



# Psychomotor Vigilance Self Test on ISS (Reaction Self Test on Expeditions 21 & 22)

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Experiment addresses the following high-priority NASA Risk Gaps in the Behavioral Health and Performance (BHP) area:

- Identify brief, valid objective measures of changes in cognitive functions during spaceflight that astronauts can use with minimal burden.
- Find a practical objective aid for astronauts to quickly identify and manage the effects of fatigue (from sleep loss, circadian disruptions, workload and other factors) on their performance during space flight.





# Reaction Self Test on Expeditions 21 & 22

## Identification of the ideal task

- Criteria for task:
1. Task assesses operationally relevant cognitive functions
  2. Task has brief duration
  3. Task is not affected by aptitude (skill)
  4. Task is not affected by learning (training or practice)
  5. Task has known neurobiological basis
  6. Task is experimentally validated for sensitivity to fatigue
  7. Avoiding, gaming or faking the task is detectable
  8. Task is operationally feasible in work environment
  9. Task is software based (no upmass)
  10. Task can be based on normative data from astronauts

An extensive scientific search for tasks meeting these criteria revealed the **Psychomotor Vigilance Test (PVT)** met all of the above criteria.\*

\* Van Dongen et al., (2003); Belenky et al. (2003); Balkin et al. (2004); Dorrian et al. (2005); Drummond et al. (2005); Durmer & Dinges (2005); Lim & Dinges (2008)





# Reaction Self Test on Expeditions 21 & 22



**Reaction Self Test measures vigilant attention performance (PVT)**, which has been extensively documented in scientific studies to be very sensitive to fatigue (>100 published studies).

The Reaction Self Test uses repeated reaction times to a light stimulus to measure the following aspects of vigilant attention during a 3-minute performance period.

- Optimal visual reaction time and psychomotor speed
- Wake state instability as measured by lapses (errors of omission)
- Impulsivity as measured by errors of commission

**Computerized 5-minute Reaction Self Test** has the following features.

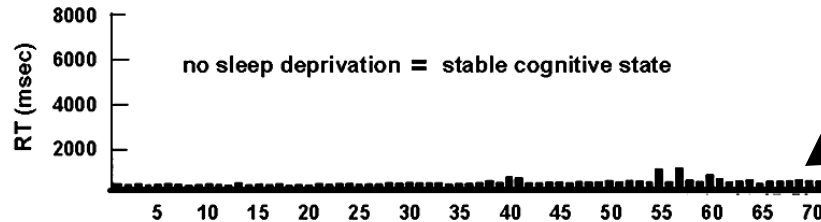
- 3-minute test is done after answering questions about activities (2 minutes).
- Test provides feedback on performance level (0-100%) relative to astronaut norms.
- Test has no aptitude or learning effects that contaminate other tests (WinSCAT).
- Test is intended as a personalized aid to astronauts for fatigue management.



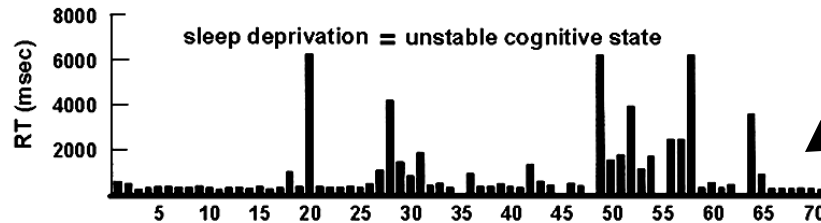


# Reaction Self Test on Expeditions 21 & 22

Reaction Self Test reveals the psychomotor slowing and wake state instability produced by fatigue from inadequate sleep and high workload.



