

The CARD Experiment:

Fluid Shifts, Vasodilatation and Ambulatory Blood Pressure Reduction during Long Duration Spaceflight

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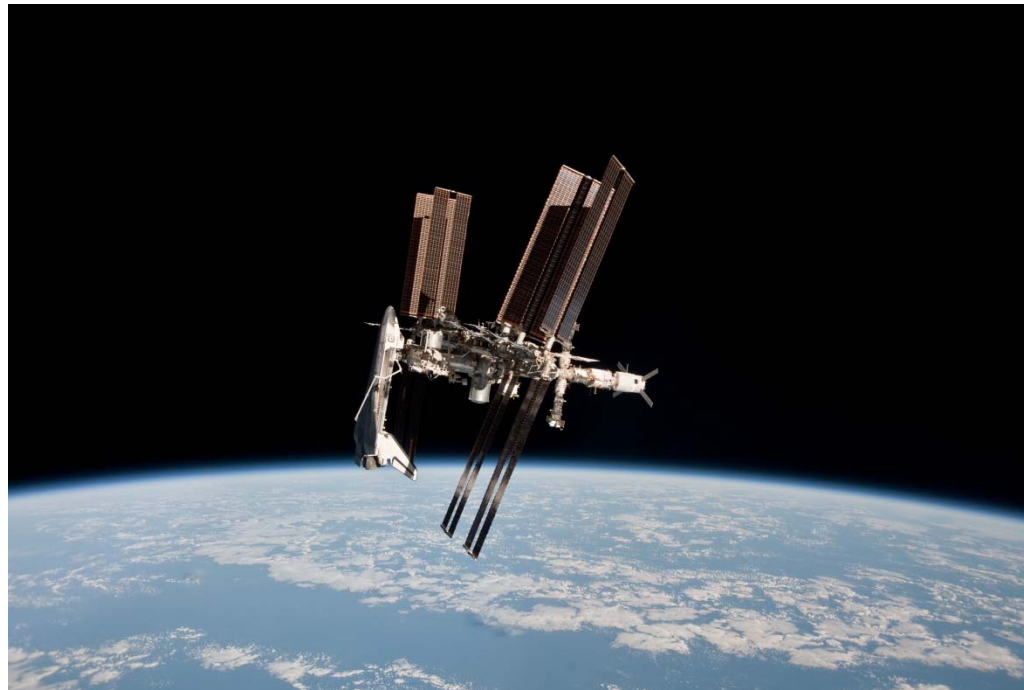
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Paolo Nespoli
European Space Agency astronaut

