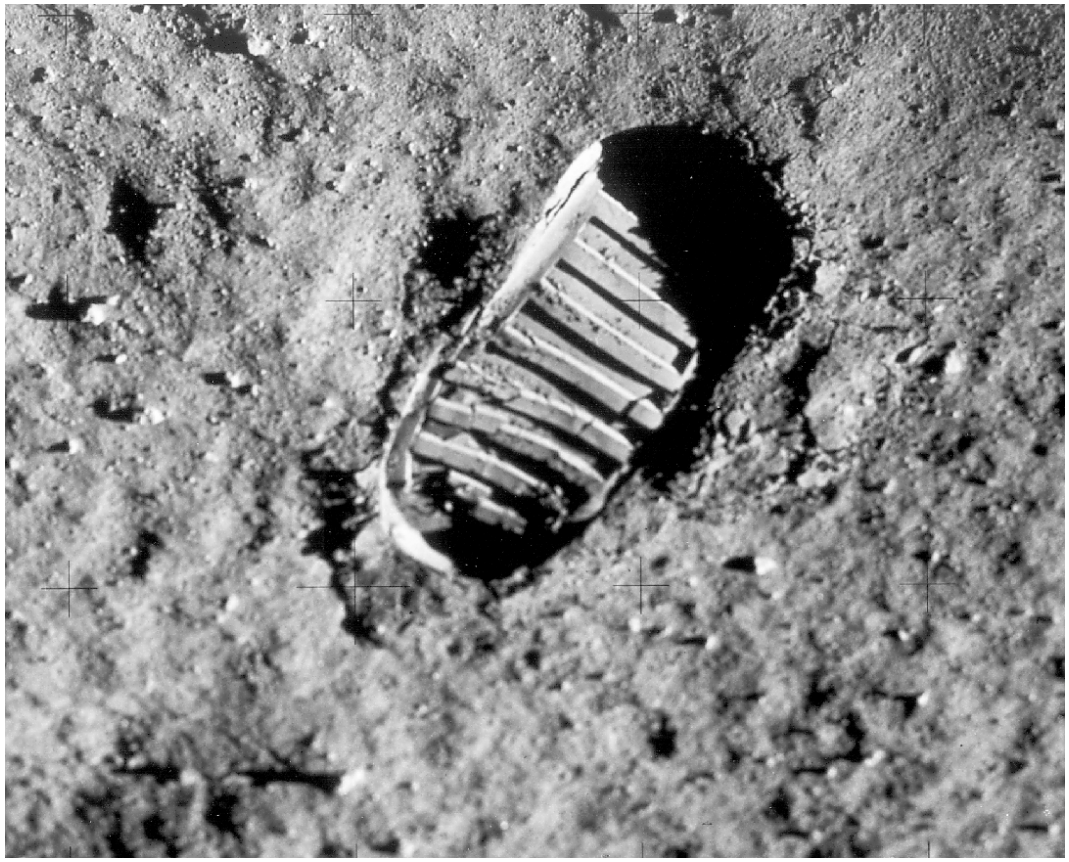
TO G OR NOT TO G: THAT IS THE QUESTION





TO G OR NOT TO G: THAT IS THE QUESTION

SO MANY GREAT IMAGES OF SPACE EXPLORATION



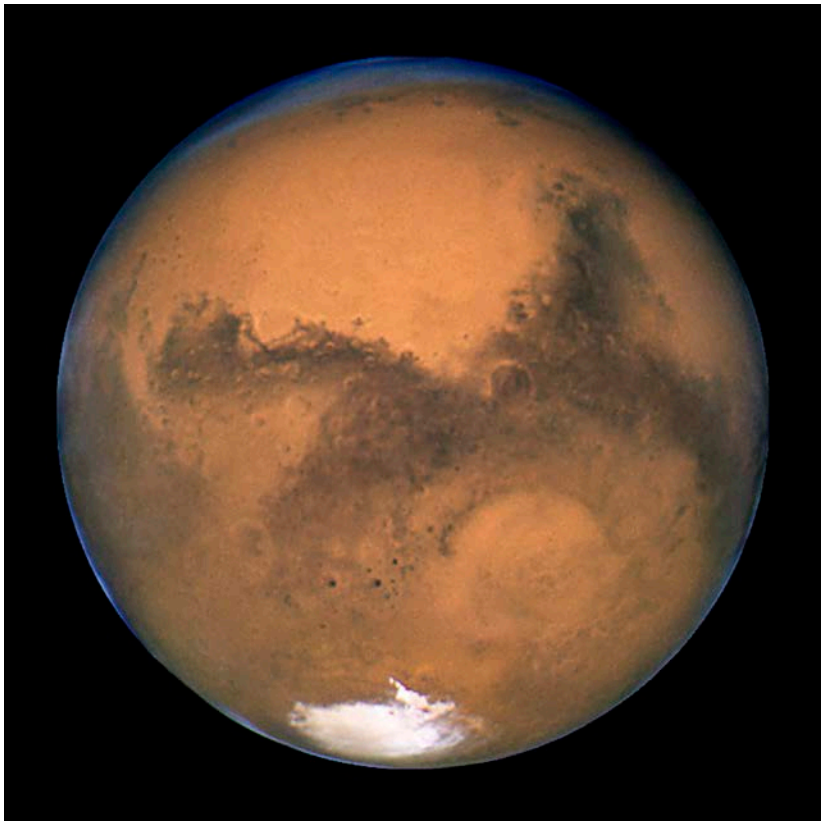
But there is one singular image that best captures the achievement of the space program…

Man's desire to explore

50 years ago come July 20, 2019

TO G OR NOT TO G: THAT IS THE QUESTION

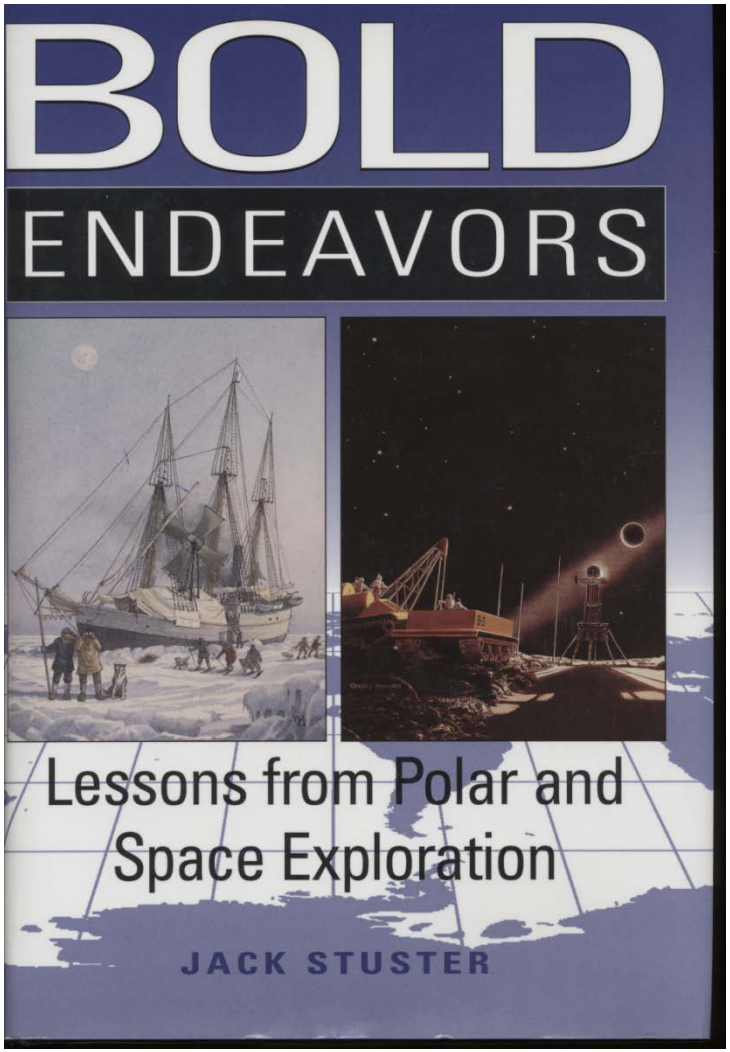
THE JOURNEY FROM EARTH TO MARS WILL BE EQUALLY HISTORICAL



"We choose to go to the **moon** in this decade and do the other things, not because they are easy, but because they are hard."