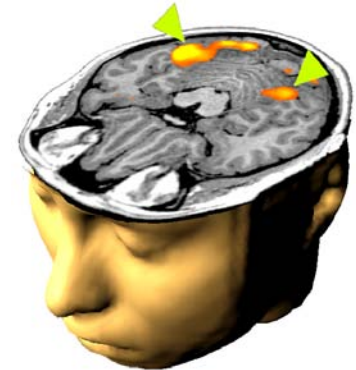
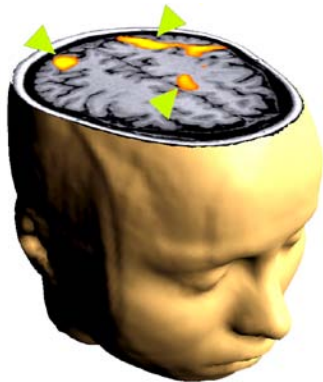
**No fatigue:** Stable (normal) vigilant attention responses



**Fatigue:** Unstable vigilant attention responses (errors of omission and commission comingle with normal responses)

consecutive RTs across a 10-min PVT performance task

Neuroimaging studies have documented that fatigue affects vigilant attention performance by causing unpredictable reductions in neural activity in distributed brain regions that include cognitive control areas in the prefrontal cortex, visual processing areas in the occipital lobe, and the thalamus.

