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14. ABSTRACT

The ability to accurately and efficiently evaluate neurocognitive status of US Warfighters exposed to diverse operational and experimental conditions is of critical importance to the ongoing mission and Force 2025 objectives of the United States military. The Automated Neuropsychological Assessment Metrics (ANAM) is a computer assisted tool for evaluating neurocognitive performance with demonstrated effectiveness for application in a wide range of military operational and research testing scenarios. The primary objective of this project is to examine select psychometric and administration properties of the ANAM4. Four studies were proposed as part of the original effort: 1) examine common use practices and determine the effect of specific administration procedures on ANAM4 performance; 2) assess the test-retest reliability and practice effects of individual ANAM4 test modules; 3) examine the validity of the ANAM4 Mood Scale, and 4) establish a representative normative dataset of ANAM4 performance outcomes specifically for use with Army National Guard service members. Data collection for Studies 1-3 is complete; data collection for Study 4 was completed in 6 states (Minnesota, Maine, Arizona, Montana, Texas, and Kentucky). Data collection for Studies 1-4 has ended. Reports summarizing data from Studies 1-3 are being finalized. Data management procedures for Study 4 are completed and analyses and manuscript preparations are nearing completion. In August 2016, a supplemental project was approved, extending the project period of performance through 31 December 2017. The primary aim of the supplemental project is to leverage work carried out as part of the initial project funding and extend this to include review and analysis of assessment tools and approaches for evaluation of Warfighter cognitive performance and readiness in military operational settings. Specifically, this supplemental effort provides recommendations and future roadmap for a synchronized, validated approach to assessment of cognitive performance and readiness in military operational environments. A Final Report documenting the findings and conclusions of the Working Group was completed and submitted to the Military Operational Medicine Research Program (MOMRP) Program Area Director (PAD) on 30 November 2017.

15. SUBJECT TERMS
ANAM, cognitive, assessment, psychometrics, validity, reliability, normative

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INTRODUCTION

The availability of easy-to-use, field-ready tools that can provide rapid, accurate, and reliable input regarding Warfighter cognitive readiness and performance is critical for establishing an accurate link between operational/environmental exposures and Warfighter cognitive status, predicting adverse health and performance outcomes, and providing guidance to leaders for mission preparations and risk mitigation. While a number of approaches have been advanced to evaluate Warfighter cognitive status and performance, most have not been suitable for implementation in rugged operational or training environments due to the sensitive nature of the equipment involved, the requirement for trained examiners to administer and interpret test results, or lengthy time requirements for task completion. A coordinated approach is needed to identify and validate accurate, sensitive, field-ready tools and models to evaluate and predict Warfighter cognitive readiness and performance under complex operational exposure scenarios.

Among the many assessment tools used to evaluate Warfighter cognitive performance, the Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) is among the most frequently used and cited. The ANAM is a computer-assisted tool for evaluating neurocognitive performance with demonstrated efficacy for application in a broad range of military operational and research testing scenarios. The primary objective of this multi-study project is to examine select psychometric and common administration properties of the ANAM4. This project includes four studies that address different psychometric and administrative elements of the ANAM4, each critical to the understanding and utilization of this computer-assisted cognitive assessment system. Study 1 examines common use practices and their impact on ANAM4 performance. Study 2 assesses the test-retest reliability and practice effects of individual ANAM4 test modules. Study 3 examines the validity of the ANAM4 Mood Scale. Study 4 aims to establish a nationally-representative normative dataset of ANAM4 performance outcomes specifically reflecting Army National Guard Service members.

A supplemental study was added in August 2016, extending examination and analysis of cognitive assessment metrics beyond ANAM4 to include other tools and approaches used to evaluate Warfighter cognitive performance and readiness in diverse military operational environments.

BODY

The original project (which includes four studies specifically focused on ANAM4) was funded 01 December 2007. The originally approved study timeline/SOW is presented in **Table 1.**

Table 1: Statement of Work/Study Timeline (Original, 2007)

Year 1	**Months 1-2**	**Task 1**	Plan and finalize logistics for Phase I (Studies 1-3)
	Months 3-12 (Dec 2008)	**Task 2**	Subject recruitment, data collection and data management for Studies 1-3
Year 2	**Month 13-14**	**Task 3**	Perform preliminary data analyses for Study 3
	Month 15-24 (Dec 2009)	**Task 4**	Complete data collection for Study 1
		Task 5	Perform preliminary data analyses for Study 1
		Task 6	Continue recruitment, data collection and data management for Study 2 & 3
		Task 7	Complete data collection for Study 3
Year 3	**Month 25-36 (Dec 2010)**	**Task 8**	Complete data collection for Study 2
		Task 9	Plan and finalize logistics for Phase II (modified Study 4)
		Task 10	Complete data analyses for Studies 1, 2, 3
		Task 11	Preparation of journal manuscript(s) for Studies 1, 2, 3
		Task 12	Preparation of Project report for Studies 1, 2, 3
		Task 13	Set-up data management procedures for Study 4
Year 4	**Month 37-48 (Dec 2011)**	**Task 14**	Initiate data collection procedures for Study 4
		Task 15	Carry out data collection procedures for Study 4
		Task 16	Initiate integrative data management structure set up for Study 4
		Task 17	Operationalize database for Study 4 analysis scheme
		Task 18	Perform preliminary data analyses for Study 4
		Task 19	Complete data collection procedures for Study 4
Year 5	**Month 49-60 (Dec 2012)**	**Task 20**	Complete data analyses for Study 4
		Task 21	Prepare Study 4 manuscript(s) for peer review
		Task 22	Preparation of Project Final Report

A request for a 12 month no-cost extension for this study was approved on 7 November 2012, extending study activities through December 2013. A modified statement of work, approved as part of the no-cost extension, is presented in **Table 2**.

