

AWARD NUMBER: W81XWH-18-1-0707

TITLE: Rehabilitation 2.0: Addressing Neuroplasticity in the Musculoskeletal Rehabilitation Model

PRINCIPAL INVESTIGATOR: Dustin Grooms

CONTRACTING ORGANIZATION: Ohio University  
Athens, OH 45701

REPORT DATE: Oct 2019

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Development Command  
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for Public Release;  
Distribution Unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

# REPORT DOCUMENTATION PAGE

*Form Approved*  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

<b>1. REPORT DATE</b> Oct 2019		<b>2. REPORT TYPE</b> Annual Report		<b>3. DATES COVERED</b> 15 Sep 2018-14 Sep 2019	
<b>4. TITLE AND SUBTITLE</b>  Rehabilitation 2.0: Addressing Neuroplasticity in the Musculoskeletal Rehabilitation Model				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b> W81XWH-18-1-0707	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Dustin Grooms  E-Mail: groomsd@ohio.edu				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>  Ohio University 1 Ohio University Athens, OH 45701-2979				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>  U.S. Army Medical Research and Development Command Fort Detrick, Maryland 21702-5012				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b>  Approved for Public Release; Distribution Unlimited					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> Musculoskeletal injuries such as to the knee's anterior cruciate ligament (ACL) degrade the operational readiness of our U.S. Service members. These injuries cause decreased physical ability that leads to reduced performance and high re-injury risk. Changes in brain activity as the result of the injury is directly related to the decreased physical performance, affecting the Service member's motor performance capability in complex or highly reactive military training and operations environments. Unfortunately, current treatments do not restore post-injury Service member's physical performance, especially when under stress. This deficit has clear consequences for military personnel, as the intense stress and constant need of situational awareness can impair physical performance when returned to active duty. To that end, new therapies are needed to restore Service member performance after injury. Thus, the purpose of this proposal is to quantify how the brain changes after injury across the typical 6-month window of physical therapy. We are also testing new functional assessments that target the brain changes that limit Service member performance. These assessments will support the transition of this research to clinical practice. This applied research award will provide the knowledge of the time course of brain changes that influence function to implement these new impactful interventions. These synergistic outcomes provide an immediate product that can be clinically implemented and propel further investigations to ensure truly restored functional capacity of our nations Service members.					
<b>15. SUBJECT TERMS</b>					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>  Unclassified	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b> USAMRMC
<b>a. REPORT</b>  Unclassified	<b>b. ABSTRACT</b>  Unclassified	<b>c. THIS PAGE</b>  Unclassified			<b>19b. TELEPHONE NUMBER</b> (include area code)

# TABLE OF CONTENTS

Page 1

## 1. Introduction

Musculoskeletal injuries such as to the knee's anterior cruciate ligament (ACL) degrade the operational readiness of our U.S. Service members. These injuries cause decreased physical ability that leads to reduced performance and high re-injury risk. Changes in brain activity as the result of the injury is directly related to the decreased physical performance, affecting the Service member's motor performance capability in complex or highly reactive military training and operations environments. Unfortunately, current treatments do not restore post-injury Service member's physical performance, especially when under stress. This deficit has clear consequences for military personnel, as the intense stress and constant need of situational awareness can impair physical performance when returned to active duty. To that end, new therapies are needed to restore Service member performance after injury. Thus, the purpose of this proposal is to quantify how the brain changes after injury across the typical 6-month window of physical therapy. We are also testing new functional assessments that target the brain changes that limit Service member performance. These assessments will support the transition of this research to clinical practice. This applied research award will provide the knowledge of the time course of brain changes that influence function to implement these new impactful interventions. These synergistic outcomes provide an immediate product that can be clinically implemented and propel further investigations to ensure truly restored functional capacity of our nations Service members.

## 2. Keywords

Neuroimaging, lower extremity, biomechanics, knee injury, anterior cruciate ligament, tactical performance, neural control of movement, neuromuscular control, cognitive motor interaction

## 3. Accomplishments

### Project Goals

The project is split into 2 primary goals\aims.