But the challenges will be profoundly greater!

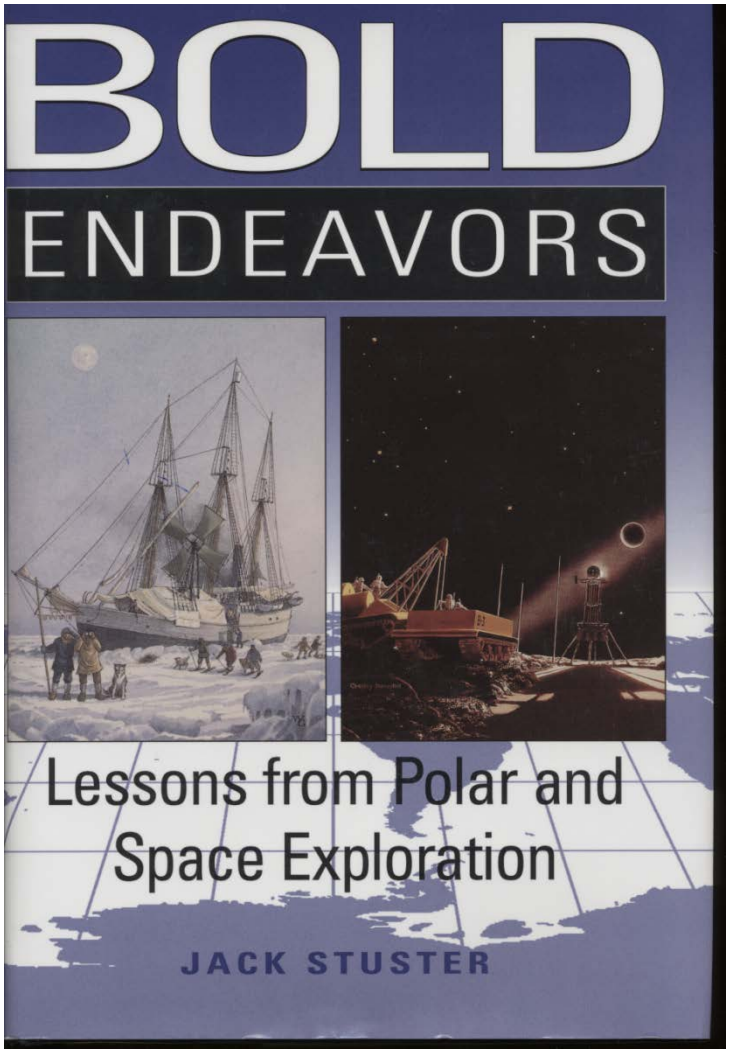
TO G OR NOT TO G: THAT IS THE QUESTION



"Men wanted for hazardous journey. Small wages, bitter cold, long months of complete darkness, constant danger, safe return doubtful. Honour and recognition in case of success."

Sir Ernest Henry Shackleton

TO G OR NOT TO G: THAT IS THE QUESTION



Exploration even within the solar system poses unique and formidable challenges never experienced during human evolution!

- space radiation
- vacuum and cold of space
- staggering distances and time
- the absence of gravity

TO G OR NOT TO G: THAT IS THE QUESTION

Profound Physiological Deconditioning/Alterations

- Vestibular System
- Cardiovascular System
- Skeletal System
- Muscle
- Intracranial Hypertension

SPACE FITNESS: NEWTON'S FOURTH LAW

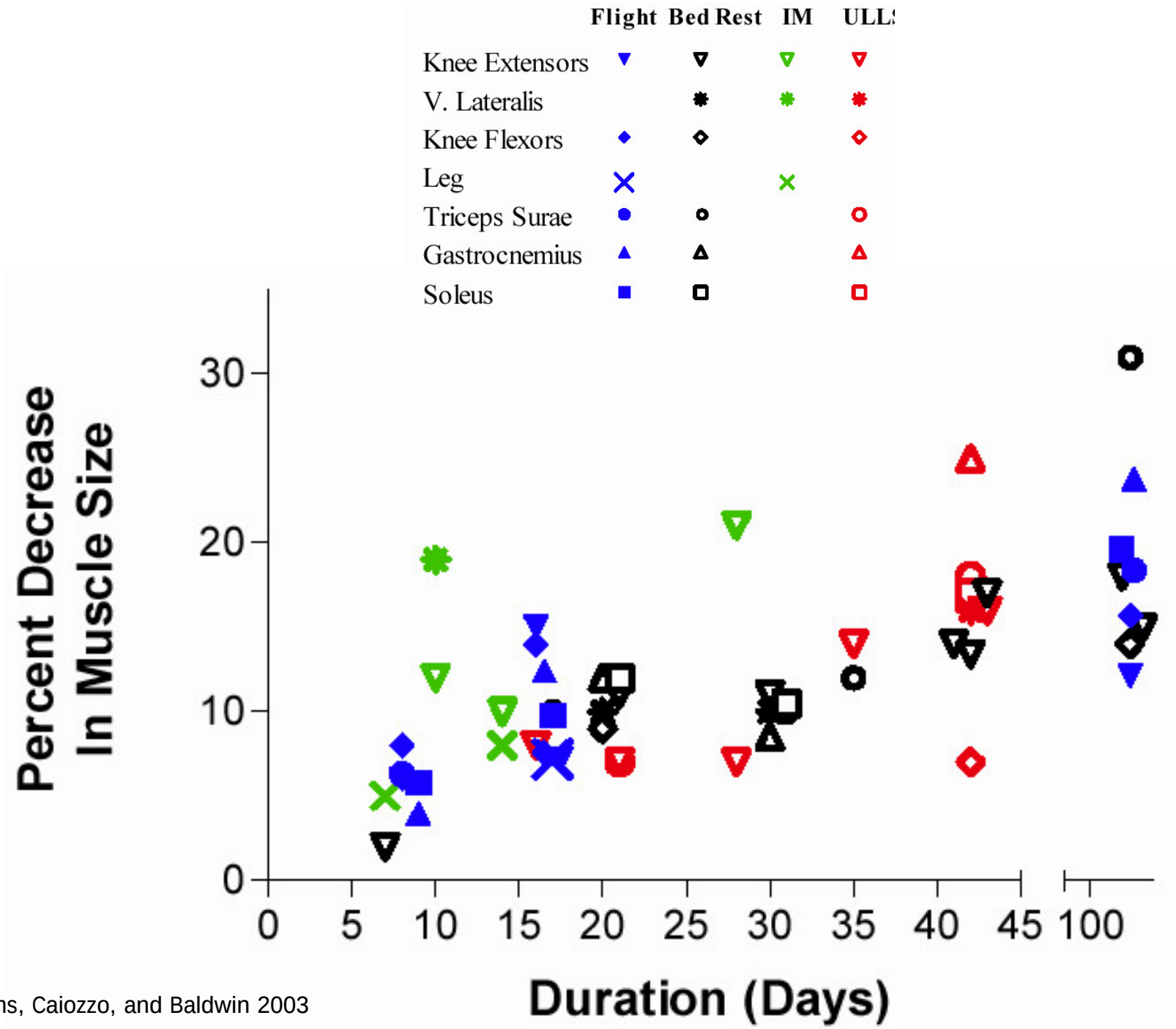
Three Laws of Motion

First Law – Uniform motion
Second Law – F = MA
Third Law – Action-reaction

So what is the Fourth Law?