Table 2: MODIFIED SOW for remaining PROJECT Tasks and STUDY TIMETABLE (Nov 2012)

Year 4	**Month 37-48 (Dec 2011)**	**Task 14**	Initiate data collection procedures for Study 4
		Task 15	Carry out data collection procedures for Study 4
		Task 16	Initiate integrative data management structure set up for Study 4
		Task 17	Operationalize database for Study 4 analysis scheme
Year 5	**Month 49-60 (ending Dec 2012)**	**Task 18**	Conduct data collection procedures for Study 4 (cont'd)
		Task 19	Complete manuscript preparations/submissions for Studies 1-3
		Task 20	Set up/operationalize data analyses plan for Study 4
Year 6	**Month 61-72 (ending Dec 2013)**	**Task 21**	Complete data collection for Study 4
		Task 22	Complete data analyses for Study 4
		Task 23	Prepare Study 4 manuscript(s) for peer review
		Task 24	Preparation of Project Final Report

A request for a second12 month no-cost extension for this study was approved on 25 September 2013, extending study activities through December 2014. The modified statement of work is presented in **Table 3**.

Table 3. MODIFIED SOW for remaining PROJECT Tasks and STUDY TIMETABLE (Nov 2013)

Year 6	**Month 61-72 (ending Dec 2013)**	**Task 21**	Conduct data collection procedures for Study 4 (cont'd)
		Task 22	Initiate data quality control checks and preliminary analyses for Study 4.
Year 7	**Month 73-84 (ending Dec 2014)**	**Task 23**	Complete data collection for Study 4
		Task 24	Complete data analyses for Study 4
		Task 25	Prepare Study 4 manuscript(s) for peer review
		Task 26	Preparation of Project Final Report

A request for an additional 12 month no-cost extension for this study was approved on 28 October 2014, extending study activities through November 2015. The modified statement of work is presented in **Table 4**.

Table 4. MODIFIED SOW for remaining PROJECT Tasks and STUDY TIMETABLE (Oct 2014)

Year 7	**Month 73-84 (ending Dec 2014)**	**Task 23**	Initiate external data request procedures for Study 4
		Task 24	Conduct data collection procedures for Study 4 (cont'd)
		Task 25	Continue data quality control checks and preliminary analyses for Study 4 • Following each data collection trip, the newly collected data are entered into database and cleaned and preliminary data checks conducted
Year 8	**Month 85-96 (ending Dec 2015)**	**Task 26**	Complete 100% data collection goal for Study 4 (with ARNG national sample from at least 8 geographically representative US states)
		Task 27	Complete data analyses for Study 4 • With 100% data collected, complete data analyses to address Study 4 research hypotheses
		Task 28	Prepare Study 4 manuscript(s) for peer review • With completion of Study 4 analyses and manuscript preparation, travel to present findings at national conference forum is planned
		Task 29	Preparation of Project Final Report

A request for no-cost extension, extending study activities through 31 August 2016, was approved on 30 October 2015. The complete statement of work with modified tasks for Years 7-9 (shaded) is presented in **Table 5.**

Table 5. MODIFIED SOW for remaining PROJECT Tasks and STUDY TIMETABLE (Oct 2015)

Year 1	**Months 1-2**	**Task 1**	Plan and finalize logistics for Phase I (Studies 1-3)
	Months 3-12 (Dec 2008)	**Task 2**	Subject recruitment, data collection and data management for Studies 1-3
Year 2	**Month 13-14**	**Task 3**	Perform preliminary data analyses for Study 3
	Month 15-24 (Dec 2009)	**Task 4**	Complete data collection for Study 1
		Task 5	Perform preliminary data analyses for Study 1
		Task 6	Continue recruitment, data collection and data management for Study 2 & 3
		Task 7	Complete data collection for Study 3

Table 5. MODIFIED SOW for remaining PROJECT Tasks and STUDY TIMETABLE (Oct 2015, Cont.)