Goal 1: To determine when the maladaptive neuroplastic sensory reweighting occurs following ACL injury.

#### Year 1 goals

Local IRB Approval: Achieved – Year 1 Continuing Review Approved

HRPO Approval: Achieved – Year 1 Continuing Review Approved

Equipment preparation: Achieved

New technology integration (virtual reality and sensorimotor monitoring during neuroimaging): achieved

Participant recruitment: Ongoing

Injured cohort Neuroimaging data collection: Ongoing (n=3 completed)

Control cohort Neuroimaging data collection: Ongoing (n=8 completed)

Goal 2: To determine the functional correlates of neuroplastic sensory reweighting for motor performance.

#### Year 1 goals

Local IRB Approval: Achieved – Year 1 Continuing Review Approved

HRPO Approval: Achieved – Year 1 Continuing Review Approved

Equipment preparation: Achieved

New technology integration (virtual reality, proprioception assessment and reactive cognitive motor 3D motion capture assessment): achieved

Participant recruitment: Ongoing

Injured cohort Biomechanical data collection (muscle strength, proprioception, postural control, neuromuscular control and patient outcomes): Ongoing (n=3 in progress)

Control cohort Biomechanics data collection (muscle strength, proprioception, postural control, neuromuscular control and patient outcomes): Ongoing (n=8 completed)

ROTC cohort tactical neuromuscular control performance data collection: Completed (n=33)

#### **4. Impact**

Work has completed development stage and is in currently in data collection. Nothing to report at this time.

#### **5. Changes/Problems**

While no changes to the deliverables, general scope of work, expenditures or human subject experience was made during this reporting period. We did have to change personnel due to two faculty leaving the University and delay human subject enrollment in the primary arm of the study (enrolling the knee injured cohort) to ensure adequate training of study personnel. We submitted these changes to Dr. Yadav Science Officer/GOR/COR, CDMRP and Robert Doan contract specialist on 8/21/2019. We foresee this only being a minor setback to the human participant enrollment timeline and envision no change in the final deliverables. As once informed of the impending moving on of those two Co-I faculty members we accelerated the training of new personnel to handle the work, and I personally increased my oversight as PI over the areas of the scope of work those faculty were responsible for to ensure rigor of the data collection. We also accelerated data collection the tactical performance assessments with our ROTC cohort to ensure completion of that arm of data collection in preparation for enrolling the knee injured participants. We will increase enrollment in year 2 as\if needed to ensure on-track with the scope of work and study timeline.

#### **6. Products**

Work has completed development stage and is in currently in data collection. Nothing to report at this time. Data from the initial development arm of the work is nearing final preparation for publication\conference submission.

#### **7. Participants & Other Collaborating Organizations**

Name: Dustin Grooms

Role: PI

Research identifier: 0000-0001-6102-8224

Person month worked: 3

Contribution: Coordinate overall project, IRB\HRPO approval, hire and train research assistants\project manager, secure technologies, patient and participant recruitment and data collection\analysis

Funding support: This award and university research release time (in-kind)

Name: Adam Haggerty

Role: Project manager\research associate

Research identifier: NA

Person month worked: 3

Contribution: Undergo training in all data collection methods and CITI training for human subject interaction. Facilitate participant recruitment, data collection\analysis and manage research equipment.

Funding support: This award

Name: Janet Simon

Role: Co-I

Research identifier: NA

Person month worked: 1

Contribution: Data analysis and experimental design, patient outcomes management

Funding support: This award

Name: Jae Yom

Role: Co-I

Research identifier: *NA*

Person month worked: 1

Contribution: Biomechanics data collection and analysis

Funding support: This award

Changes: In year 1 quarter 4, two Co-I faculty indicated moving on from the University, their scopes of work were accelerated to be completed in year 1, transferred to the PI and a new research associate to start January 1.

**8. Special Reporting Requirements**

Updated quad chart included

**9. Appendices**

No appendices