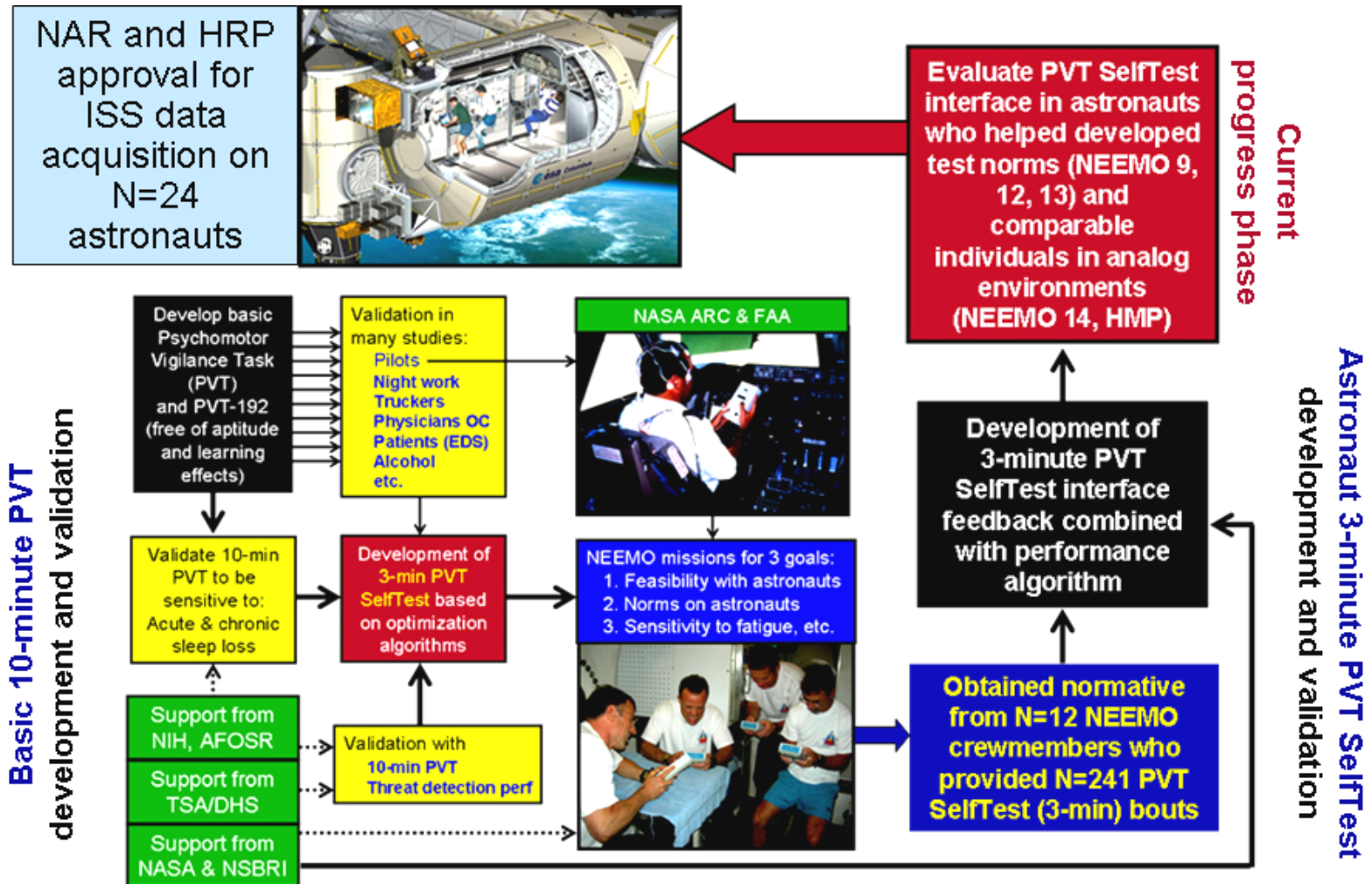




# Reaction Self Test on Expeditions 21 & 22



The Reaction Self Test was algorithmically optimized for astronauts based on normative data on astronauts working in analog environments.





# Reaction Self Test on Expeditions 21 & 22

## Objectives and Hypotheses

1. Evaluate the extent to which Reaction Self Test performance of astronauts is sensitive to fatigue from **sleep loss and circadian disruption** during ISS missions.

**Hypothesis:** Reaction Self Test performance will decline in response to wake durations >16 hours; sleep restricted to <6 hours per day for 3+ days; sleep shifts

2. Evaluate the extent to which Reaction Self Test performance of astronauts is sensitive to fatigue from **work intensity** during ISS missions.

**Hypothesis:** Reaction Self Test performance will decline in response to extended work periods >12 hours per day; >6 work days without a day off for rest; EVAs.

3. Evaluate the extent to which Reaction Self Test performance of astronauts declines with **time in mission**.

4. Evaluate the extent to which Reaction Self Test performance of astronauts will be sensitive to the **carry-over effects of medications** for sleep on ISS.

5. Evaluate the extent to which Reaction Self Test performance is **useful to astronauts** for assessing performance capability and utilizing fatigue countermeasures on ISS.