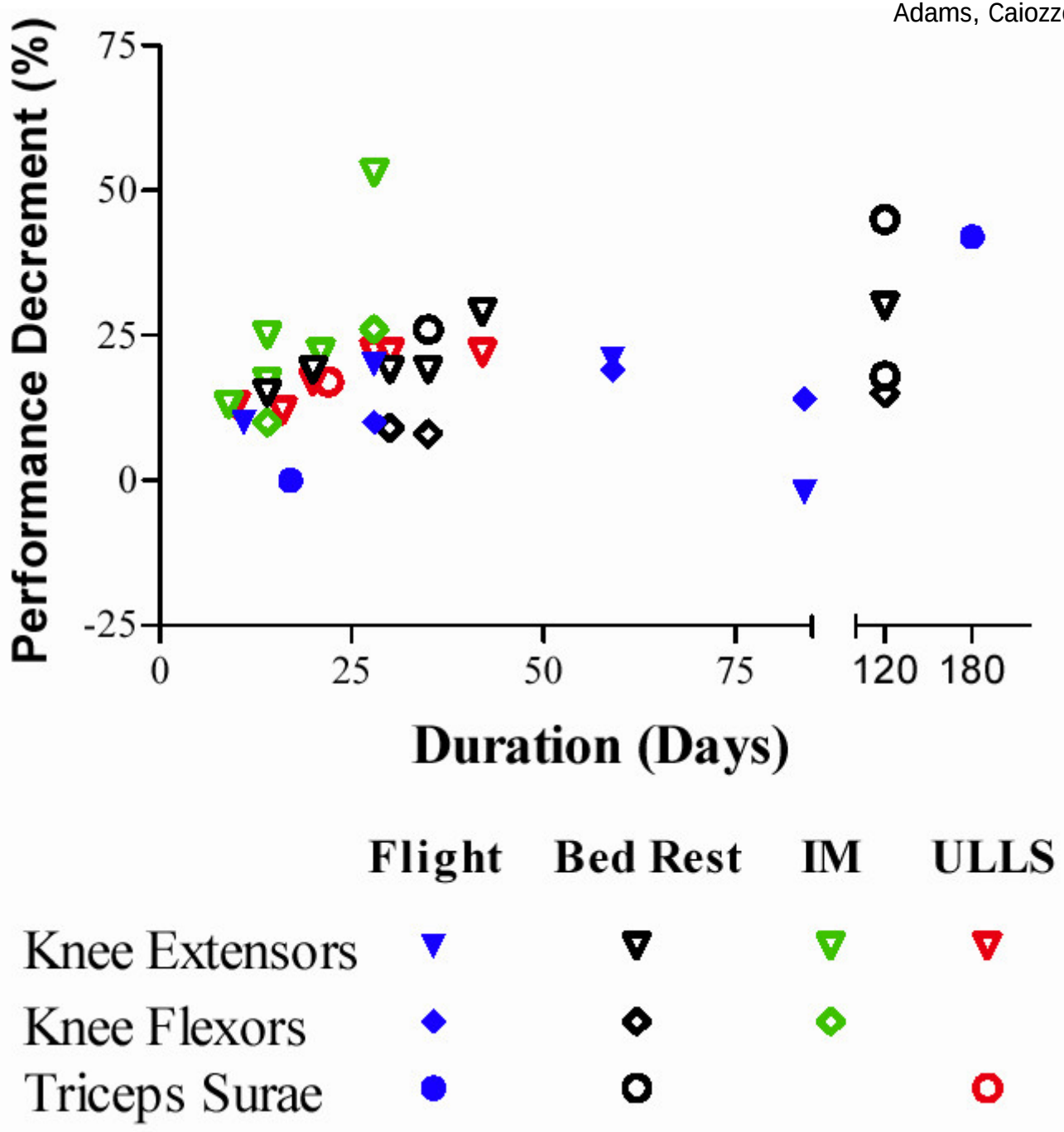
It is the law of physiological plasticity and is analogous to the Third Law.