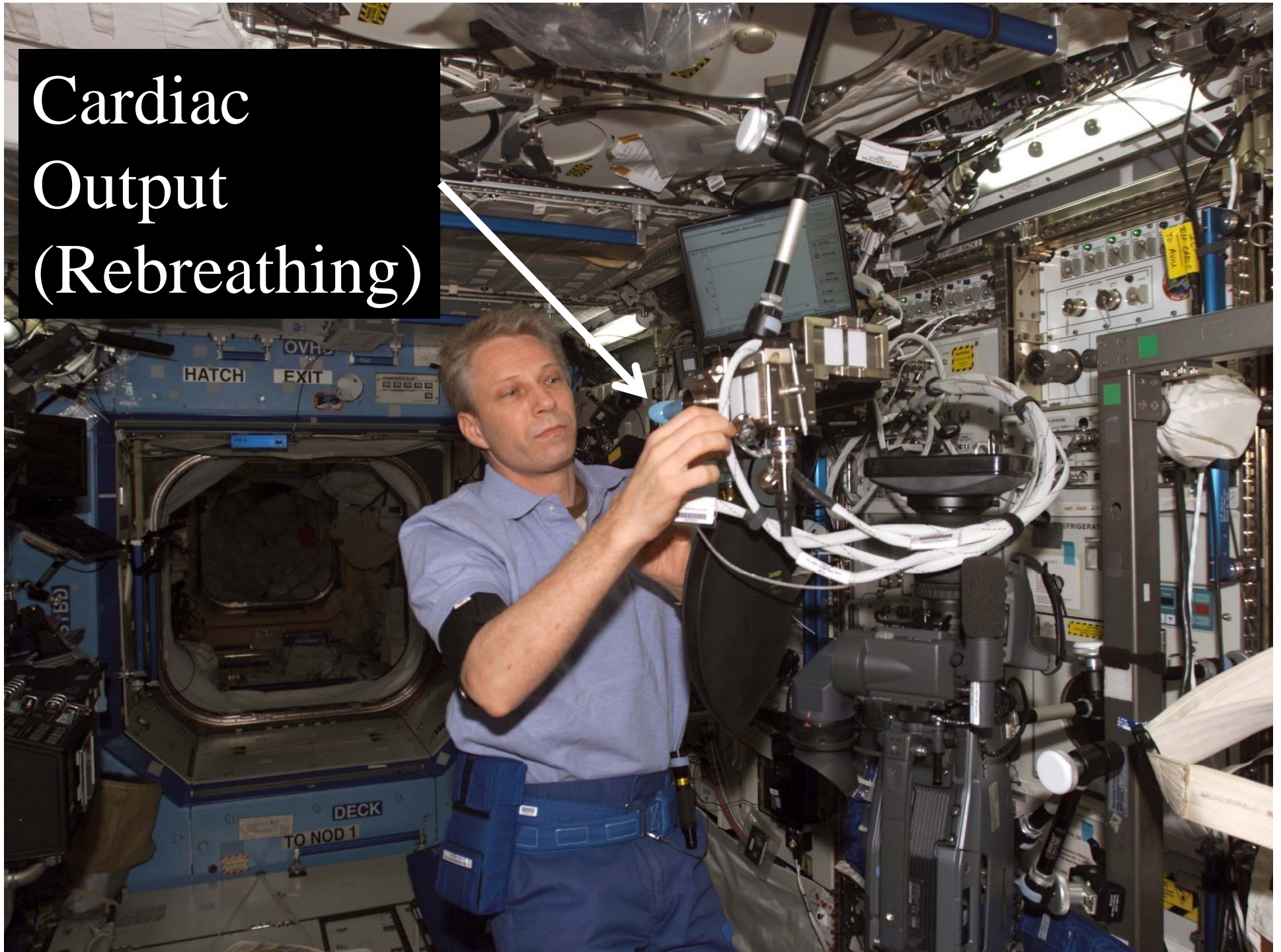
Purpose

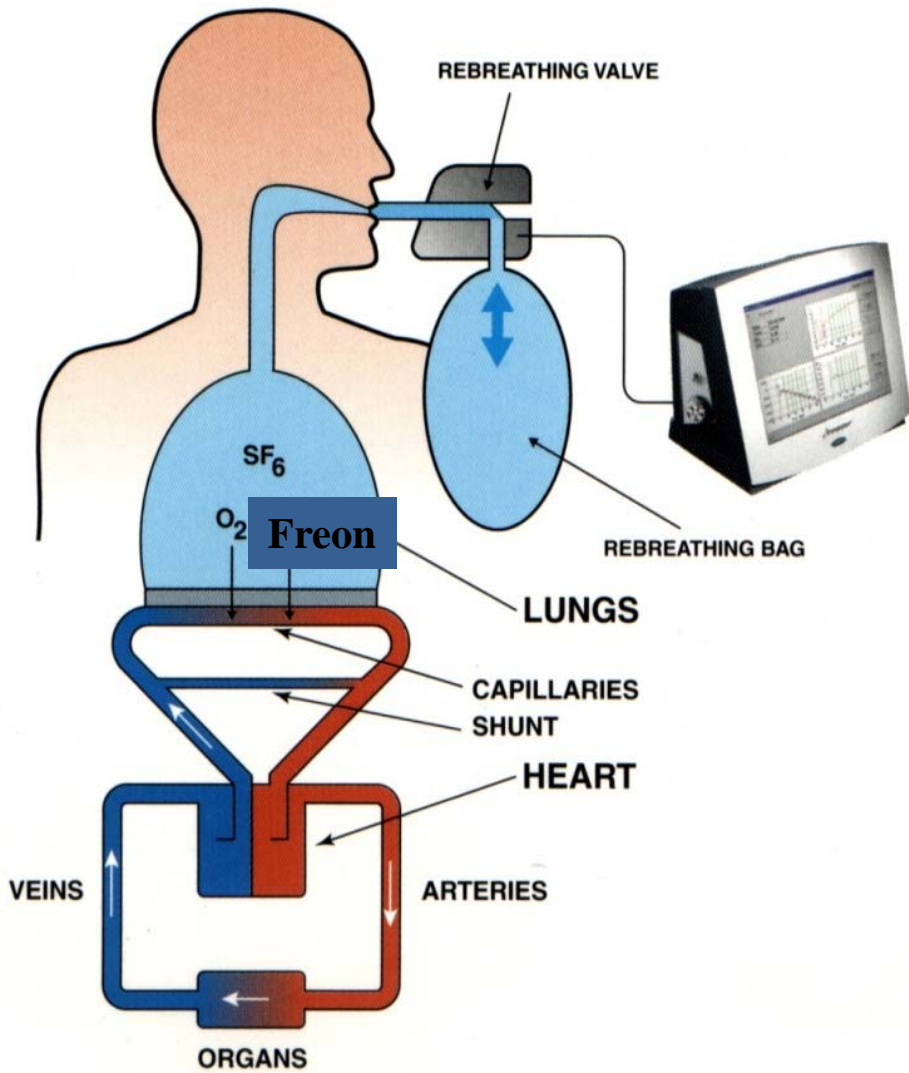
To investigate how fluid shifts, blood pressure and systemic vascular resistance adapt to long duration (3-6 months) spaceflight.

*Based on results from one week into a shuttle mission
(Norsk et al., Hypertension, 47: 69-73,2006)*



Cardiac Output (Rebreathing)

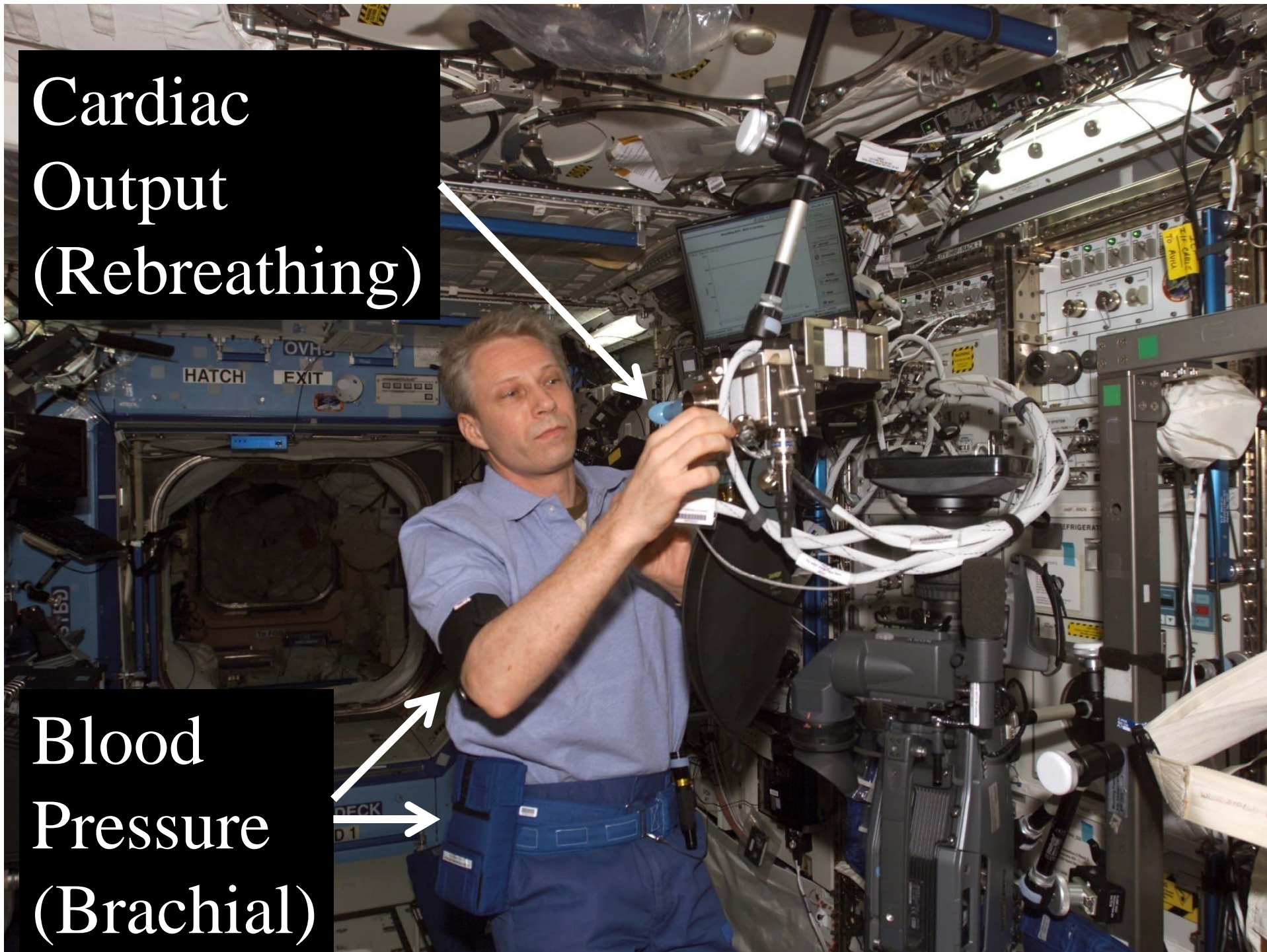




Cardiac output
by
rebreathing

Cardiac
Output
(Rebreathing)

Blood
Pressure
(Brachial)