Year 3	**Month 25-36 (Dec 2010)**	**Task 8**	Complete data collection for Study 2
Year 3 Year 4	**Month 25-36 (Dec 2010) Month 37-48 (Dec 2011)**	**Task 9**	Plan and finalize logistics for Phase II (modified Study 4)
		Task 10	Complete data analyses for Studies 1, 2, 3
		Task 11	Preparation of journal manuscript(s) for Studies 1, 2, 3
		Task 12	Preparation of Project report for Studies 1, 2, 3
		Task 13	Set-up data management procedures for Study 4
		Task 14	Initiate data collection procedures for Study 4
Year 4 Year 5	**Month 37-48 (Dec 2011) Month 49-60 (ending Dec 2012**	**Task 15**	Carry out data collection procedures for Study 4
		Task 16	Initiate integrative data management structure set up for Study 4
		Task 17	Operationalize database for Study 4 analysis scheme
		Task 18	Conduct data collection procedures for Study 4 (cont'd)
Year 5 Year 6	**Month 49-60 (ending Dec 2012 Month 61-72 (ending Dec 2013)**	**Task 19**	Complete manuscript preparations/submissions for Studies 1-3
		Task 20	Set up/operationalize data analyses plan for Study 4
		Task 21	Conduct data collection procedures for Study 4 (cont'd)
Year 6	**Month 61-72 (ending Dec 2013)**	**Task 22**	Initiate data quality control checks and preliminary analyses for Study 4

Table 5. MODIFIED SOW for remaining PROJECT Tasks and STUDY TIMETABLE (Oct 2015, Cont.)

Year 7	**Month 73-84 (ending Dec 2014)**	**Task 23**	Initiate external data request procedures for Study 4
Year 7 Year 8	**Month 73-84 (ending Dec 2014) Month 85-96 (ending Dec 2015)**	**Task 24**	Conduct data collection procedures for Study 4 (cont'd)
		Task 25	Continue data quality control checks and preliminary analyses for Study 4 Following each data collection trip, the newly collected data are entered into database and cleaned and preliminary data checks conducted
		Task 26	• Conduct data collection procedures for Study 4 (cont'd)
Year 8 Year 9	**Month 85-96 (ending Dec 2015) Month 97-104 (ending Aug 2016)**	**Task 27**	Continue data quality control checks and preliminary analyses for Study 4 Following each data collection trip, the newly collected data are entered into database and cleaned and preliminary data checks conducted
		Task 28	• Complete 100% data collection goal for Study 4 (with ARNG national sample from at least 8 geographically representative US states)
Year 9	**Month 97-104 (ending Aug 2016)**	**Task 29**	Complete data analyses for Study 4 With 100% data collected, complete data analyses to address Study 4 research hypotheses
		Task 30	Prepare Study 4 manuscript(s) for peer review • With completion of Study 4 analyses and manuscript preparation, travel to present findings at national conference forum is planned
		Task 31	• Preparation of Project Final Report

<u>Task 1 (Month 1-2)</u>

Plan and finalize logistics for Phase I (Studies 1-3) – COMPLETED

All logistical aspects for USARIEM IRB approved studies (Studies 1-3) have been confirmed. Recruitment procedures, equipment, testing facilities, and other data collection elements have been finalized and are now complete

Task 2 (Month 3-12) Subject recruitment, data collection and data management for Studies 1-3 – COMPLETED
Subject recruitment, data collection and data management efforts have been completed for Studies 1-3. Recruitment of both Human Research Volunteers and civilian participants was effective and efficient.

Task 3 (Month 13-14) Perform preliminary data analyses for Study 3– COMPLETED
All preliminary data analyses for Study 3 have been completed. Initial analyses suggested that additional participants would be necessary to explore noted differences between military and civilian participants on discrete mood measures. Thus an amendment (14 July 2009) to increase enrollment from 50 to 80 participants was submitted and approved. Data analyses have been completed on this expanded sample.

Task 4 (Month 15-24) Complete data collection for Study 1– COMPLETED
Study 1 involves the examination of common use practices and specific administration procedures (individual or group administration, practice or no practice, single session or two sessions) on ANAM4 task performances. Our recruitment goal for Study 1 was 90 participants, 30 participants per condition. Enrollment data are presented in **Table 6**.

Table 6. Study 1 Enrollment

# Participants Enrolled	90
# Participants Completed	86*

**NOTE: 15 participants completed the ANAM4 without practice test modules; 15 participants completed the ANAM4 in a group setting and 15 participants completed the ANAM4 in two administration sessions. The remaining 41 participants served as controls for these discrete administration scenarios (individual administration using practice test modules and completed in a single testing session). Thus each condition had at least 30 participants, as required.*

Task 5 (Month 15-24) Perform preliminary data analyses for Study 1 – COMPLETED
Preliminary analyses (sample characterization, demographic analyses, and preliminary group analyses) on the Study 1 data set have been completed.

Task 6 (Months 15-24) Continue recruitment, data collection and data management for Study 2 & 3 – COMPLETED
Our recruitment goal for Study 2 was 90 participants, 30 participants per condition (days 1 & 7 / days 1 & 30 / 7 consecutive day retest). Recruitment goal for Study 3 was 80 participants. Recruitment goals were reached for Studies 2 and 3 and data collection has been completed for these studies.

Task 7 (Months 15-24) Complete data collection for Study 3 – COMPLETED
Data collection for Study 3 is complete. Enrollment data are presented in **Table 7**.

Table 7. Study 3 Enrollment

# Participants Enrolled	113
# Participants Completed	77

Task 8 (Months 25-36) Complete data collection for Study 2- COMPLETED
Data collection for Study 2 has been completed. Enrollment data are presented in **Table 8**.