# Reaction Self Test on Expeditions 21 & 22



## Measurements

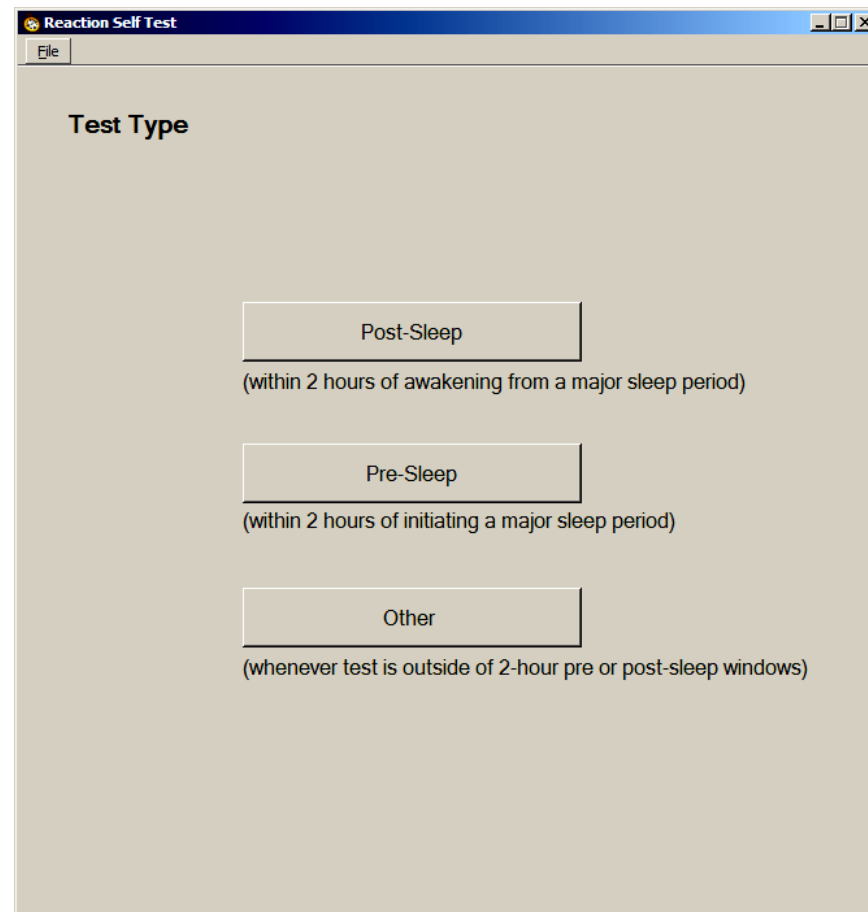
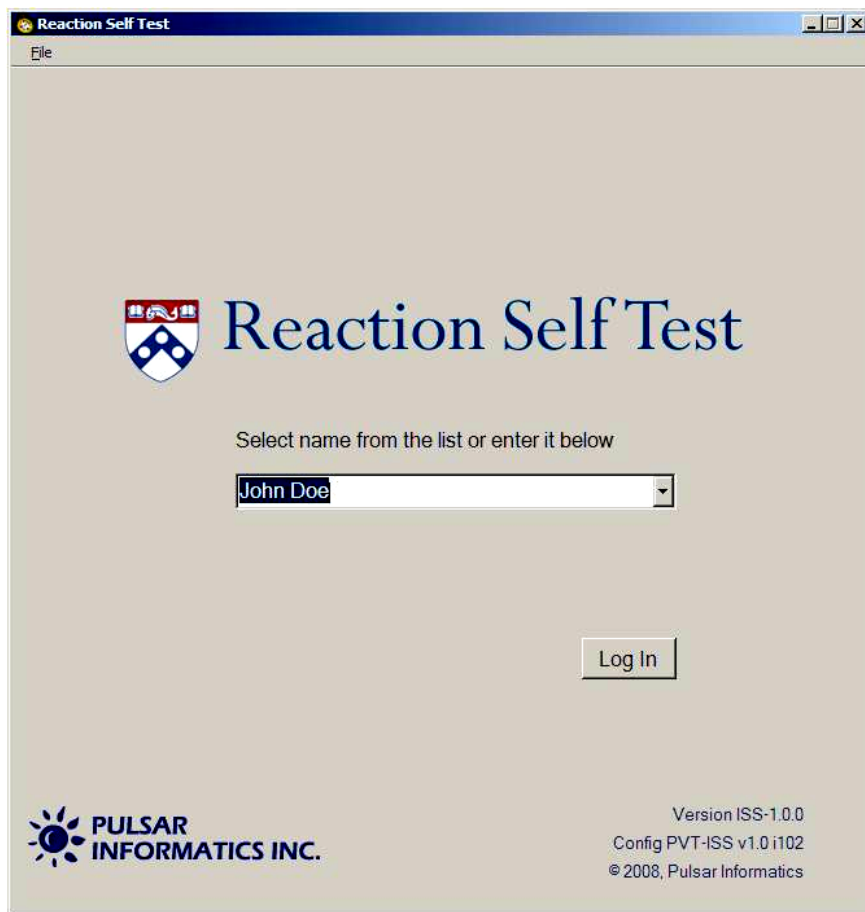
Preflight	In-Flight	Postflight
<p>1) Familiarization session prior to L-180 BDC</p> <p>2) BDC Sessions: Reaction Self Test (5 mins per session) 2/day (post sleep &amp; pre-sleep)</p> <p>L-180 L-150 L-120 L-90 L-60 L-30 L-7 to L-1 (daily, if possible)</p> <p>Total Time =130 mins</p>	<p>Reaction Self Test (5 mins per session)</p> <p>2/day (post sleep &amp; pre-sleep)</p> <ul style="list-style-type: none"> <li>• MD-1 to MD-180, every 4<sup>th</sup> MD (180/4 = 45 days)</li> <li>• EVA-1 &amp; EVA+0 (for 3 of 6 EVAs)</li> <li>• Sleep Shift (SS) (for 1 of 9 SS) SS-3, SS-2, SS-1 SS+0 SS+1, SS+2, SS+3, SS+4, SS+5</li> </ul> <p>Total Time = 605 mins</p>	<p>Reaction Self Test (5 mins per session)</p> <p>2/day (post sleep &amp; pre-sleep)</p> <p>R+0 to R+7 (daily if possible) R+30 R+60 R+90</p> <p>Total Time = 110 mins</p>