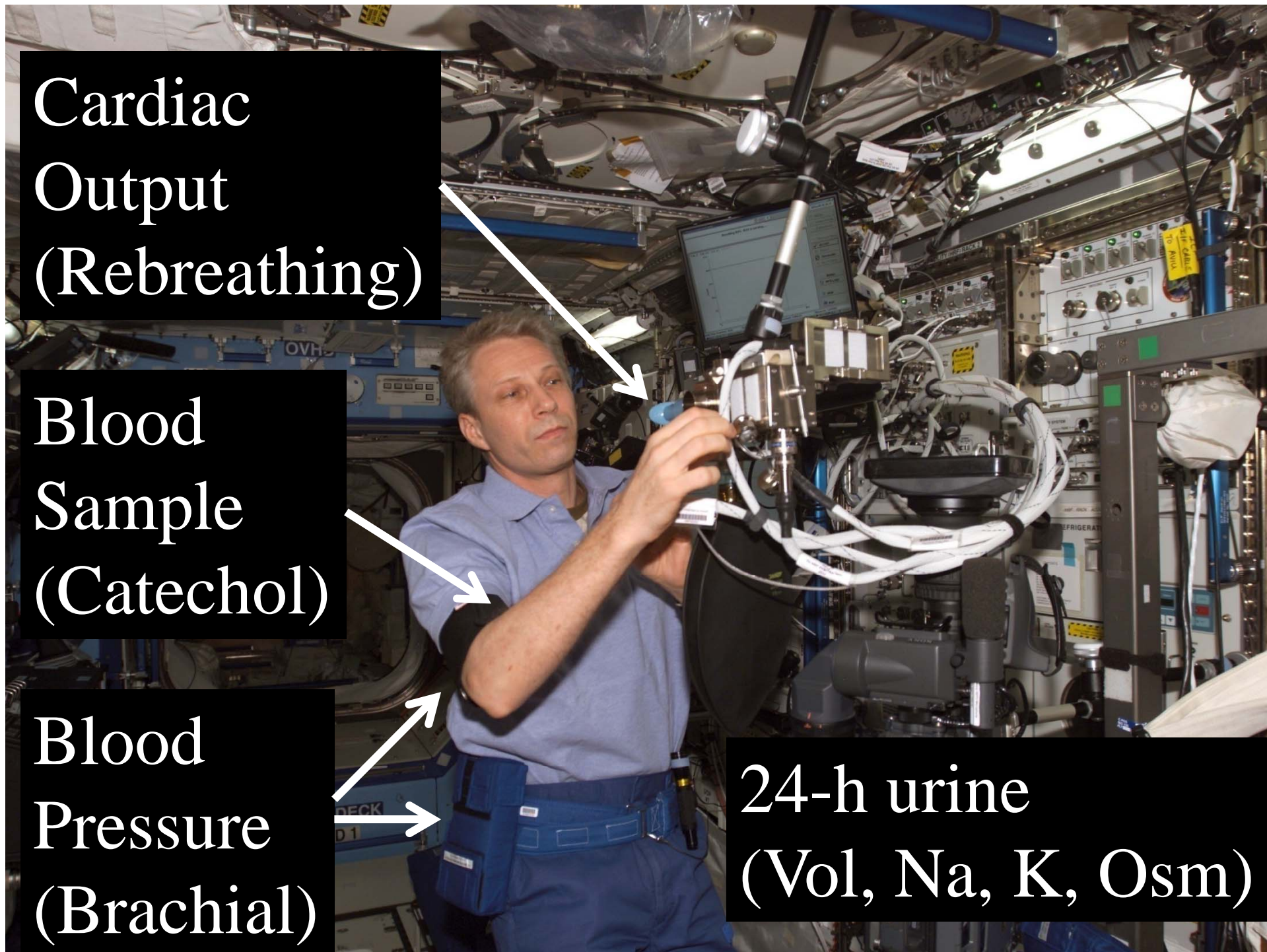


Cardiac
Output
(Rebreathing)

Blood
Sample
(Catechol)

Blood
Pressure
(Brachial)

24-h urine
(Vol, Na, K, Osm)



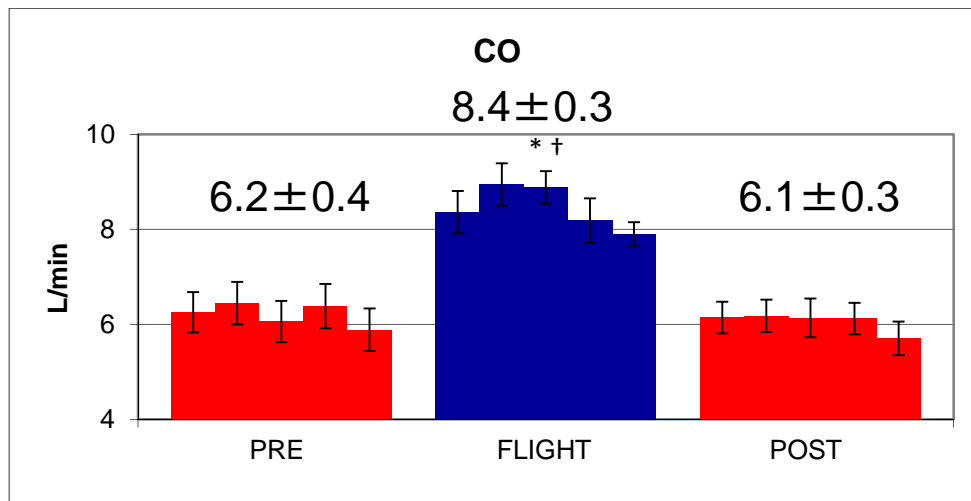
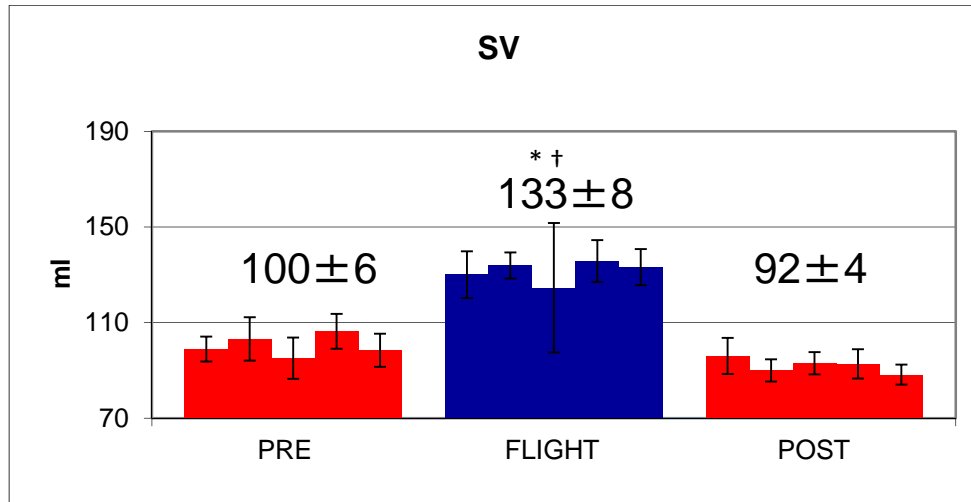
Results

N = 8 males:

