



Human Research Program Standard Measures in Analogs

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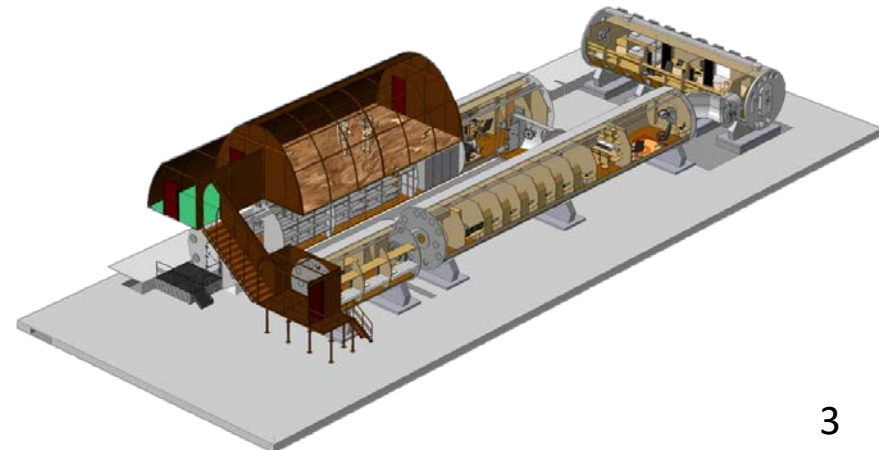
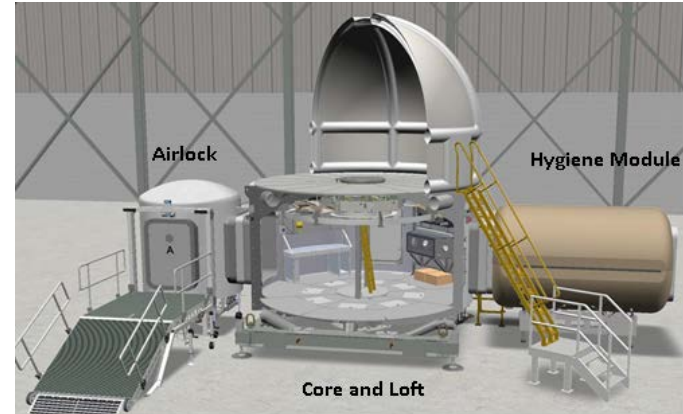


Objectives

- To ensure that a minimal set of measures, relevant to human spaceflight risks, is consistently captured from subjects participating in spaceflight analog environments
- The data from these measures will be placed in an archive managed by HRP and made available to studies via data sharing agreements
- *HRP Standard Measures* will constitute a database for:
 - Providing context for data acquired by concurrent experiments
 - Supporting or developing hypotheses
 - Evaluating the effectiveness of various countermeasure profiles
 - Comparing population responses to various mission durations and scenarios

Analogs

- **enviHab, DLR Cologne**
 - International Standard Measures
 - VaPER – 30 d
 - AGBRESA – 60 d
- **HERA, NASA JSC**
 - HRP Standard Measures
 - C5
 - C6
- **NEK, IBMP Moscow**
 - HRP Standard Measures
 - SIRIUS-19 – 120 d
 - SIRIUS-20 – 240 d