Look at a couple of examples with direct relevance to space flight

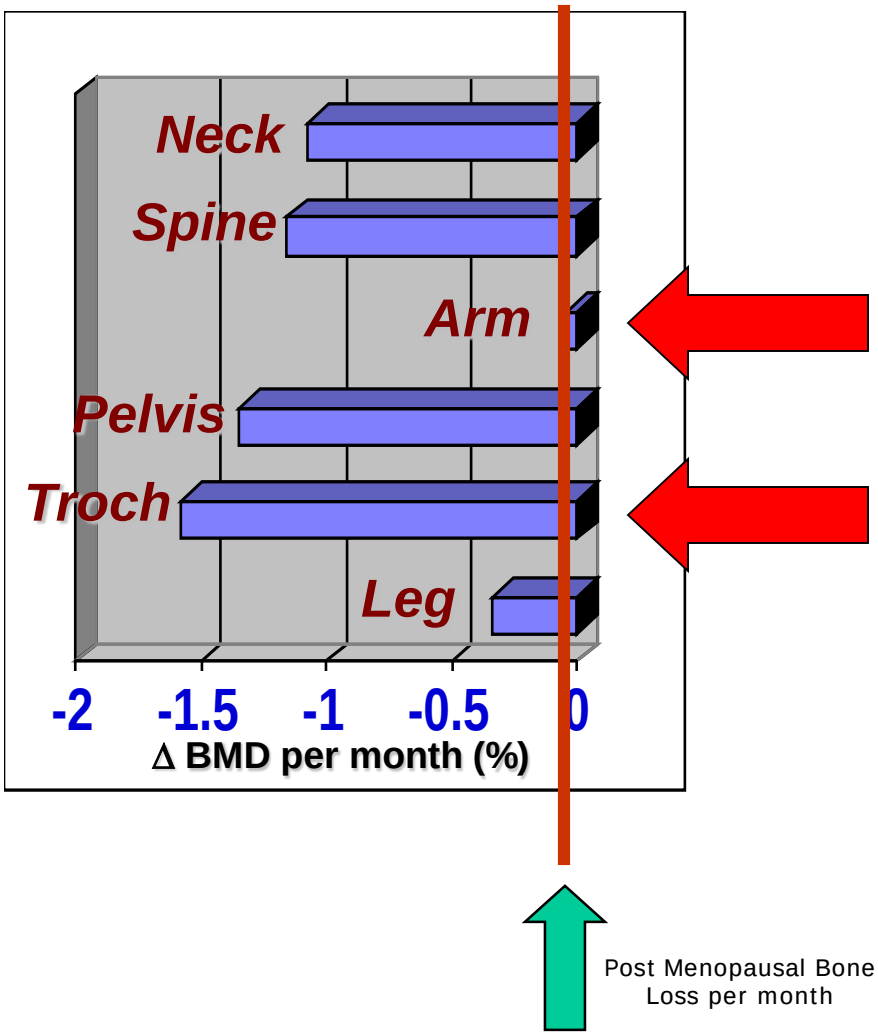


Adams, Caiozzo, and Baldwin 2003

Adams, Caiozzo, and Baldwin 2003



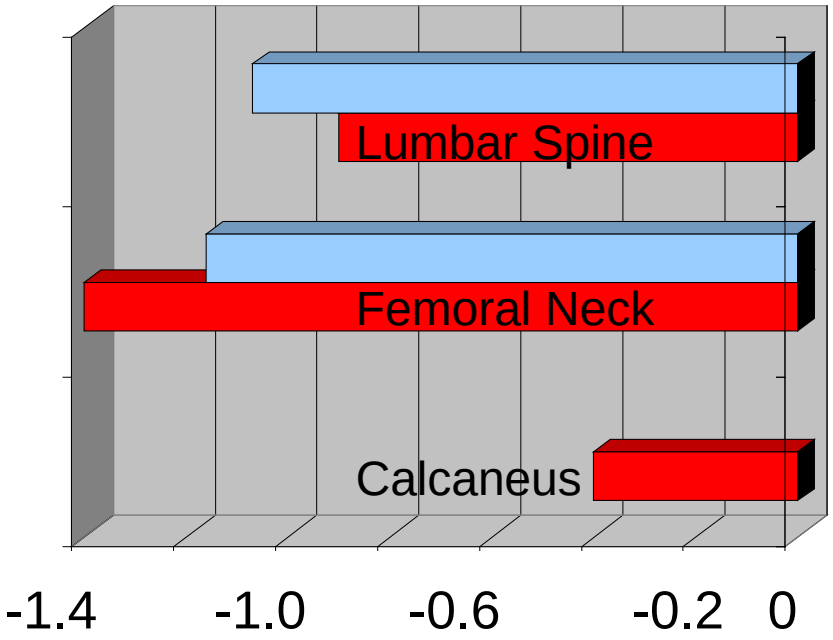
SPACE FITNESS: NEWTON'S FOURTH LAW



Bone Loss on MIR

LeBlanc et al. 1996

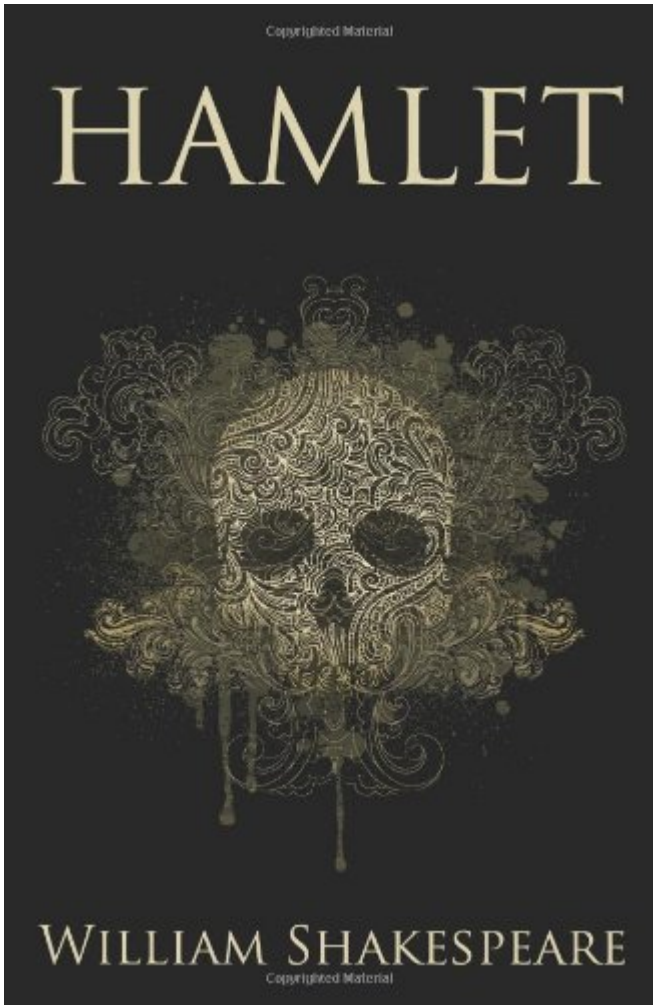
SPACE FITNESS: NEWTON'S FOURTH LAW



Bone Loss on MIR

Lang et al. 2004

TO G OR NOT TO G: THAT IS THE QUESTION



Hamlet – Scene I

"To be, or not to be: that is the question"

How does that apply to the topic of this presentation?

"To G, or not to G: that is the question"

TO G OR NOT TO G: THAT IS THE QUESTION

WHY SHOULD WE BE INTERESTED IN THIS TOPIC?

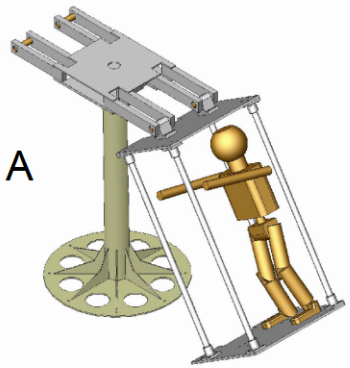
The Space Cycle

Unique Attributes

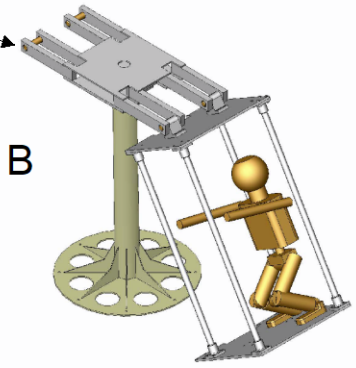
- Load skeletal muscle
- Load bone
- Provide gravitational challenge to cardiovascular system
- Vestibular challenge
- May be effective in mitigating intracranial hypertension

TO G OR NOT TO G: THAT IS THE QUESTION

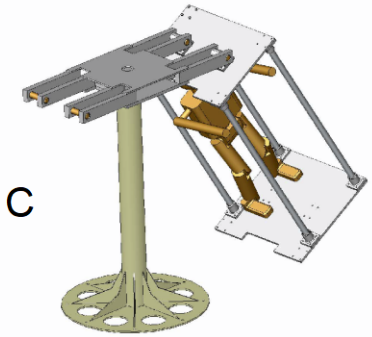
STRATEGIES FOR LOADING MUSCLE AND BONE: HYPERGRAVITY RESISTANCE TRAINING



Note redesign of pivot block. Length of pivot block has been increased to prevent base platform from striking center post.