Age:	49 ± 1 y
Height:	181 ± 2 cm
Weight:	85 ± 4 kg

Fluid Shifts

Stroke volume

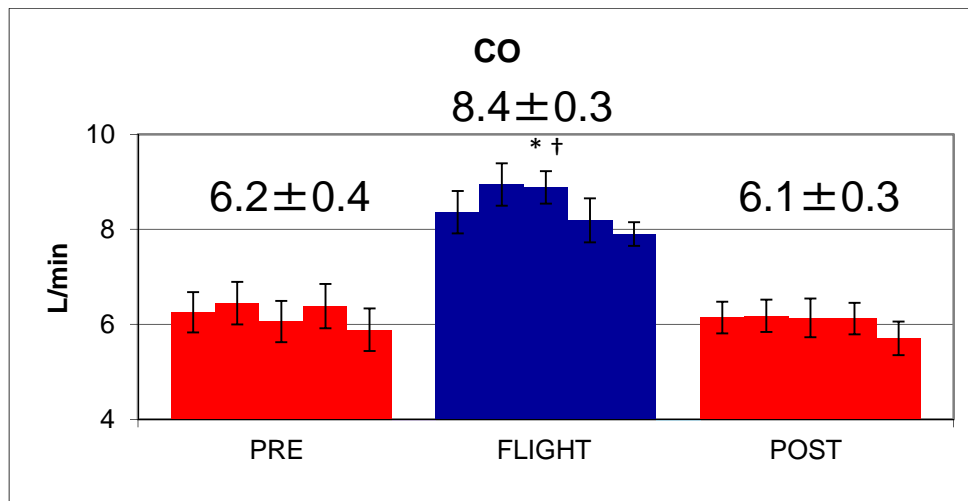
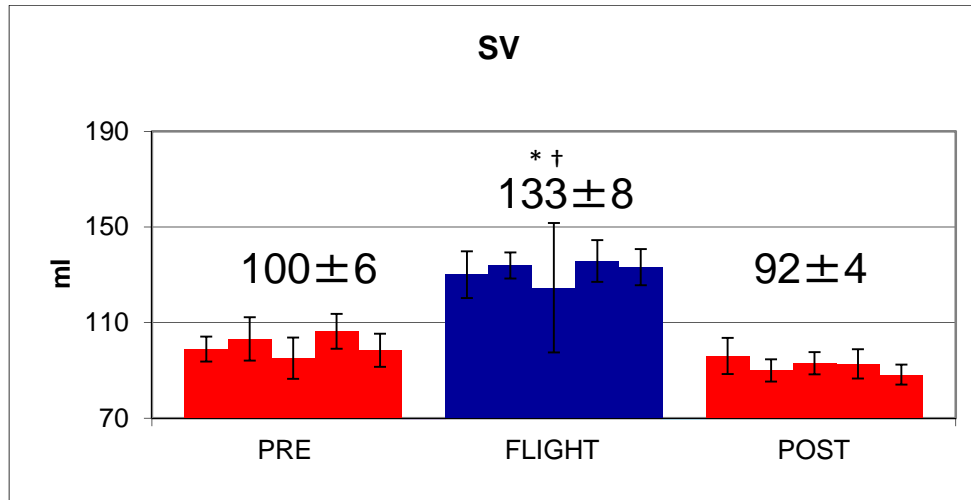


Cardiac output

Fluid Shifts

Stroke volume

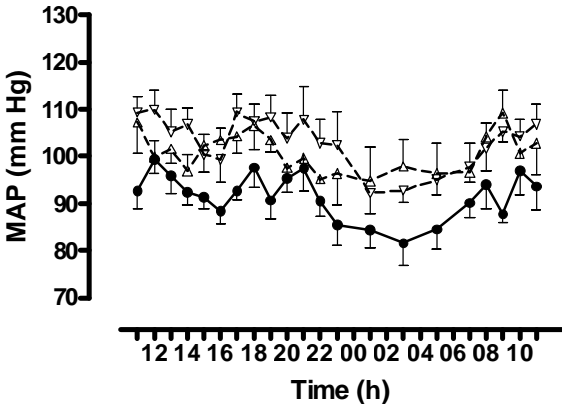
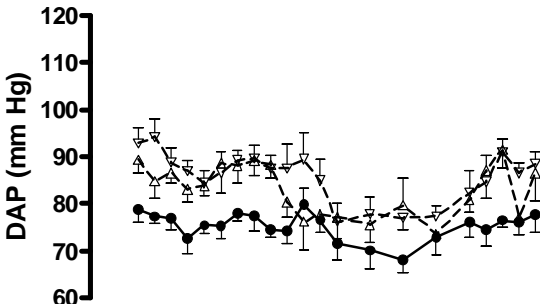
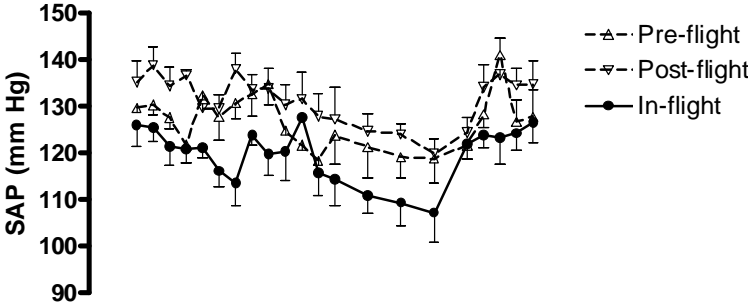
$35 \pm 10\%$ increase



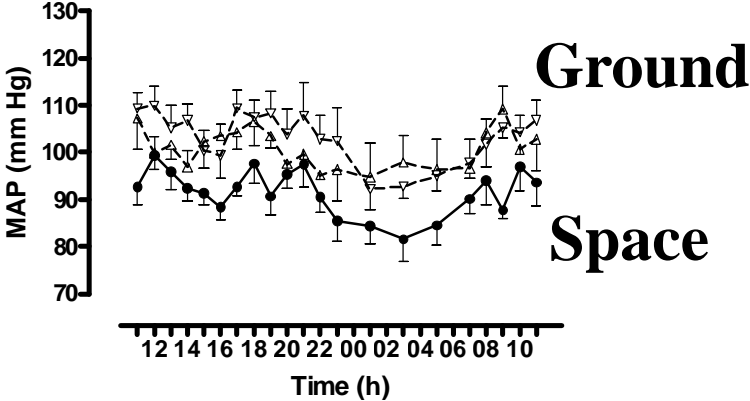
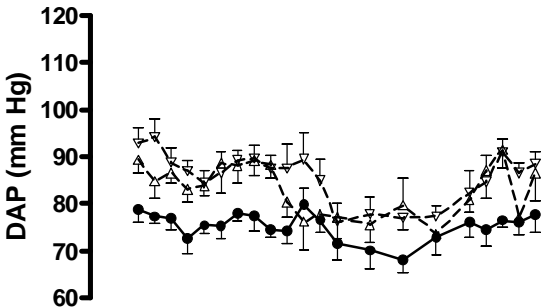
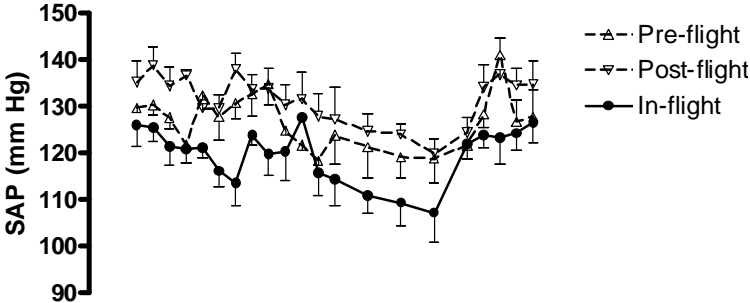
Cardiac output