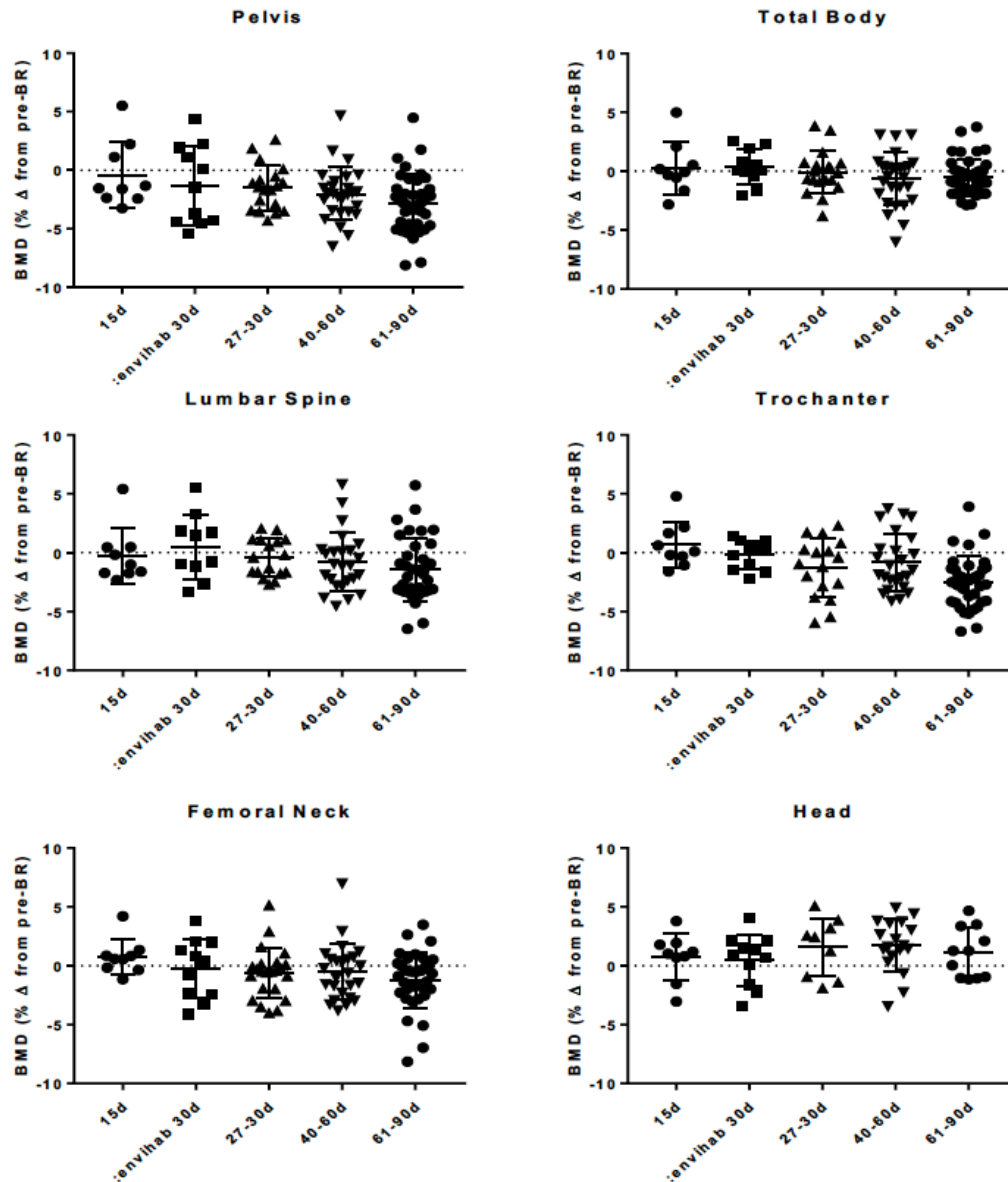




International Standard Measures Timeline

Discipline	International Standard Measure	Pre	During	Post
Psychology	Positive and Negative Affect Scale	BR-13	BR14	BR+1
	General Health Questionnaire	BR-1	BR28	BR+13
SANS	Ocular Tests (IOP, Ultrasound, OCT)	BR-3		BR+0
Biochemistry	Nutritional assessment (blood, urine) Hematology	BR-3		BR+0
Immunology	Immunology (blood, saliva)	BR-3		BR+0
Muscle	Neuromuscular Power: Vertical Jump	BR-5		BR+0
	Muscle Strength	BR-5		BR+2
Bone	Bone Marker (blood)	BR-3		BR+0
	Bone Mineral Density (DEXA)	BR-14		BR+11
Cardiovascular	Orthostatic Tolerance Tilt Test	BR-5		BR+0
	Maximal Aerobic Capacity (VO2 max)	BR-4		BR+0
Sensorimotor	Postural Equilibrium Control	BR-1		BR+0
	Treadmill Locomotion Test	BR-2		BR+0
Vitals	Pulse, Blood pressure; Respiration rate; Weight; Height; Body temperature; Water intake; Urine output; Bowel movements Humidity; CO ₂ reading; Ambient temperature	Daily	Daily	Daily
Rehabilitation	Physiotherapy		BR1-30	BR+0-6
	Reconditionning		BR4-12	
	Stretching	BR-4	BR1-30	

VaPER Study – Bone Mineral Density



Mean (\pm SD) percent change in subjects' bone mineral density (BMD) in pelvis, whole body, lumbar spine, trochanter, femoral neck, and head (skull) after HDT bed rests ranging from 15 to 90 days.

The VaPER study is referred as “:envihab 30d”.