Table 8. Study 2 Enrollment

# Participants Enrolled	99
# Participants Completed	92

Task 9 (Months 25-36) Plan and finalize logistics for Phase II (modified Study 4) – COMPLETED

The Study 4 protocol has been reviewed and approved by USARIEM IRB and Army Human Research Protections Office (HRPO) (final approval to initiate received June 2011). Endorsement of the approved Study 4 protocol was received 20 October 2011 by National Guard Bureau (NGB) and all 8 states (Arizona, Kentucky, Maine, Minnesota, Mississippi, Montana, Oklahoma, and Pennsylvania) were contacted by both NGB and USARIEM study staff. Oklahoma declined participation in September 2012. We identified Texas as a suitable replacement for Oklahoma and secured NGB endorsement for the state in October 2012.

Task 10 (Months 25-36) Complete data analyses for Studies 1, 2, 3 - COMPLETED

Preliminary data analyses have been completed for Studies 1, 2, and 3. Higher-level analyses of these data, including new ANAM Composite Score and Effort Measure analyses, have also been conducted.

Task 11 (Months 25-36) Preparation of journal manuscript(s) for Studies 1, 2, 3 – COMPLETED

Manuscripts for these studies have been prepared. Data were presented at a professional meeting (Force Health Protection, 2010).

Task 12 (Months 25-36) Preparation of project report for Studies 1, 2, 3 – COMPLETED

Project summaries and completion of Studies 1-3 were included in previous continuing review reports. Manuscripts for these studies were prepared and data were reported at a professional meeting (Force Health Protection, 2010).

Kryskow E, Proctor S, Maule A, Heaton K. Automated Neuropsychological Assessment Metrics (ANAM4) Mood Scale is a reliable and valid measure of mood state in a military sample. Poster presented at the 12th Annual Force Health Protection Conference, Phoenix, AZ, 10-11 August 2010 (APPENDIX B).

Maule A, Proctor S, Kryskow E, Heaton K. Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) is robust to differences in several common administration practices. Poster presented at the 12th Annual Force Health Protection Conference, Phoenix, AZ, 10-11 August 2010 (APPENDIX C).

Task 13 (Months 25-36) Set-up data management procedures for Study 4 - COMPLETED

Study 4 data management procedures have been established. Study 4 datasets have been created and are being populated as data are obtained from field sites. Data entry and data quality and control checks have been successfully coordinated and are ongoing with data entry procedures.

Task 14 (Months 25-36) Initiate data collection procedures for Study 4 – COMPLETED

Data collection procedures were coordinated for Arizona, Montana and Maine in 2010-2011, with data collection commencing in these three states in 2011-2012.

<u>Task 15 (Months 37-48)</u> Carry out data collection procedures for Study 4 – COMPLETED (See Task 18, 21, 24, & 26 for further updates)
Data collection was completed in Arizona, Maine, and Montana.

<u>Task 16 (Months 37-48)</u> Initiate integrative data management structure set up for Study 4 - COMPLETED
Databases associated with Study 4 have been created and are being populated as data are obtained and subjected to data quality and control procedures.

<u>Task 17 (Months 37-48)</u> Operationalize database for Study 4 analysis scheme – COMPLETED
Data entry has commenced and databases have been refined for analytic schemes.

<u>Task 18 (Months 49-60)</u> Conduct data collection procedures for Study 4 (cont'd) – CARRIED OUT (*See Task 21, 24, & 26 for further updates*)
Data collection procedures were completed previously in four states (AZ, ME, MT, MN) and completed in two states (KY, TX) during the current reporting period.

<u>Task 19 (Months 49-60)</u> Complete manuscript preparations/submissions for Studies 1-3 – COMPLETED
Primary data analyses for Studies 1-3 have been completed and reported at professional meetings (Force Health Protection, 2010) during an earlier reporting period. Manuscripts were prepared but not submitted in order to include additional data being generated within the laboratory.

<u>Task 20 (Months 49-60)</u> Set up/operationalize data analyses plan for Study 4 **– COMPLETED**
Primary data analytic plan for Study 4 has been established and completed. Data have been populated in the Study 4 dataset as they were collected and checked for accuracy/quality.

<u>Tasks 21 (Months 61-72)</u> Conduct data collection for Study 4 (cont'd) – CARRIED OUT
Data collection continued in two states (KY, TX) in 2015-2016. ARNG Adjutant General-level approval to initiate data collection in New Hampshire was received and coordination of data collection activities were ongoing during this period. Efforts to coordinate Adjutant General-level approval to initiate data collection in Pennsylvania and Florida were continued. **(*See Task 26 and 28 for final update*)**

<u>Task 22 (Months 61-72)</u> Initiate data quality control checks and preliminary analyses for Study 4 - COMPLETED
Data quality control checks and preliminary analyses were carried out as planned. **(See Task 27 & 29 for final updates)**

<u>Task 23 (Months 73-84)</u> Initiate external data request procedures for Study 4 – CARRIED OUT
An external data request (with DMDC for military service history, AFQT, and additional demographic data) was initiated and completed (October 2014) for those participants from the three states in which data collection activities were completed (AZ, MT, ME). External data request for the remaining states (MN, KY, TX) has been completed.

<u>Task 24 (Months 73-84)</u> Conduct data collection procedures for Study 4 (cont'd) – CARRIED OUT

Coordination of data collection activities continued in Kentucky, Texas and New Hampshire Coordination of ARNG Adjutant General-level approvals continued with ARNG in Pennsylvania, Florida, & Tennessee.