$41 \pm 9\%$ increase

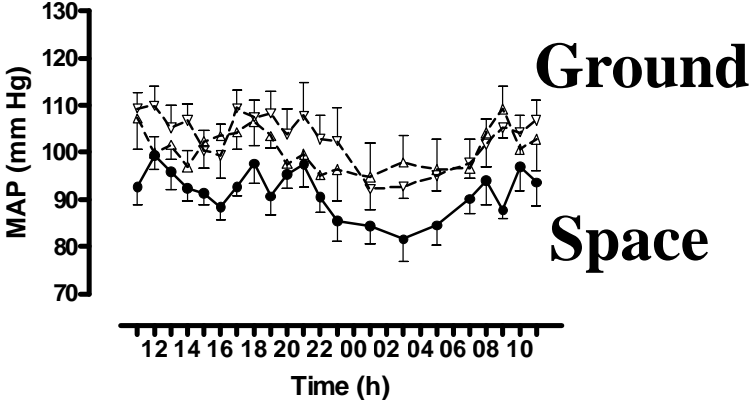
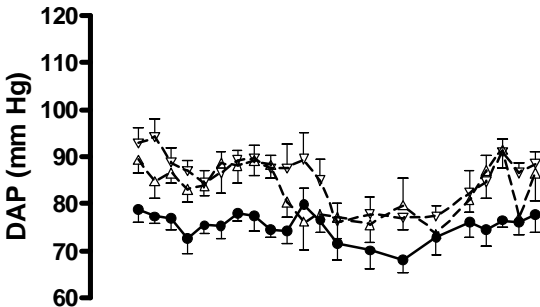
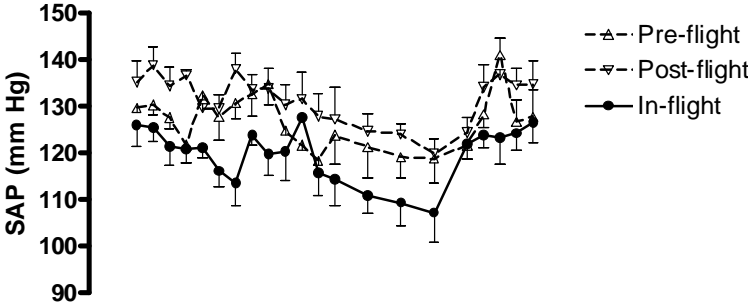
Blood Pressure (24-h ambulatory brachial)



Blood Pressure (24-h ambulatory brachial)

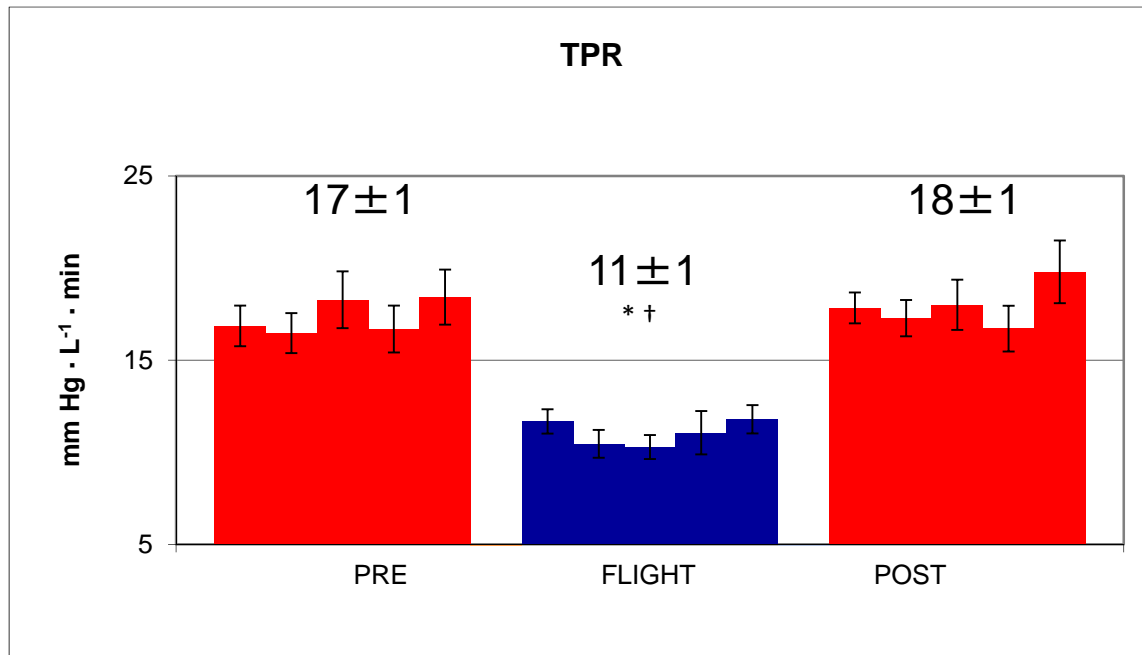


Blood Pressure (24-h ambulatory brachial)