Data courtesy of Sara Zwart

VaPER Study – Sensorimotor Measures

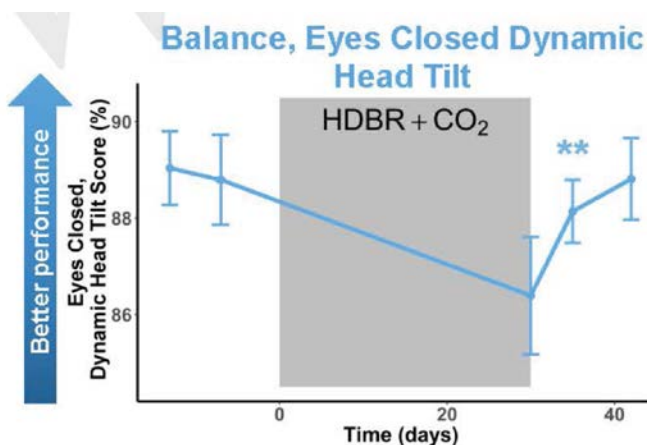
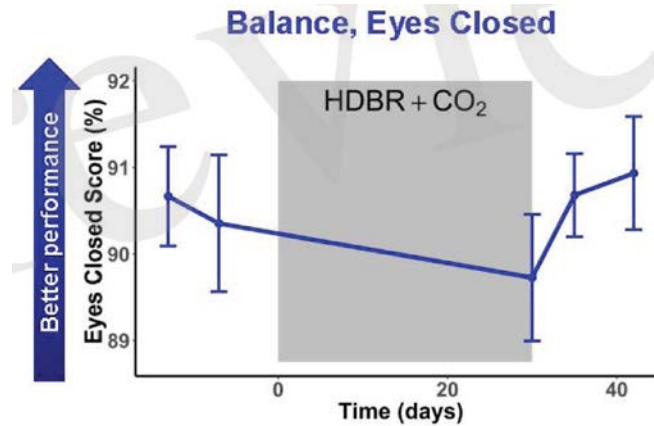
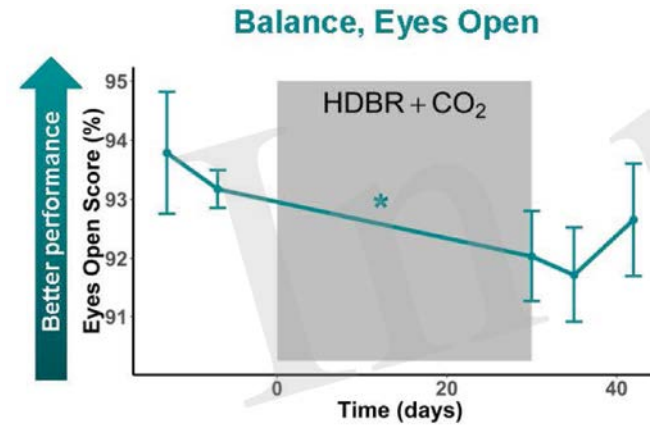
Hupfeld et al. (2020) Front Syst Neurosci, in press



Neural correlates of vestibular processing during a spaceflight analog with elevated carbon dioxide (CO₂): A pilot study

Kathleen E. Hupfeld¹, Jessica K. Lee², Nichole E. Gadd³, Igor S. Kofman³, Yiri E. De Dios³, Jacob Bloomberg⁴, Ajitkumar Mulavara³, Rachael D. Seidler^{1*}