# Reaction Self Test on Expeditions 21 & 22

## Reaction Self Test Screen Shots







# Reaction Self Test on Expeditions 21 & 22

## Reaction Self Test Screen Shots

**Reaction Self Test**

File

### Post-Sleep Questions

I will perform an EVA in the next 24 hours.  Yes  No

Enter approximate times.

Time went to bed: h: 21 : min: 30 GMT

Time out of bed: h: 05 : min: 15 GMT

Total time in bed: 7 : 45

How long did it take you to fall asleep? h: 00 : min: 15

Total amount of time awake last night due to sleep disturbances. h: 00 : min: 00

After the end of your sleep period how long did you remain in bed before getting up? h: 00 : min: 30

Total sleep time: 7 : 00

What was the quality of your sleep? Good  Poor

List all medications you took before going to bed last night.

	Name	Dose unit	Doses taken
<input type="checkbox"/> None	Tylenol	Tablet, 325 mg	2
<input type="checkbox"/> Decline to answer	Sonata	Capsule, 5 mg	1
			0
			0

(Use dropdown options or type directly)

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**Reaction Self Test**

File

### Subjective Questions

How are you feeling right now?

Tired  Fresh, ready to go

Mentally sharp  Mentally fatigued

Energetic  Physically exhausted

Not stressed at all  Very stressed

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# Reaction Self Test on Expeditions 21 & 22




## Reaction Self Test Screen Shots

How sleepy are you?

Not at all  Very much


First use the   Keys to select a value

When finished, press the  to continue.

ESC to end test

Psychomotor Vigilance Test:

Watch the rectangle on the screen.  
A counter will appear inside the rectangle that counts your response in milliseconds.  
As soon as you see the counter begin, respond as quickly as possible by pressing the space bar.  
Try to get the lowest number you can, but avoid false starts.

Press the  to continue.