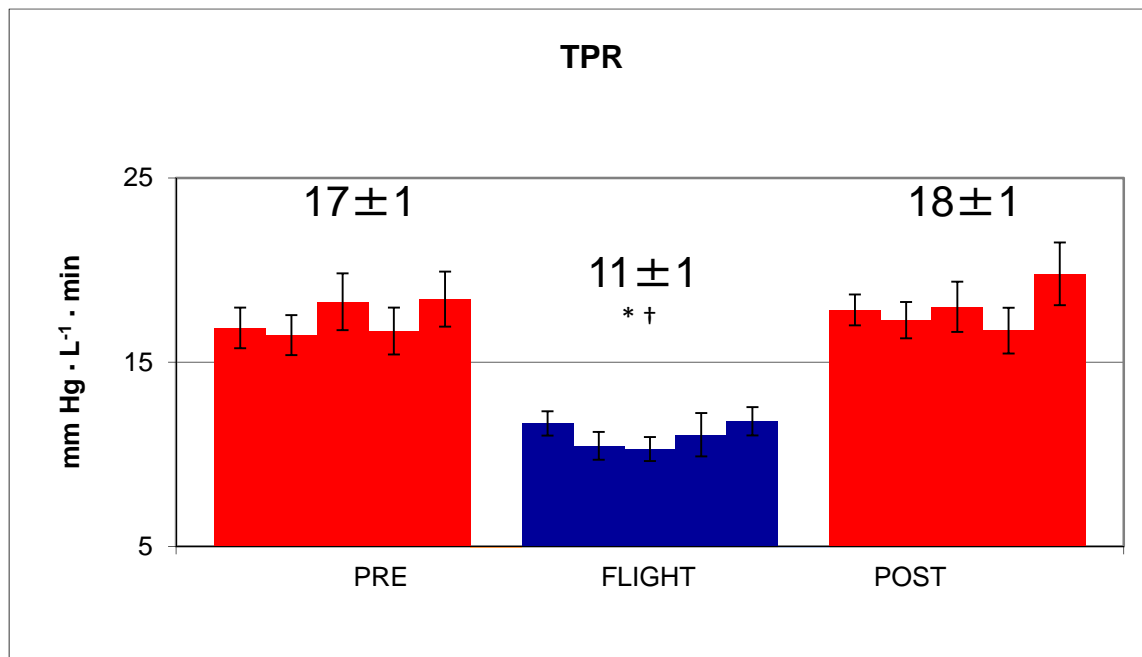


- 10 mm Hg decrease
- No change in heart rate
- Nightly dip maintained

Systemic Vascular Resistance



Systemic Vascular Resistance



39 ± 4 % decrease

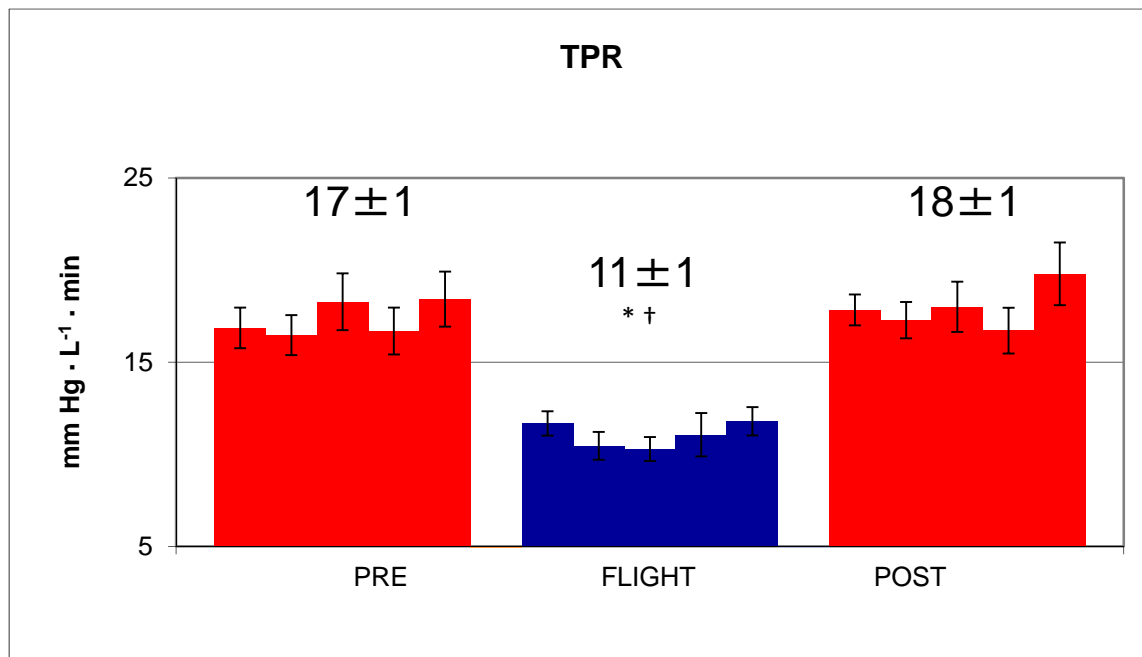
Systemic Vascular Resistance

Plasma noradrenaline (ng/l):

730 ± 130

720 ± 90

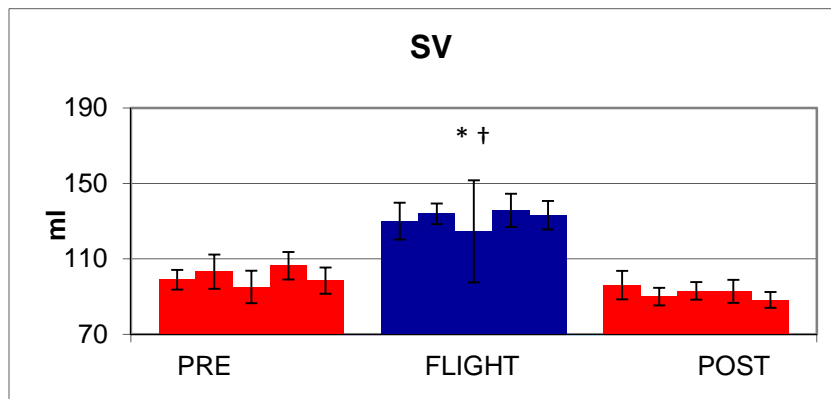
730 ± 100



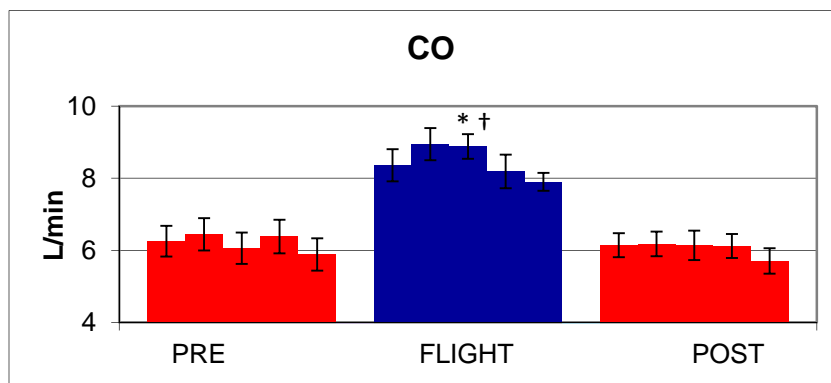
39 ± 4 % decrease

Future challenge (I):

To relate stroke volume and cardiac output to VIIP!