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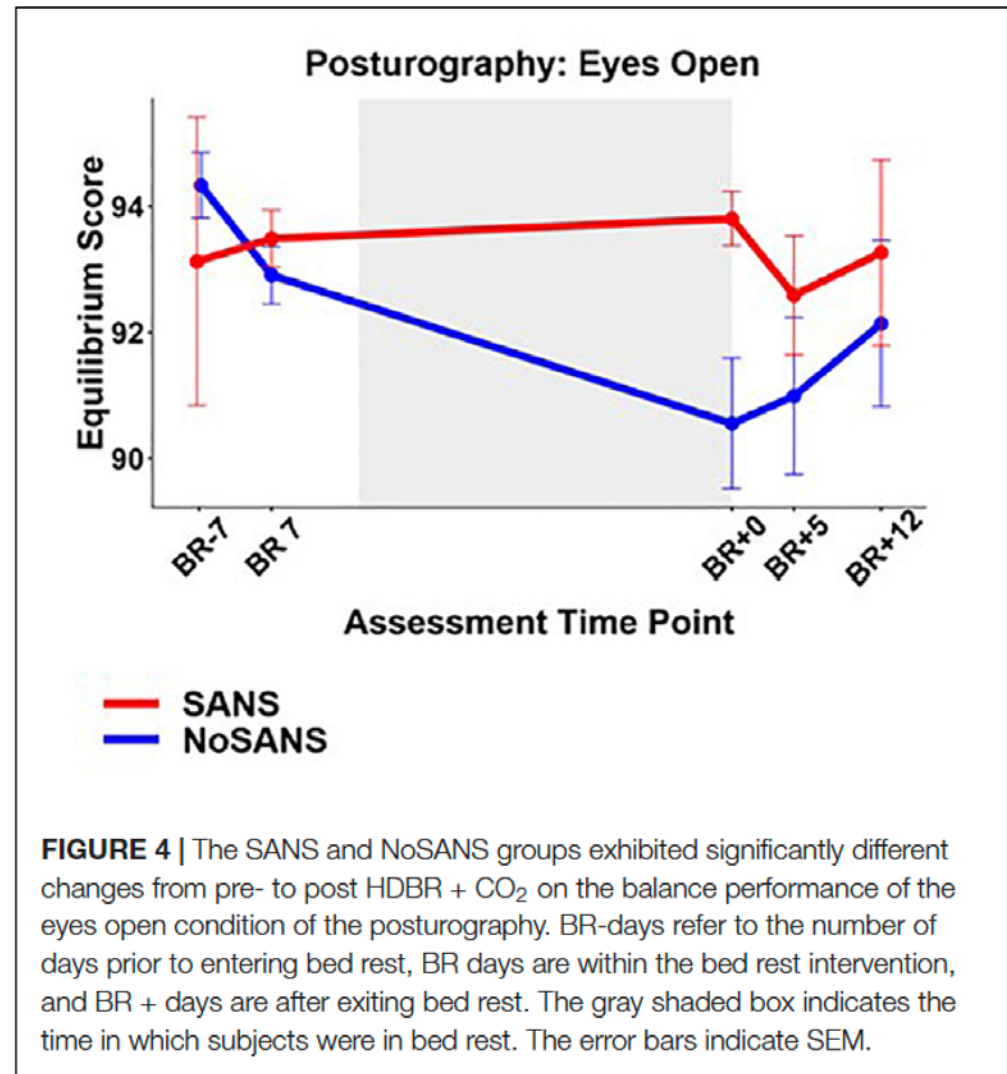
VaPER Study – Sensorimotor Measures

Lee et al. (2019) Front Hum Neurosc 13:355



Head Down Tilt Bed Rest Plus Elevated CO₂ as a Spaceflight Analog: Effects on Cognitive and Sensorimotor Performance

Jessica K. Lee^{1,2}, Yiri De Dios³, Igor Kofman³, Ajitkumar P. Mulavara³, Jacob J. Bloomberg⁴ and Rachael D. Seidler^{1,5*}





Differences Between SANS and no-SANS Groups

Discipline	International Standard Measure	Significant Difference	In What Data
Psychology	Positive and Negative Affect Scale	Yes	<ul style="list-style-type: none"> • Negative Affect • Anxiety • Insomnia
	General Health Questionnaire	Yes	
Biochemistry	Nutrition	No	
	Hematology	No	
Immunology	Immunology	No	
Muscle	Vertical Jump	No	
	Muscle Strength	No	
Bone	Bone Marker	No	
	Bone Mineral Density (DEXA)	No	
Cardiovascular	Orthostatic Tolerance Tilt Test	Yes	<ul style="list-style-type: none"> • Pre-Post BR Percent change in Cardiac Output before tilt • Pre-Post Percent change in Brachial DBP during tilt • Heart Rate during bed rest
	Maximal Aerobic Capacity	Yes	
Sensorimotor	Postural Equilibrium Control	No	
	Treadmill Locomotion Test	No	
Vitals	Ancillary Measures	Yes	<ul style="list-style-type: none"> • Respiration Rate • Body Temperature