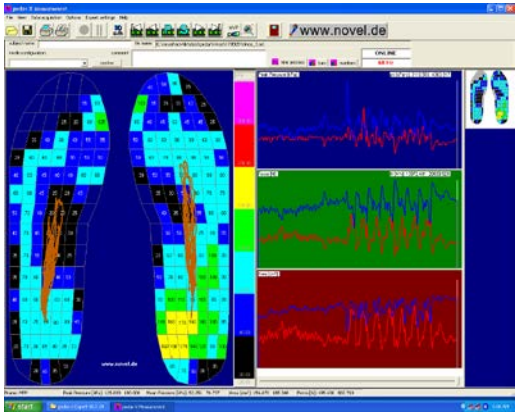
Panels A & B show oblique view of device spinning and with the centrifuge arm swung out from the center post. Two views in A & B show subject standing (A) and then squatting (B). Panel C is included to convey the rotational movement of the centrifuge arm.

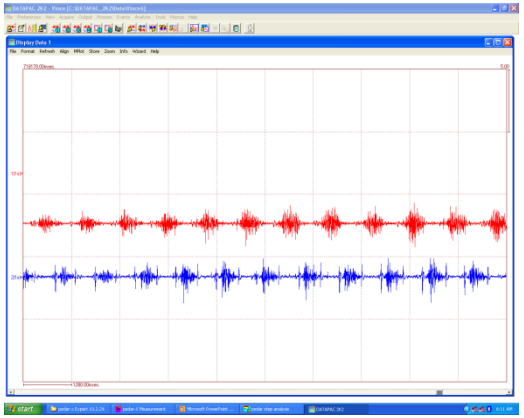


Note the flange that attaches down tubes to platform. See following two slides for more Detail.

TO G OR NOT TO G: THAT IS THE QUESTION

STRATEGIES FOR LOADING MUSCLE AND BONE: HYPERGRAVITY RESISTANCE TRAINING





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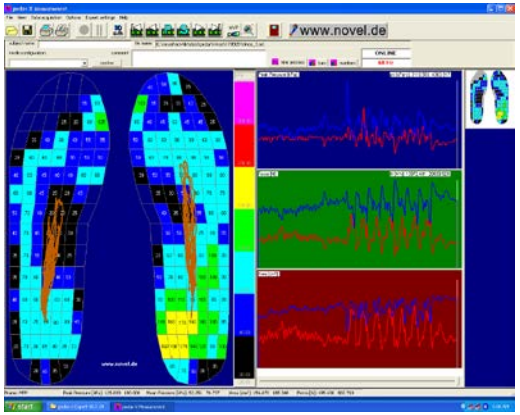
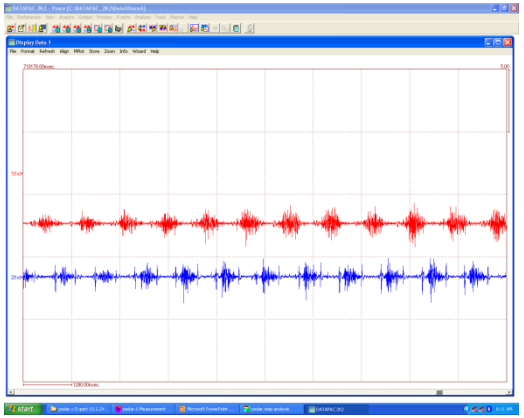
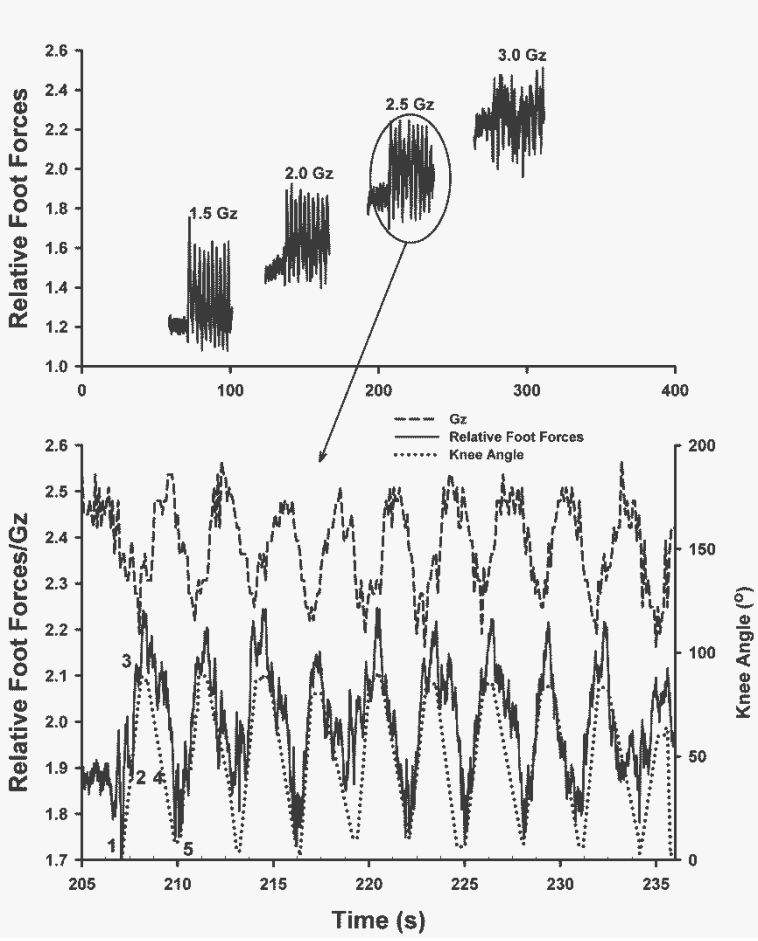