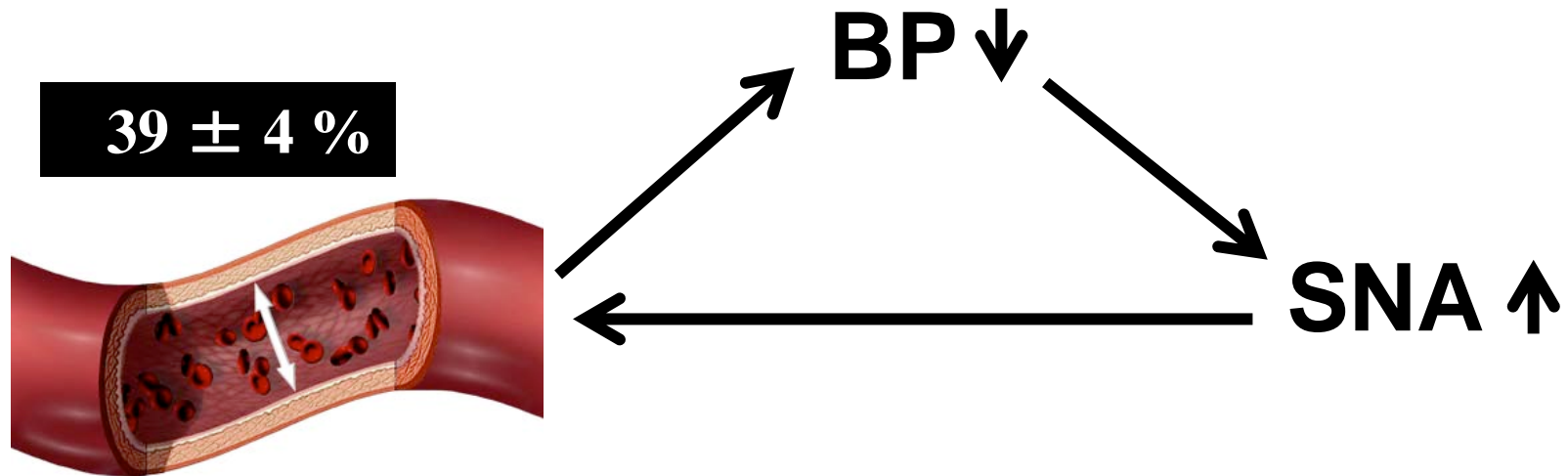
35 ± 10



41 ± 9

Future challenge (II):

To identify the spaceflight vasodilatation mechanism



Acknowledgements:

Co-authors

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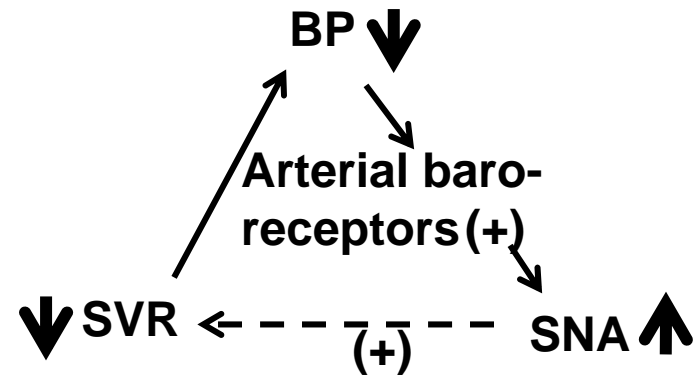
Astronauts (NASA-JSC)

Norsk et al. J. Physiol. 593: 573-584, 2015.

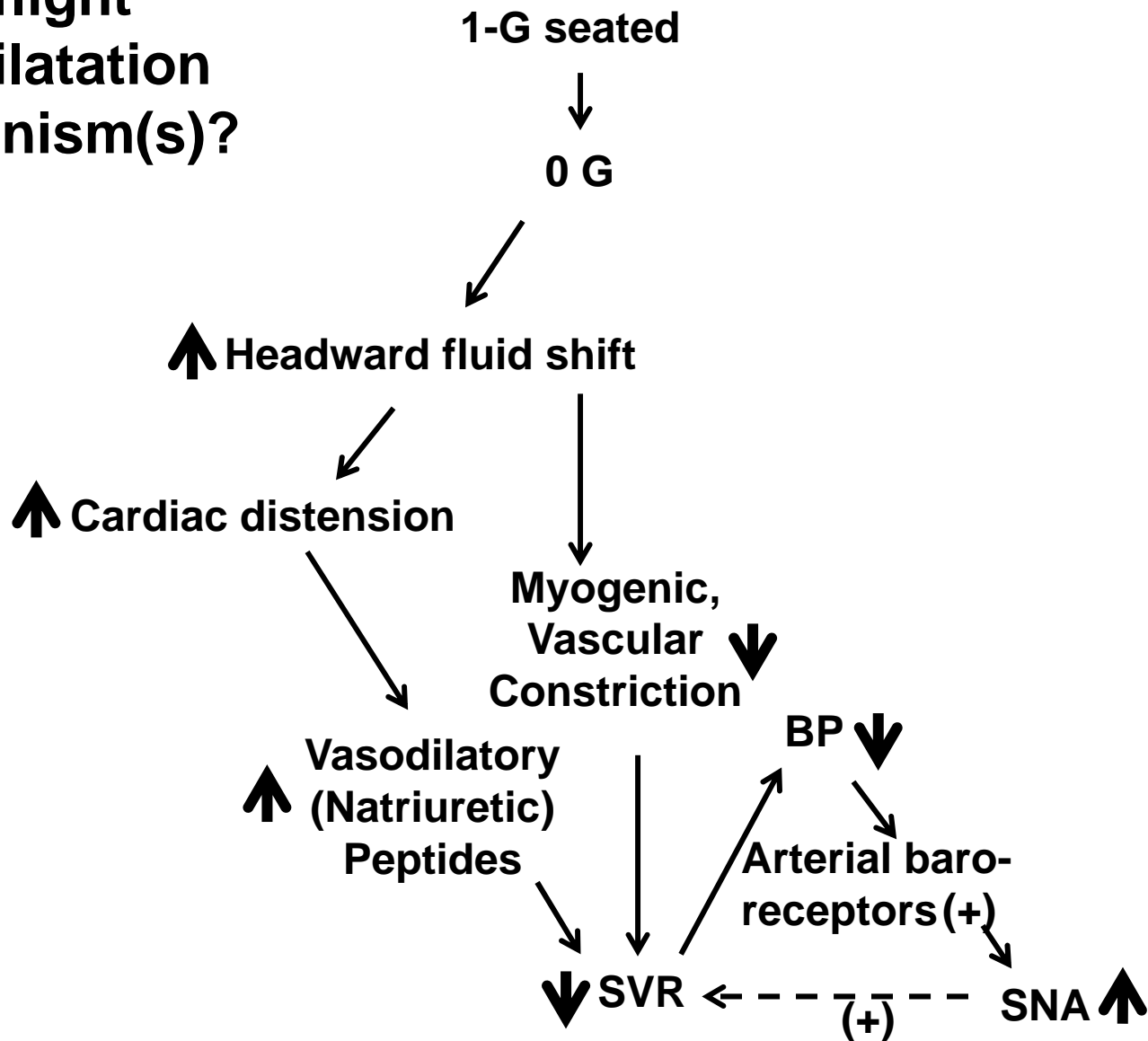
Thank you!