<u>Task 25 (Months 73-84)</u> Continue data quality control checks and preliminary analyses for Study 4: Following each data collection trip, the newly collected data are entered into database and cleaned and preliminary data checks conducted – COMPLETED

Data quality control checks were carried out on an ongoing basis as data collection activities were completed at each approved site. Preliminary analyses were performed on data from three states in which data collection was completed (AZ, MT, ME) and were presented (posters) at professional conferences.

> Proctor, S.P., Heaton, K.J., Dillon, C., Rudov, S., & Vincent, A.S. (2014). Descriptive Analyses of ANAM4 TBI Performance Among a National Sample of U.S. Army National Guard Soldiers. Poster presented at the Annual Meeting of the Association of Military Surgeons of the United States. Washington, DC, Dec. 2, 2014 (APPENDIX D).
>
> C Dillon, SP Proctor, AS Vincent, K Heaton. Demographic differences on ANAM4 TBI performance among U.S. Army National Guard Soldiers. Poster Presented at 123rd Annual Convention of the American Psychological Association, Toronto, Canada, 6-9 August 2015 (APPENDIX E).

<u>Task 26 (Months 85-96)</u> Conduct data collection procedures for Study 4 (cont'd) – CARRIED OUT

Data collection was completed with ARNG in two states (KY, TX) and efforts to coordinate data collection with New Hampshire were pursued. Efforts continued to coordinate TAG-level approvals with two states (Pennsylvania, Tennessee).

Data collection was completed in Kentucky with approximately 64% of the target sample (300) for this state completed. Data collection also continued in Texas with approximately 63% of the target sample completed for the state (300). Additional trips to complete data collection in Texas, Kentucky and New Hampshire were coordinated but not ever completed due to scheduling/availability of National Guard members. (See further details under Task 28 below.)

Final enrollment by state is presented in **Table 9**.

Table 9: Final Study 4 enrollment

State	# Completed
Arizona	223
Maine	250
Montana	301
Minnesota	306
Kentucky	193
Texas	188
Total	**1461**

<u>Task 27 (Months 85-96)</u> Continue data quality control checks and preliminary analyses for Study 4: Following each data collection trip, the newly collected data are entered into database and cleaned and preliminary data checks conducted – CARRIED OUT
Data quality control checks were carried out as planned. Preliminary analyses have been performed on data from three states in which data collection was completed (AZ, MT, ME). These data were presented (posters) at professional conferences***. Preliminary analyses have now been performed on data from all states (n=1461).***

<u>Task 28 (Months 97-104)</u> Complete 100% data collection goal for Study 4 (with ARNG national sample from at least 8 geographically representative US states) – GOAL NOT REACHED

Data collection activities were carried out and completed to the extent possible in six states: MT, ME, MN, AZ, TX, and KY. Our study goal was to attain complete data from N=2000 Army National Guard Soldiers and we achieved ~75% of that goal. Two states declined participation. Coordination for TAG approval in one state (Pennsylvania), while ongoing, was not achieved during the funding period. Data collection activities received TAG-level approval in New Hampshire, however, we were unable to gain access to appropriate units.

<u>Task 29 (Months 97-104)</u> Complete data analyses for Study 4: With 100% data collected, complete data analyses to address Study 4 research hypotheses – COMPLETED

Data management and data quality control checks have been completed with all data collected as part of this effort. Data analyses have been completed for data obtained from all six states (ME, MT, AZ, MN, TX, KY) and analyses addressing primary research objectives have been completed.

<u>Task 30 (Months 97-104)</u> Prepare Study 4 manuscript(s) for peer review: With completion of Study 4 analyses and manuscript preparation, travel to present findings at national conference forum is planned – CARRIED OUT

With the completion of primary analyses for Study 4 objectives, at least two manuscripts are being finalized for submission.

> Heaton KJ, Dillon C., Finkelstein K., Proctor SP. Army National Guard Reference Data for Automated Neuropsychological Assessment Metrics (Version 4). *In preparation.*
>
> Heaton KJ, Dillon C., Finkelstein K., Taylor K, Proctor SP. Factors associated with changes in neurocognitive performance over time. *In preparation.*

<u>Task 31 (Months 97-104)</u> Preparation of Project Final Report - COMPLETED

SUPPLEMENTAL PROJECT
A supplemental, 16-month project extending the original project period of performance to 31 December 2017 was approved in August 2016. The supplemental project has 2 primary objectives:

- Recommend cognitive assessment tools/approaches (toolkit) from existing tools/approaches that have been validated for use within military-relevant environments and for evaluation of performance of military personnel;

- Propose the way- ahead (roadmap) for the execution of an integrated research program to address novel/emerging cognitive assessment strategies for use in future military-relevant environments

The supplemental project has two primary deliverables:

- Proposed Toolkit of cognitive assessment tools/approaches from existing tools/approaches that have been validated for use within military-relevant environments;
- Proposed Roadmap for an integrated research program on cognitive assessment strategies for cognitive readiness metrics for use in operational environment

Table 10 provides the statement of work for the supplemental project:

Table 10. Supplemental Project SOW

Year 1	**Months 1-2 (Beginning Sept 2016)**	**Task 1**	**Assemble the Working Group of SMEs, stakeholders, etc. (8-10 max)**
	Months 3-4 (ending Dec 2016)	**Task 2**	**Assemble the Steering Committee**
		Task 3	**Conduct series of periodic meetings (via teleconference) with the Working Group to (reaching out to Steering Committee members as needed):** • **Summarize cognitive assessments currently in use in military relevant environments** • **Summarize the reliability/validity of these instruments** • **Summarize the environments in which these instruments are being implemented and in what way(s)/for what purpose they are being implemented** • **Identify gaps/needs in assessment of cognitive performance within military-relevant environments** **Identify recommended cognitive performance tasks based on current knowledge/tests available**
	Month 5	**Task 4**	**Cont. work summarized under Task 34**
	Month 6-7	**Task 5**	**Convene the Working Group in-person Workshop to prepare Report Draft**
		Task 6	**Vet Report and Cognitive performance recommendations through Steering Committee**
		Task 7	**Provide Toolkit Report**

Table 10. Table 10. Supplemental Project SOW (Cont.)

Year 1 (+4 mos)	**Months 8-12**	**Task 8**	**Conduct series of periodic meetings (via teleconference) with MRMC Working Group to:** • **Present several course-of-action case-studies to depict implementation of the cognitive toolkit within training, garrison, and forward, operational settings** **Make recommendations for identification of existing metrics or development of new assessment instruments to address gaps**
	Months 13-16 (ending Dec 2017)	**Task 9**	**Convene MRMC Working Group in-person meeting to prepare Report Draft for roadmap**
		Task 10	**Finalize recommendations for an implementation approach/roadmap to address gaps in cognitive performance assessment within military-relevant environments & integrate/update performance toolkit (e.g., new/modified task area plan)**
		Task 11	**Provide Roadmap recommendations**

<u>Task 1 (Months 1-2)</u>: Assemble the Working Group of SMEs, stakeholders, etc (8-10 max) – COMPLETED

Working group consisting of 8 SMEs from USARIEM, WRAIR and USAARL has been convened.

<u>Task 2 (Months 3-4)</u>: Assemble the Steering Committee – COMPLETED

Members for the Steering Committee were identified and invited to participate.

<u>Tasks 3 & 4 (Months 3-5)</u>: Conduct series of periodic meetings (via teleconference) with the Working Group to (reaching out to Steering Committee members as needed): 1) Summarize cognitive assessments currently in use in military relevant environments, 2) Summarize the reliability/validity of these instruments, 3) Summarize the environments in which these instruments are being implemented and in what way(s)/for what purpose they are being implemented, and 4) Identify gaps/needs in assessment of cognitive performance within military-relevant environments. Identify recommended cognitive performance tasks based on current knowledge/tests available. - COMPLETED

As part of the information gathering process for this effort, surveys were distributed online to investigators at USARIEM, WRAIR and USAARL, as well as to select Military Operational Medicine Research Program (MOMRP) and Military Research and Materiel Command (MRMC) stakeholders. This survey, which is described in the Cognitive Performance Readiness Assessment Initiative (CPRAI) Final Report document, gathered investigator and stakeholders' input regarding instruments they have used in their research and gaps in current operational cognitive assessment capabilities. Investigators also were asked to provide references for assessment tools and approached used for operational cognitive assessment. In addition, the USARIEM support team conducted extensive literature reviews of the peer reviewed literature and technical reports related to assessment of cognitive performance in military operational settings. Working group members

reviewed all information compiled as part of the information gathering process and identified four key gaps that, until addressed, prevented identification of an operational cognitive assessment toolkit. The Working Group then discussed, along with input from the Steering Committee, recommendations to close the identified gaps. The Working Group also provided input for progress reports and briefings to MOMRP Program Area Director (PAD) Director.

Task 5 (Month 6-7): Convene the Working Group in-person Workshop to prepare Report Draft – COMPELTED

An in-person meeting of the Working Group was held at USARIEM in January 2017. The Working Group discussed and finalized conclusions and recommendations for inclusion in an Interim Report to the MOMRP PAD Director.

Task 6 (Month 6-7): Vet Report and Cognitive performance recommendations through Steering Committee - COMPLETED

The Interim Report draft and provisional recommendations were distributed to stakeholders within MRMC for feedback.

Task 7 (Months 6-7): Provide Toolkit Report – COMPLETED

The Working Group identified four key gaps that, until addressed, prevented identification of an operational cognitive assessment toolkit. The Working Group These conclusions and recommendations were summarized in an Interim Report that was delivered to the MOMRP PAD Director in March 2017.

Task 8 (Months 8-12): Conduct series of periodic meetings (via teleconference) with MRMC Working Group to 1) Present several course-of-action case-studies to depict implementation of the cognitive toolkit within training, garrison, and forward, operational settings and 2) Make recommendations for identification of existing metrics or development of new assessment instruments to address gaps. - - COMPLETED

The Working Group communicated via teleconference and electronic correspondence to discuss and finalize recommendations for a coordinated program of research to implement recommendations to close identified gaps in operational cognitive assessment capabilities. The Working Group and identified MRMC and DoD stakeholders provided additional feedback through review of report drafts.