TO G OR NOT TO G: THAT IS THE QUESTION

STRATEGIES FOR LOADING MUSCLE AND BONE: HYPERGRAVITY RESISTANCE TRAINING



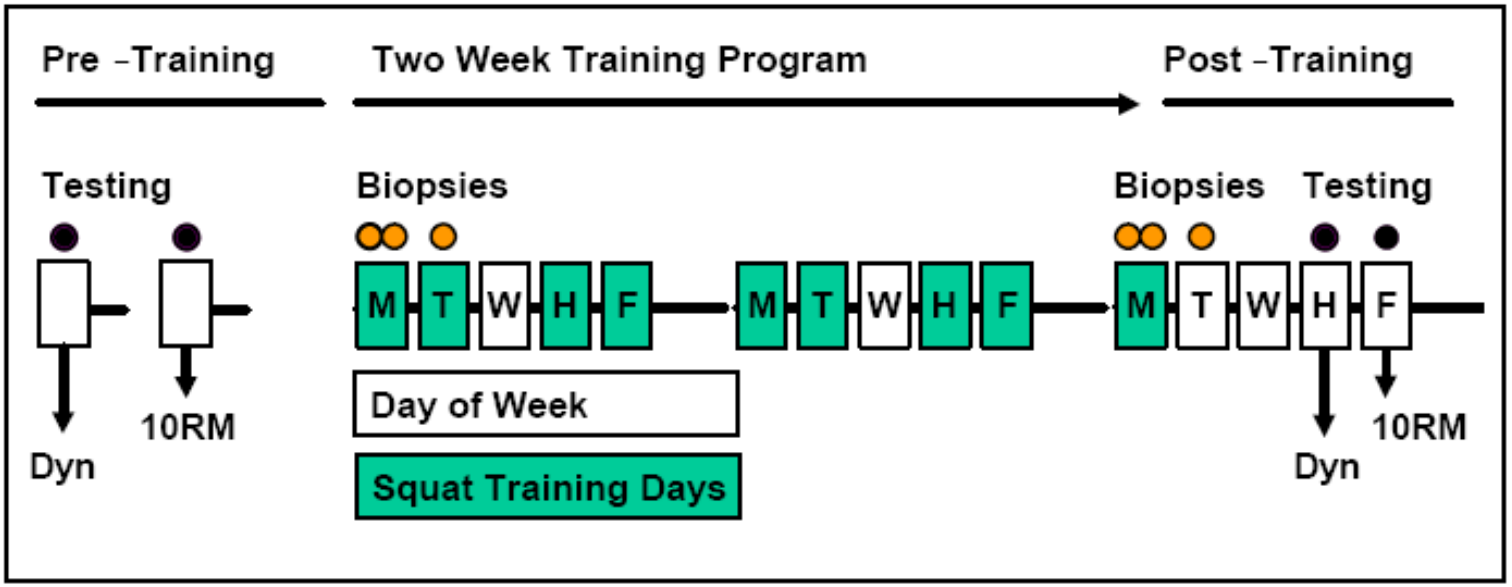
TO G OR NOT TO G: THAT IS THE QUESTION

Hypergravity Resistance Training Hypotheses

AG can be used to create hypergravity-loading conditions that result in muscle adaptations similar to those seen when performing resistance training in a normal 1 G environment.

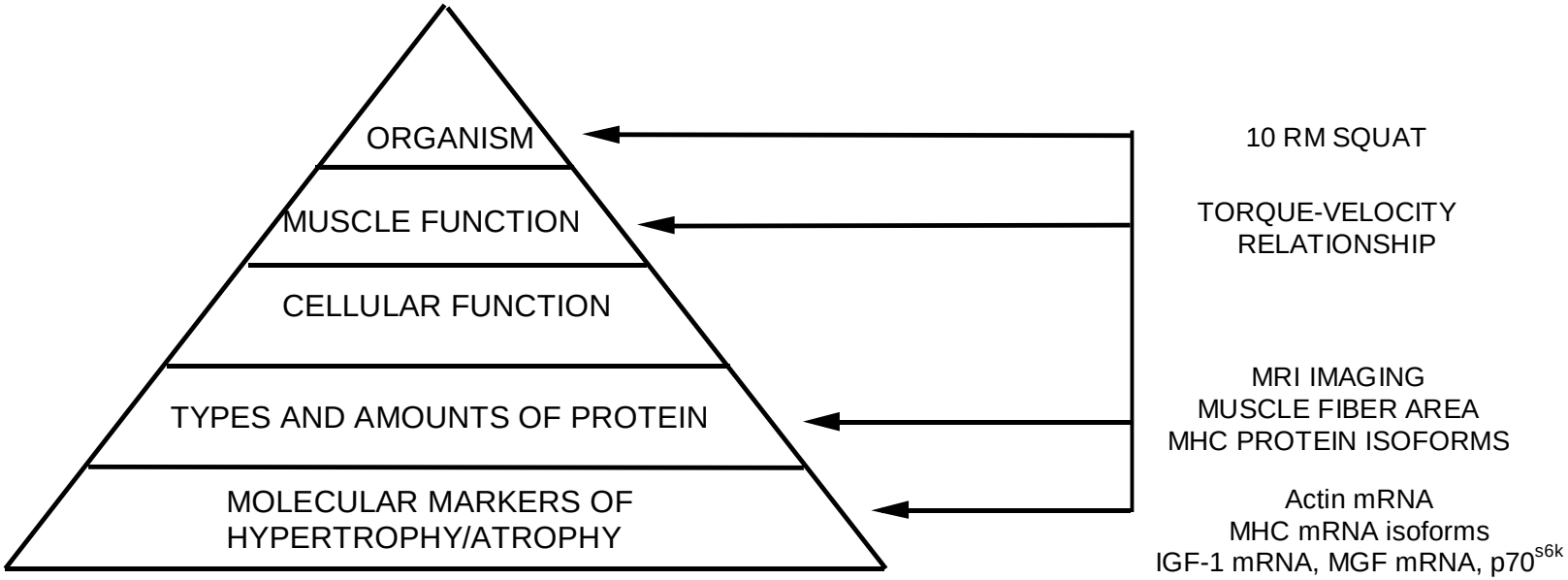
TO G OR NOT TO G: THAT IS THE QUESTION

Proof-of-Principle Study Design



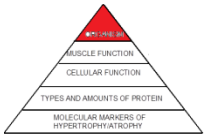
TO G OR NOT TO G: THAT IS THE QUESTION

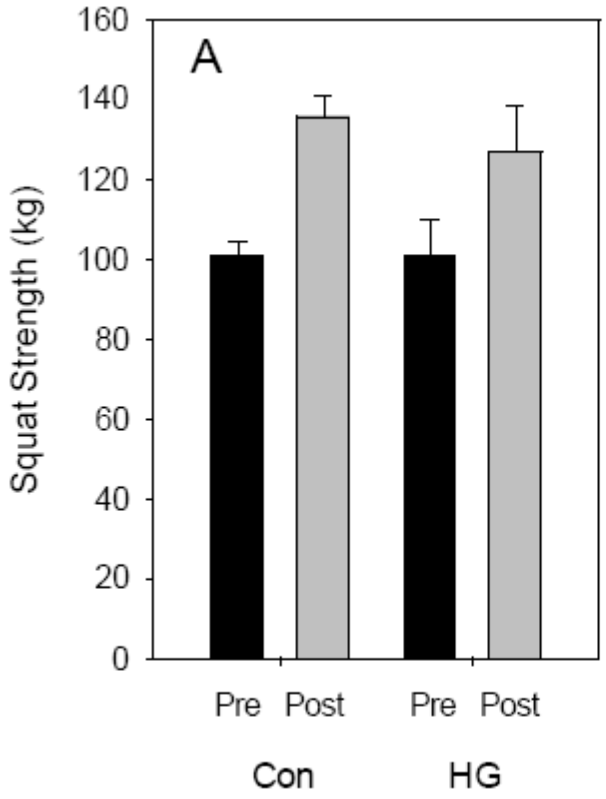
Molecules-to-Function Paradigm:
A Play on Structure-Function Relationships