HERA HRP Standard Measures

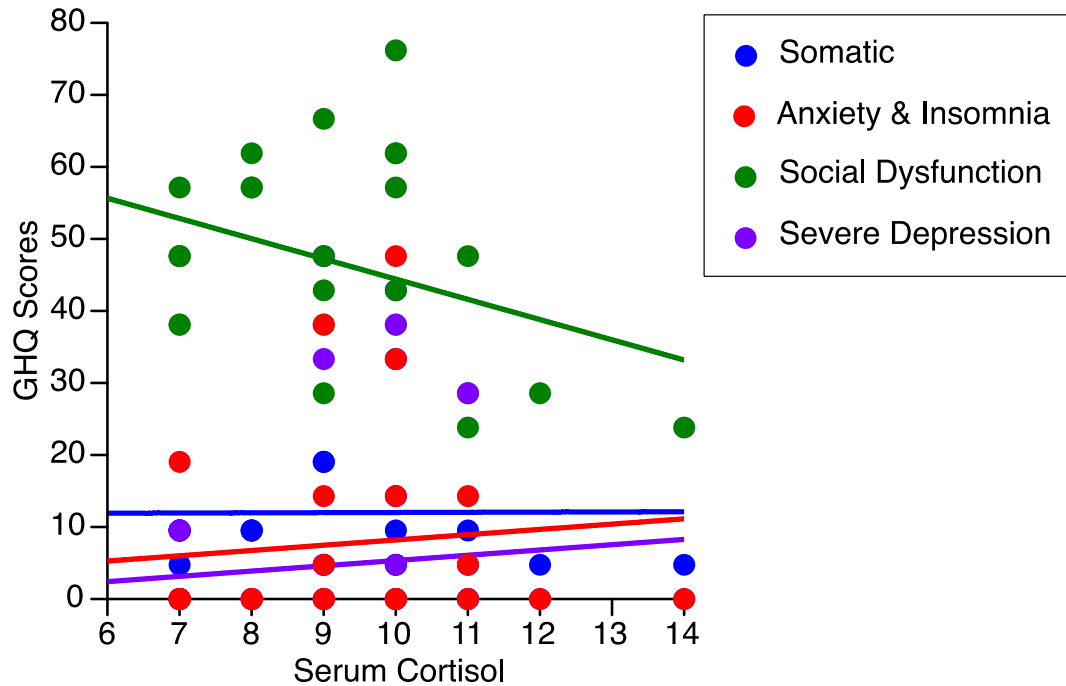
Test Name	Methods	Pre	During	Post
Positive and Negative Affect Scale (PANAS)	The PANAS is a 20-item self-evaluation questionnaire that measures affects, or indicators of emotional states. The PANAS separately assesses positive and negative affects. A positive affect reflects the extent to which a person feels enthusiastic, active and alert. Low-positive affect is characterized by sadness and lethargy. A high-negative affect is described by anger, contempt, disgust, guilt, fear and nervousness. A low-negative affect describes a state of calmness and serenity.	BDC-13 ± 2d BDC-1 ± 1d 5 min	Weekly 5 min	R+1 ± 1d R+7 ± 2d 5 min
General Health Questionnaire (GHQ)	GHQ provides an overall total score for mental health. Each item on the GHQ is rated on a 4-point scale (0 to 3) indicating 'less than usual', 'no more than usual', 'rather more than usual', and 'much more than usual'.	BDC-13 ± 2d BDC-1 ± 1d 5 min	Weekly 5 min	R+1 ± 1d R+7 ± 2d 5 min
Serum Cortisol	Serum cortisol is assessed by liquid chromatography-tandem mass spectrometry (LC-MS/MS). The blood collection for this test (3.5 mL BD SST tube) is at the same time in the morning because there are known fluctuations throughout the day in healthy subjects. Total blood volume is 17.5 mL.	BDC-3 ± 2d 15 min	MD5 ± 2d MD20 ± 2d MD45 ± 2d 15 min	R+1 ± 1d 15 min



NEK HRP Standard Measures

Test Name	Methods	Pre	During	Post
Positive and Negative Affect Scale (PANAS)	The PANAS is a 20-item self-evaluation questionnaire that measures affects, or indicators of emotional states. The PANAS separately assesses positive and negative affects. A positive affect reflects the extent to which a person feels enthusiastic, active and alert. Low-positive affect is characterized by sadness and lethargy. A high-negative affect is described by anger, contempt, disgust, guilt, fear and nervousness. A low-negative affect describes a state of calmness and serenity.	BDC-13 ± 2d BDC-1 ± 1d 5 min	Weekly 5 min	R+1 ± 1d R+7 ± 2d 5 min
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Serum Cortisol	Serum cortisol is assessed by liquid chromatography-tandem mass spectrometry (LC-MS/MS). The blood collection for this test (3.5 mL BD SST tube) is at the same time in the morning because there are known fluctuations throughout the day in healthy subjects. Total blood volume is 17.5 mL.	BDC-3 ± 2d 15 min	MD Early (2 wk) MD Mid (4 mo) MD Late (8 mo) 15 min	R+1 ± 1d 15 min

SIRIUS-19 Preliminary Results



GHQ score, courtesy of Pete Roma
 Serum cortisol, courtesy of Sara Zwart