Task 9 (Months 8-16): Convene MRMC Working Group in-person meeting to prepare Report Draft for roadmap. - COMPLETED

The Working Group held a second in-person meeting in September 2017 to discuss and finalize recommendations for a Research Roadmap.

Task 10 (Months 13-16): Finalize recommendations for an implementation approach/roadmap to address gaps in cognitive performance assessment within military-relevant environments & integrate/update performance toolkit (e.g., new/modified task area plan) - - COMPLETED

The Working Group finalized recommendations for a Research Roadmap outlining a coordinated Program of Research to close identified gaps and to establish common data elements for inclusion in future research The Working Group and identified MRMC and DoD stakeholders provided additional feedback through review of report drafts.

<u>Task 11 (Months 13-16)</u>: Provide Roadmap recommendations -- COMPLETED

A Final Report of the Working Group's conclusions and recommendations for a Research Roadmap outlining a coordinated Program of Research to close identified gaps and to establish common data elements for inclusion in future research was delivered to the MRMC PAD Director on 30 November 2017.

> Proctor SP, Heaton KJ, Lieberman HR, Smith CD, Edens EN, Kelley A, Balkin TJ, Capaldi V, Doty TJ, Quartana PJ. Military Cognitive Performance and Readiness Assessment Initiative: Final Report. Submitted to the Program Area Director, Military Operational Medicine Research Program, Medical Research and Material Command. 30 November 2017. *Available upon request.*

A manuscript detailing the Working Group's conclusions and recommendations is being prepared for submission to a peer reviewed journal.

> Heaton KJ, Smith CD, Quartana PJ, Lieberman HR, Balkin TJ, Doty TJ, Edens EN, Kelley A, Capaldi V, Proctor SP. Assessment of Cognitive Performance in Military Operational Settings: Findings and Recommendations of the Military Cognitive Performance and Readiness Assessment Initiative: *In preparation.*

KEY RESEARCH ACCOMPLISHMENTS

Key research accomplishments include:

- Data collection and data management tasks for Studies 1-3 have been completed. Data analyses also have been completed. Reports related to Studies 1-3 were previously revised and refined to include additional analyses related to the ANAM Composite Score and Effort Measure metrics, and also to include additional information generated within the laboratory. Two abstracts were presented at professional meetings (see Appendices). Two manuscripts are being finalized for submission to peer reviewed journals by June 2018.

- Data collection for Study 4 has been completed. Data analyses addressing primary objectives of Study 4 are completed and the results have been prepared for reporting in manuscript and conference presentation formats. Two abstracts describing preliminary results of Study 4 were presented at professional meetings (see Appendices). Two manuscripts are being finalized for submission to peer-reviewed journals (1 by June 2018 and 1 by August 2018).

- Transfer of IRB review, approval and oversight responsibilities from the USARIEM IRB to the Headquarters, US Army Medical Research and Materiel Command Institutional Review Board (HQ USAMRMC IRB) was effective 19 April 2017. USARIEM Protocol Continuing Review was reviewed and approved by the MRMC IRB 31 July 2017. USAMRMC HRPO closure was received on 27 February 2018.

- The Supplemental Project was completed with the submission of a Final Report to the PAD Director on 30 November 2017. Conclusions and recommendations of the convened CPRAI Working Group and a research roadmap to close the gaps identified by this Working Group are detailed in the Final Report. One manuscript is being finalized for submission to a peer-reviewed journal by June 2018.

REPORTABLE OUTCOMES

Reportable outcomes during the funding period include:

1. Reports, manuscripts, abstracts (included as Appendices)

Proctor, S. Prospective Assessment of Neuropsychological Functioning Associated with Military Deployments. Invited talk at the conference 'Issues and Challenges with Rapid Neuropsychological Assessment', University of Toronto Concussion Program, University of Toronto, Toronto Canada, 10-11 Dec 2009 (APPENDIX A).

Kryskow E, Proctor S, Maule A, Heaton K. Automated Neuropsychological Assessment Metrics (ANAM4) Mood Scale is a reliable and valid measure of mood state in a military sample. Poster presented at the 12th Annual Force Health Protection Conference, Phoenix, AZ, 10-11 August 2010 (APPENDIX B).

Maule A, Proctor S, Kryskow E, Heaton K. Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) is robust to differences in several common administration practices. Poster presented at the 12th Annual Force Health Protection Conference, Phoenix, AZ, 10-11 August 2010 (APPENDIX C).

Proctor, S.P., Heaton, K.J., Dillon, C., Rudov, S., & Vincent, A.S. (2014). Descriptive Analyses of ANAM4 TBI Performance Among a National Sample of U.S. Army National Guard Soldiers. Poster presented at the Annual Meeting of the Association of Military Surgeons of the United States. Washington, DC, Dec. 2, 2014 (APPENDIX D).

C Dillon, SP Proctor, AS Vincent, K Heaton. Demographic differences on ANAM4 TBI performance among U.S. Army National Guard Soldiers. Poster Presented at 123rd Annual Convention of the American Psychological Association, Toronto, Canada, 6-9 August 2015 (APPENDIX E).

Five manuscripts are under preparation for submission to peer-reviewed journals. This task will be completed by August 2018.