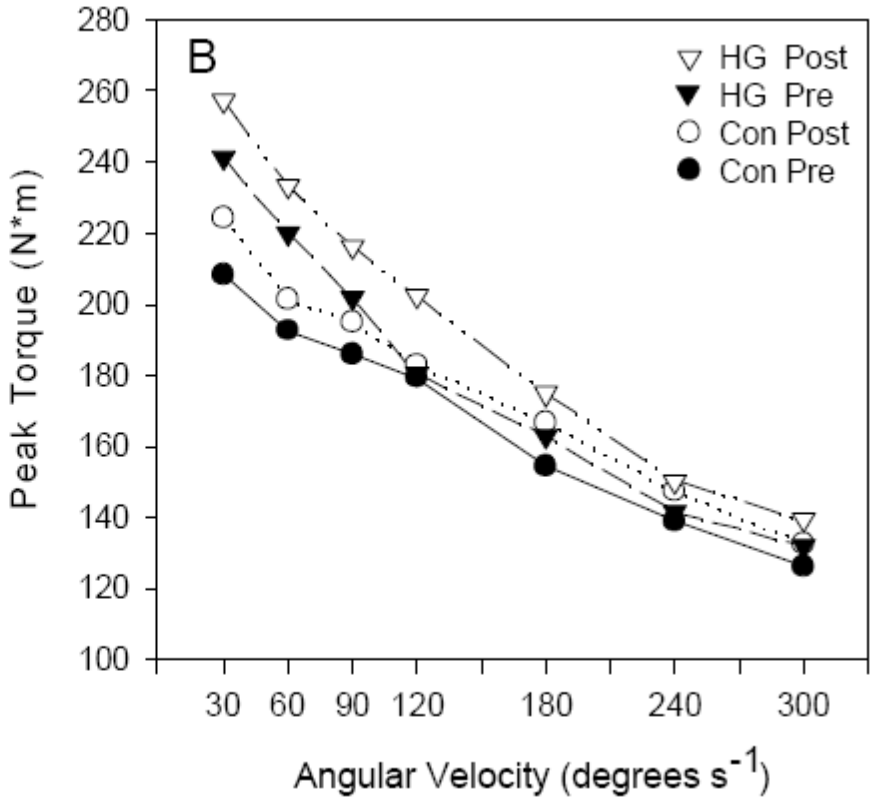


TO G OR NOT TO G: THAT IS THE QUESTION

Muscle Strength

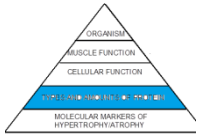


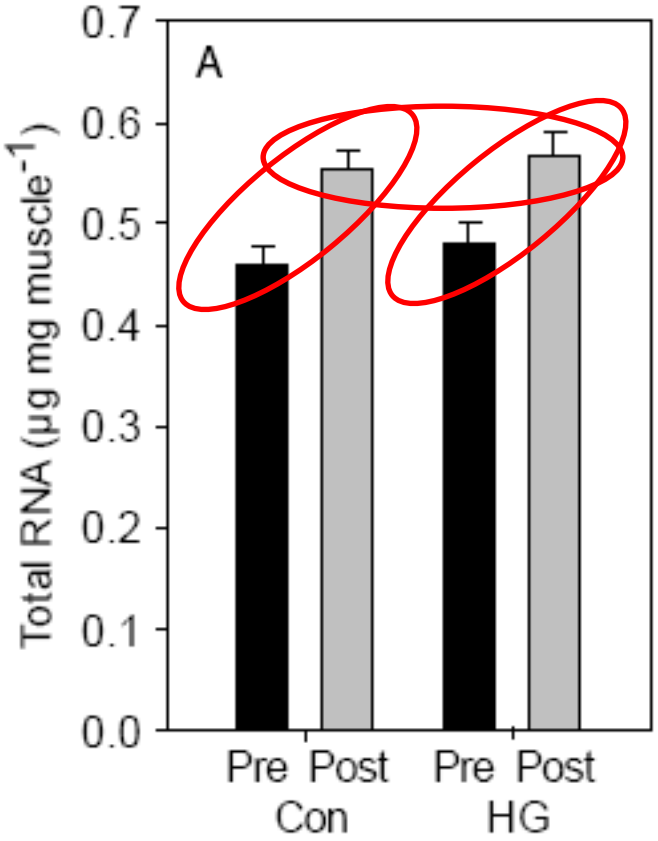




TO G OR NOT TO G: THAT IS THE QUESTION

Protein Synthesis – Total RNA



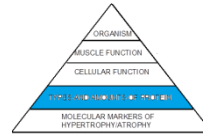


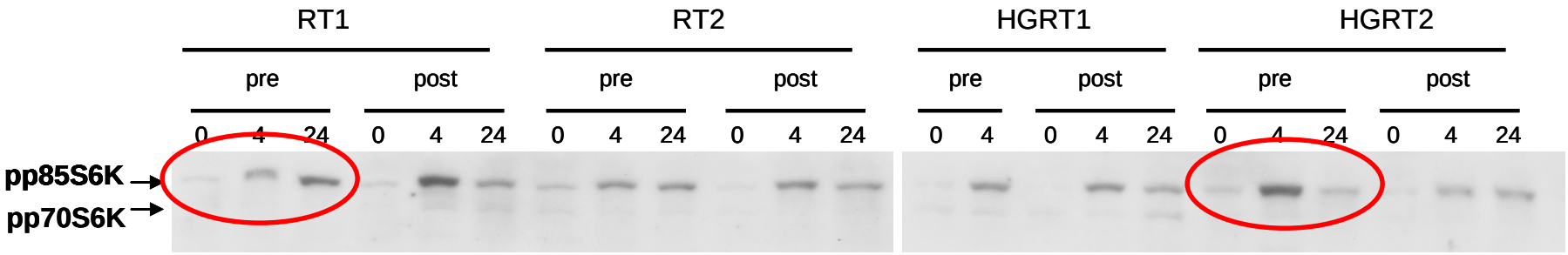
Note that both groups had significant increases in total RNA.

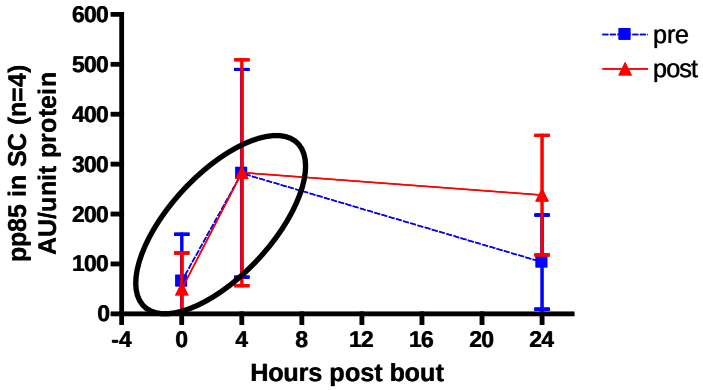
Also, note that the increases for both Groups were very similar.

