Fiscal Year:	FY 2012	**Task Last Updated:**	FY 04/14/2012
PI Name:	Simpson, Richard Ph.D.		
Project Title:	Development of a Submaximal Cycling Protocol to Identify the Ventilatory Threshold in Astronauts: Application to Monitor Changes in Endurance Capacity in Response to Long-Duration Spaceflight Missions		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Muscle**:Risk of Impaired Performance Due to Reduced Muscle Size, Strength and Endurance		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Tucson	**State:**	AZ
Zip Code:	85721-0001	**Congressional District:**	3
Comments:	NOTE: Formerly at University of Houston until September 2017 move to University of Arizona.		
Project Type:	Ground	**Solicitation / Funding Source:**	Directed Research
Start Date:	06/01/2010	**End Date:**	12/31/2011
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NASA JSC
Contact Monitor:	Norsk, Peter	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: End date is now 12/31/2011, per NSSC information (Ed., 5/31/2011) NOTE: Period of performance is 06/01/2010-05/31/2011, per NSSC (changed from 10/1/09-1/17/11)--jvp/editor 6/7/2010 NOTE: Period of performance may change as not fully awarded (jvp/editor 2/17/2010)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Paloski, William (University of Houston) McFarlin, Brian (University of Houston)		
Grant/Contract No.:	NNX10AE13G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	BACKGROUND: Monitoring aerobic fitness in the microgravity environment is important to ensure mission success and maintain crew safety. The “gold standard” assessment of aerobic capacity (VO2max) involves the use of a maximal exercise protocol, which is inconvenient to the crew and contrary to the restrictions imposed by NASA medical staff. The ventilatory threshold (VT) is regarded as a better indicator of endurance than VO2max and, because VT is reached at 55-75% of the VO2max for most individuals, it might be possible to detect this threshold in "real time" using a submaximal exercise protocol. AIM: To identify a “cut-point” during a graded exercise test that allows accurate detection of VT. METHODS: Twenty male and 19 females (n=39) with similar physical characteristics to crewmembers (Age: 35-55yrs; VO2max: 35-50ml.kg.min) completed a single graded cycling exercise test to volitional exhaustion. Respiratory gases were quantified using automated analysis of expired air. The first (VT1) and second (VT2) ventilatory thresholds were determined manually for each subject. DATA ANALYSIS: An automated algorithm is being developed to identify VT1 and VT2 during graded exercise using non-linear regression analysis. Comparisons between the manual and automated techniques will be used to establish the validity of the latter for full and truncated data sets. Subsequently the same data set will be used to optimize the algorithm to identify VT1 in real-time. SUMMARY: This study aims to develop a submaximal exercise test that directly measures VT. Such a test would be useful for the real time monitoring of crewmember aerobic fitness in the microgravity environment without the need for maximal exercise testing.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	It is envisaged that the developed algorithm used to measure the ventilatory threshold in real-time during a submaximal graded exercise test will be a useful tool in clinical exercise testing. This will allow an objective assessment of aerobic capacity in patients presenting with contraindications for maximal exercise testing, allowing physicians and exercise physiologists to more accurately prescribe exercise training protocols and monitor physiological progression in cardiac patients and other special populations.
Task Progress:	The data collected in this study indicate that ventilatory threshold can be accurately determined in a subject cohort with similar physical characteristics to NASA crewmembers. As VT1 is a more reliable indicator of endurance performance than VO2max, in addition to being more sensitive to training adaptations and deconditioning, NASA should focus on establishing methods to accurately identify VT1 in crewmembers and not VO2max. Although these data indicate a tendency for VT1 to be underestimated when metabolic data is progressively truncated from the point of VO2max and identified by graph visualization, more than 60% of all subjects were still within a 1MET (metabolic equivalent) (5.3-10.9% VO2max) error when data up to 70% VO2max was used. We propose that a submaximal exercise test that requires the individual to reach exercise intensities no greater than 70% of the VO2max would be preferred in order to minimize crew inconvenience and the potential risk of an adverse event during spaceflight missions. The data we have collected and analyzed so far indicates that exercise intensities of 60-70% VO2max will be sufficient for most, if not all, crewmembers when attempting to identify VT during a submaximal exercise test. We also manufactured an algorithm for automated detection of VT during a graded exercise test. At the time of this task book report submission, our investigative team are still optimizing the algorithm to analyze truncated data sets as we did with visual identification. We anticipate that the percentage of subjects within a 1MET error will be substantially greater when data up to 70% VO2max is used and VT1 is identified using our automated algorithm. Unfortunately, we were unable to complete this part of the analysis as funding for this project expired before we had finished collecting data. Future work includes determining the minimum amount of metabolic data required to accurately identify VT1 within a 1MET error using our automated algorithm, and also optimizing the computer-generated algorithm to monitor real-time changes in V-slope for the submaximal identification of VT1. To achieve this, a graduate student in the Department of Health and Human Performance (Mr. Patrick Howell) will work on optimizing the algorithm part of this project as an MS research thesis. Mr. Howell will complete this project under the supervision of Drs. Simpson and Paloski and a copy of his MS thesis and any publications that arise from this project will be sent to NASA when they are made available.
Bibliography Type:	Description: (Last Updated: 07/09/2025)
Abstracts for Journals and Proceedings	Simpson RJ, Ploutz-Snyder L, O'Connor DP, Ivkovic V, Wickwire PJ, McFarlin BK, Paloski WH. "Development of a submaximal exercise protocol to identify the ventilatory threshold in astronauts." 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Abstracts for Journals and Proceedings	Simpson RJ, Ploutz-Snyder L, Wickwire PJ, Howell PT, O'Connor DP, Paloski WH. "Development of a submaximal exercise protocol to identify the ventilatory threshold in astronauts." 2012 NASA Human Research Program Investigators’ Workshop, Houston, TX, February 14-16, 2012. 2012 NASA Human Research Program Investigators’ Workshop, Houston, TX, February 14-16, 2012. , Feb-2012