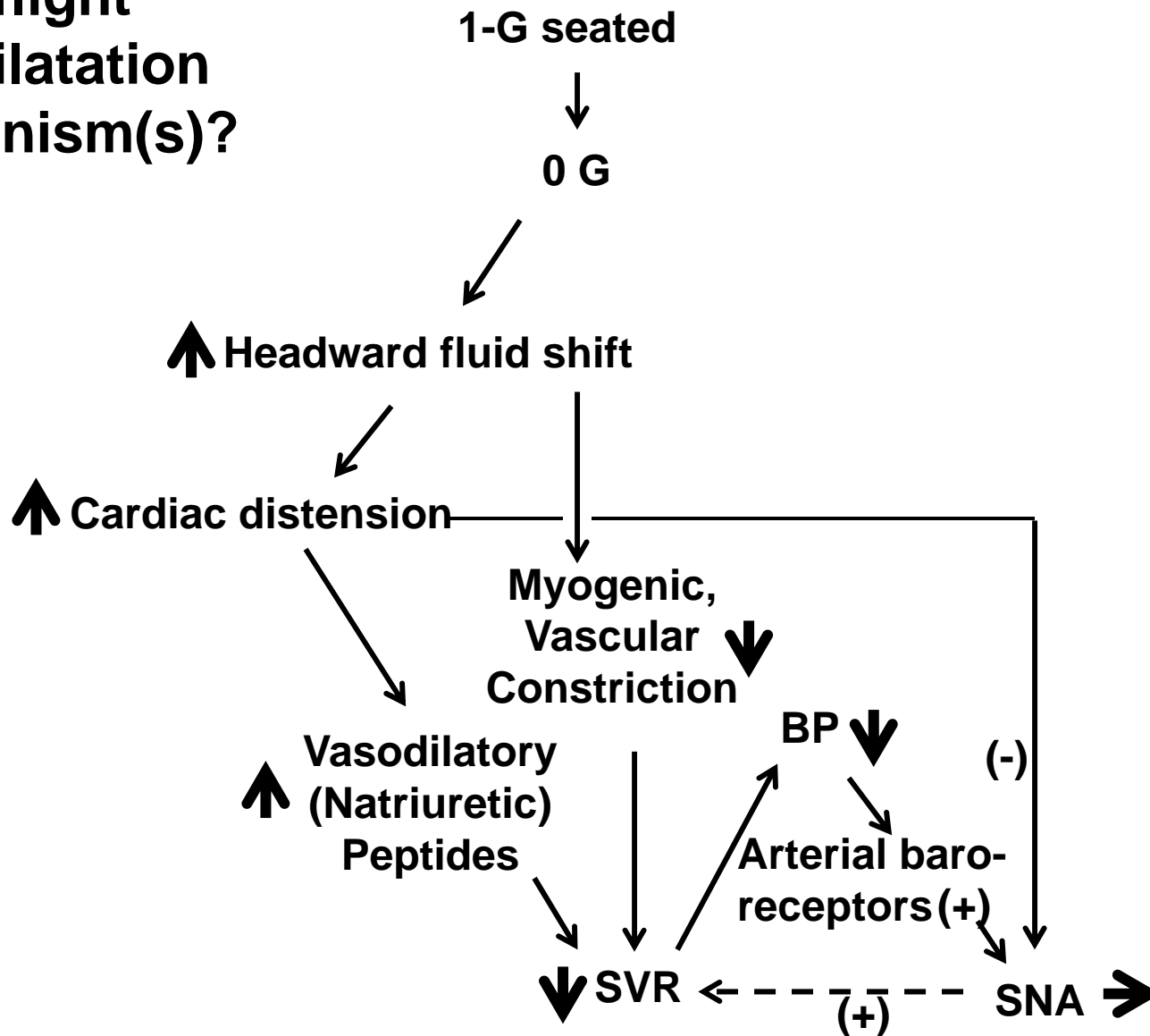
Spaceflight Vasodilatation Mechanism(s)?



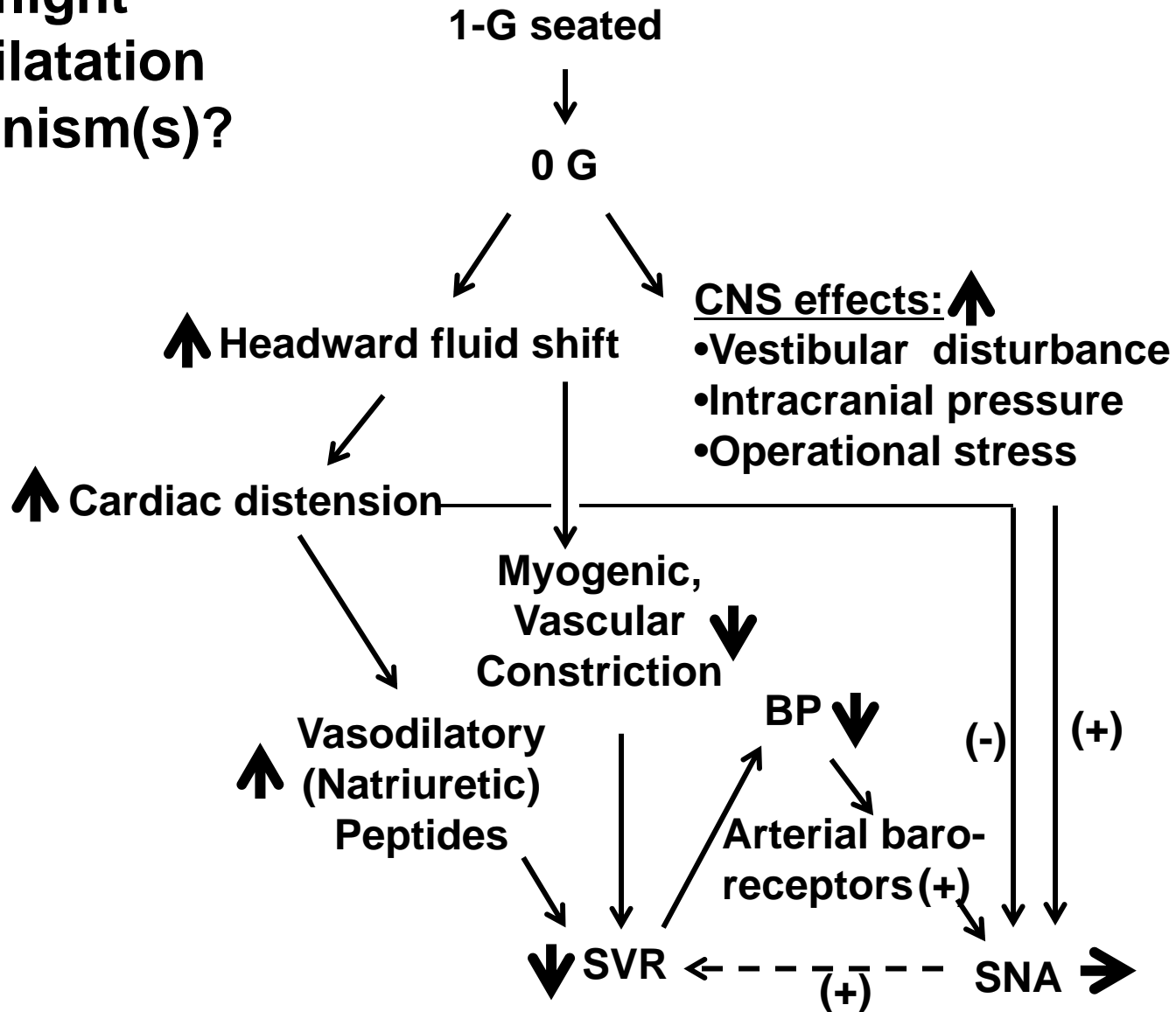
Spaceflight Vasodilatation Mechanism(s)?



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