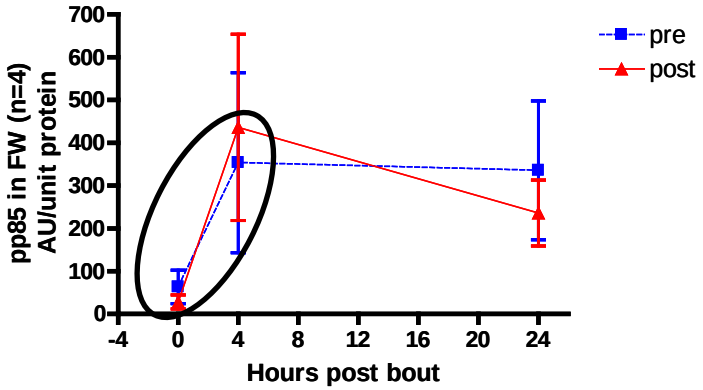
TO G OR NOT TO G: THAT IS THE QUESTION

Protein Synthesis – Translational Control



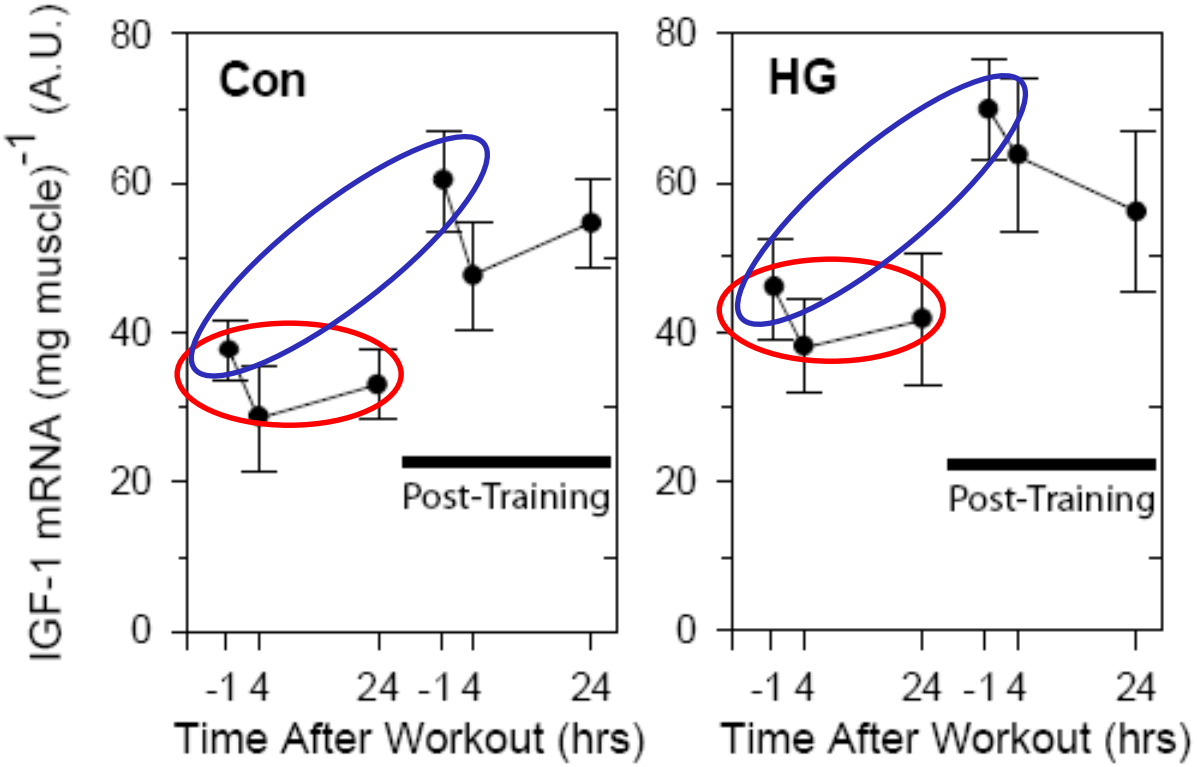






TO G OR NOT TO G: THAT IS THE QUESTION

Molecular Marker of Muscle Hypertrophy



Note similarity in acute responses.

Note that both types of resistance training programs produced similar chronic elevation.

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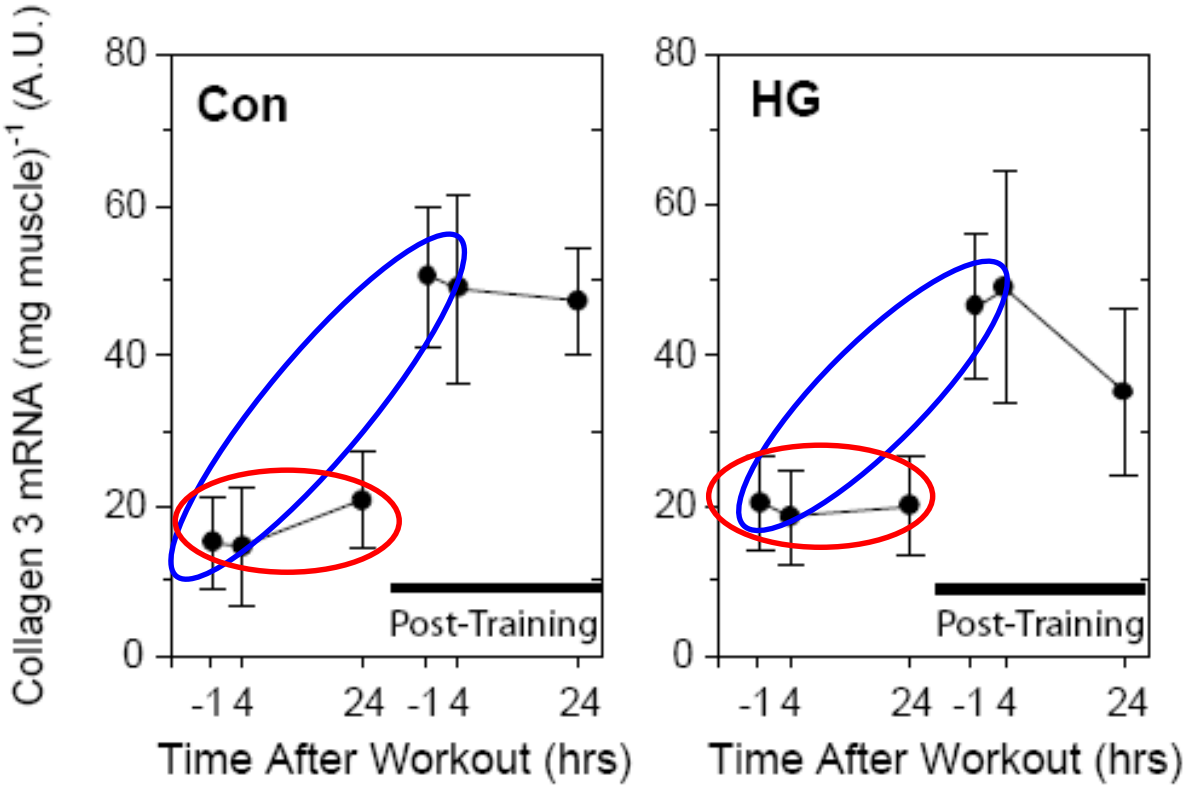
Molecular Marker of Extracellular Matrix Remodeling



Note similarity in acute responses.

Note that both types of resistance training programs produced similar chronic elevation.

TO G OR NOT TO G: THAT IS THE QUESTION

Where Do We Go From Here?

So in taking Mother Earth to Mars, can we forget about taking Earth's gravitational environment?

We need to answer this fundamental question!

Consider that Earth's gravitational field was probably one of the most important evolutionary pressures!

.

TO G OR NOT TO G: THAT IS THE QUESTION

Where Do We Go From Here?

Artificial gravity has the potential to mimic Earth's gravitational field and load every element of the human body, which is not possible with other countermeasure devices.

Simply stated, artificial gravity can provide Earth-like challenges to muscle, skeletal, cardiovascular, and vestibular systems during a single session something that no other countermeasure can achieve.

TO G OR NOT TO G: THAT IS THE QUESTION

Where Do We Go From Here?

Need a sustained gravitational biology program that addresses this fundamental question if we are to ensure the health and safety of our astronauts.

Data clearly demonstrate that hypergravity resistance training produces adaptations very similar to 1g squat resistance training.

Good initial set of data that should stimulate additional studies on the effectiveness of artificial gravity.

TO G OR NOT TO G: THAT IS THE QUESTION

FUNDING

National Aeronautical Space Administration (NASA)
Hypergravity Resistance Training: Countermeasure to Microgravity
MA00403 2004-2008

National Institutes of Health
U.C. Irvine General Clinical Research Center
GCRC MO1RR00827-S1 2000-2005

TO G OR NOT TO G: THAT IS THE QUESTION

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