ESC to end test

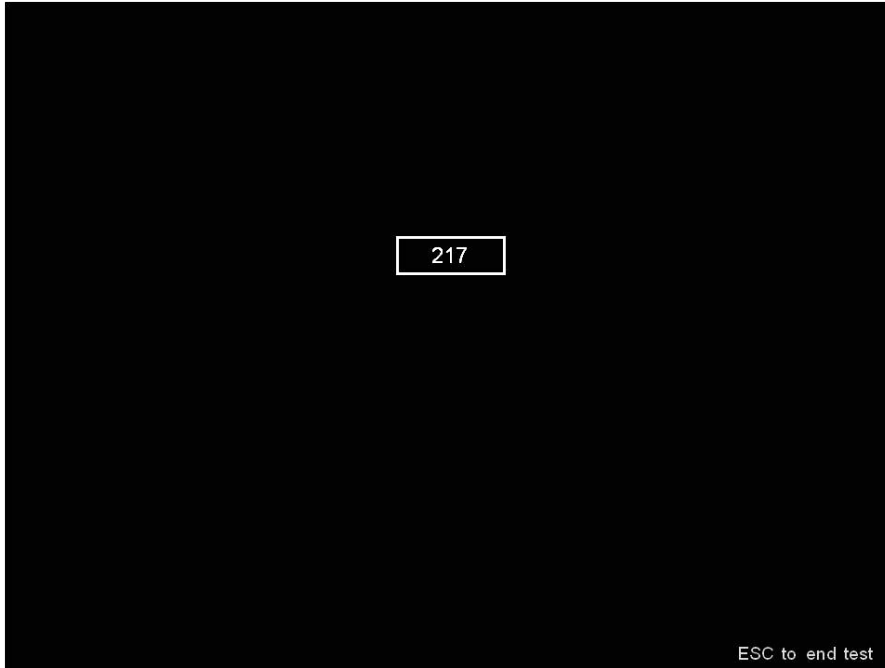




# Reaction Self Test on Expeditions 21 & 22



## Reaction Self Test Screen Shots

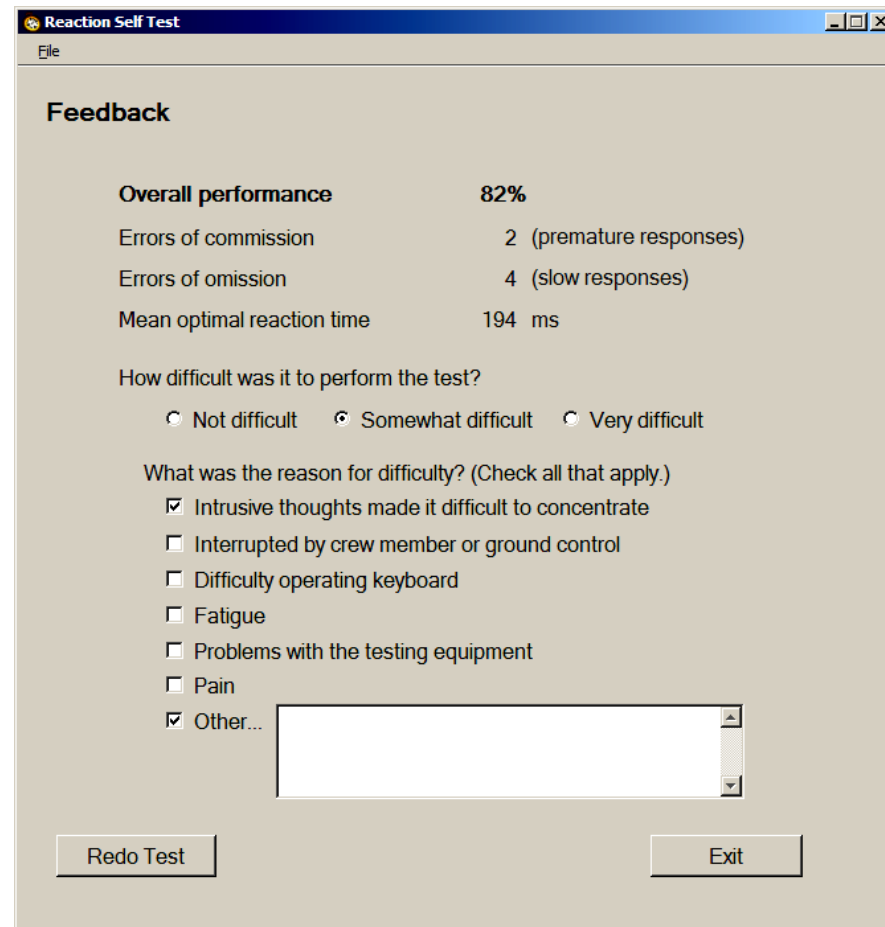
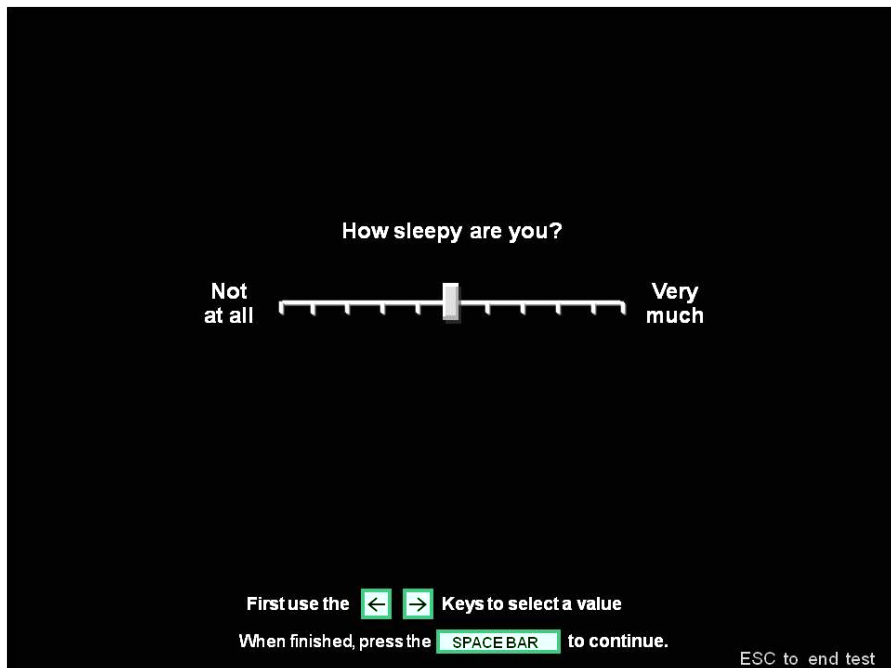




# Reaction Self Test on Expeditions 21 & 22



## Reaction Self Test Screen Shots





# Reaction Self Test on Expeditions 21 & 22



## Reaction Self Test Screen Shots

Reaction Self Test

File

### Pre-Sleep Questions

Did you perform an EVA today?  Yes  No

What was today's workload? Very high  Very low

List the caffeinated food or beverages you took since awakening this morning.

	Name	Portion size	Portions taken
<input type="checkbox"/> None	Tea	bag	2
<input type="checkbox"/> Decline to answer			0
			0
			0

(Use dropdown options or type directly)

List the medications you took since awakening this morning.

	Name	Dose unit	Doses taken
<input type="checkbox"/> None	Amoxicillin	Capsule, 500 mg	1
<input type="checkbox"/> Decline to answer			0
			0
			0

(Use dropdown options or type directly)

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Reaction Self Test

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### Questions for SelfTest taken outside pre or post-sleep period

Please indicate why you are taking the test now.

- I missed the two hour window after sleep.
- I missed the two hour window before sleep.
- I wanted to check my performance.

Please indicate the reason.

Did you perform an EVA today?  Yes  No

Will you perform an EVA today?  Yes  No

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# Reaction Self Test on Expeditions 21 & 22



## Measurement Approach

### Reaction Self Test Ease of Use

- No training required to learn Reaction Self Test
- No stow/unstow time required to do Reaction Self Test
- No more than 5 minutes required for Reaction Self Test
- Reaction Self test software on all ISS SSC and HRF computers
- If necessary, preflight and postflight Reaction Self Tests can be done on notebook computer at location convenient for astronaut
- Encrypted data will be stored on the hard drive and ISS data server and down-linked once per month





# Reaction Self Test on Expeditions 21 & 22

## Experiment Benefits

**The experiment must be performed on astronauts on ISS.**

**It addresses the following high-priority NASA research gaps:**

- Identify a brief objective measure of cognitive function in spaceflight
- Find a practical objective aid for astronauts to identify the effects of fatigue

**The experiment could provide the following space flight benefits.**

1. Tool for astronauts to detect effects of fatigue from sleep/circadian disruptions.
2. Tool for astronauts to detect the effects of fatigue from EVA and high workload.
3. Objective information on effects of time in mission.
4. Possible identification of differential carryover effects of medications for sleep.

**Earth-based benefits The experiment could provide the following benefits.**

The PVT Self Test has wide application to any group that must operate remotely at high levels of alertness, such as first responders, Homeland Security personnel, flight crews, special military operations, police and firefighters.