Dillon C, Proctor SP, Finkelstein K, Heaton KJ. Influence of Group Versus Individual Administration on Performance Outcomes for the Automated Neuropsychological Assessment Metrics (Version 4). *In preparation.*

Heaton KJ, Dillon C, Finkelstein K, Maule A, Proctor SP. Repeatability of Automated Neuropsychological Assessment Metrics (Version 4) Task Modules: Test-retest reliability and practice effects. *In preparation.*

Heaton KJ, Dillon C., Finkelstein K., Proctor SP. Army National Guard Reference Data for Automated Neuropsychological Assessment Metrics (Version 4). *In preparation.*

Heaton KJ, Smith CD, Quartana PJ, Lieberman HR, Balkin TJ, Doty TJ, Edens EN, Kelley A, Capaldi V, Proctor SP. Assessment of Cognitive Performance in Military Operational Settings: Findings and Recommendations of the Military Cognitive Performance and Readiness Assessment Initiative: *In preparation.*

2. Degrees and research training opportunities

Individuals receiving direct salary support from this project across the award funding period have included two post-doctoral researchers, two masters-level interns, two Bachelor-level interns and one research support staff person.

3. Collaborative funding applications related to work supported by this award

- "Eye-Tracking Rapid Attention Computation (EYE-TRAC)" (USARIEM Protocol # H09-07; Site PI: Heaton). This project was funded as a FY08 CDMRP Advanced Technology Award to Dr. Jamshid Ghajar, Brain Trauma Foundation, New York, NY (W81XWH-08-2-0646). This study examines the efficacy of a novel visual tracking system for assessing the integrity of the attention system. The ANAM4-TBI-MIL battery was used in this study to provide cognitive performance outcomes for validation of the visual tracking paradigm. Healthy military volunteers were subjected to a 26-hour period of sleep loss during which cognitive and visual tracking performance were evaluated. Test-retest reliability of the ANAM4-TBI-MIL was examined across a 2 week interval and sensitivity of the ANAM4 TBI battery to central fatigue were determined. One abstract involving ANAM4-TBI-MIL data collected from this study has been presented at a professional meeting; a related paper is currently being finalized for submission to a peer-reviewed journal (by July 2018).

- "Identifying biomarkers that distinguish post-traumatic stress disorder and mild traumatic brain injury using advanced magnetic resonance spectroscopy," was funded via a Department of Defense Congressionally Directed Medical Research Programs Psychological Health/Traumatic Brain Injury (PH/TBI) Research Program award to Dr. Alex Lin, Brigham and Women's Hospital, Boston, MA. Dr. Heaton is a co-Investigator and site PI on this project. This study proposes a multi-parametric approach using major advances on spectroscopic methods and neuroimaging to identify biomarkers that can be used to distinguish between post-traumatic stress disorder, traumatic brain injury, and their co-occurrence. This will be achieved in part by correlating quantitative MR spectroscopy results with behavioral and neuropsychological metrics (including ANAM4TBI) using newly developed algorithmic approaches that are capable of revealing discriminating metabolic markers in MR spectroscopy measurements. Data collection for this project has been completed. Manuscripts are in preparation.

- "Multimodal Assessment of Cognitive Readiness and Recovery: Initial Modeling of Physiological and Neurological Inputs" (USARIEM Protocol 15-05HC; PI: Heaton), was funded by Defense Health Program (DHPe, RDT&E, Operational Performance Sustainment; "Multimodal Assessment of Cognitive Readiness and Recovery: Modeling and Analysis of Physiological and Neurological Inputs") to Dr. Heaton and MIT Lincoln Laboratory investigator, Dr. Thomas Quatieri. This study will examine the sensitivity of a multi-modal platform for detecting change in cognitive functioning under different cognitive load

conditions. The platform consists of vocal, facial, physiological (heart rate, skin conductance, respiration), and cognitive data inputs. The ANAM4 is included in the cognitive test battery. Data collection is nearing completion for this project; currently 90% complete with

4. Related projects and collaborations initiated

- "Multimodal Assessment of Cognitive Readiness and Recovery: Initial Modeling of Physiological and Neurological Inputs" (USARIEM Protocol 15-05HC; PI: Heaton), was funded by Defense Health Program (DHPe, RDT&E, Operational Performance Sustainment; "Multimodal Assessment of Cognitive Readiness and Recovery: Modeling and Analysis of Physiological and Neurological Inputs") to Dr. Heaton and MIT Lincoln Laboratory investigator, Dr. Thomas Quatieri. This study examines the sensitivity of a multi-modal platform for detecting change in cognitive functioning under different cognitive load conditions. The platform consists of vocal, facial, physiological (heart rate, skin conductance, respiration), and cognitive data inputs. The ANAM4 is included in the cognitive test battery. Three abstracts and a paper (accepted) involve ANAM4-TBI-MIL data collected from this study:
- "Analyses of ANAM4™TBI Predeployment Assessment Data: USARIEM-OTSG Research Collaborative" (USARIEM #11-07HC; PI: Proctor)involves the creation of a research database system (ANAM4TBI Military Performance Database (AMP-D)) which incorporates all mandated pre-deployment ANAM4TBI assessment data from DoD military personnel (maintained by the Office of the Surgeon General, ANAM Program Office). We have initiated the process of linking these neurocognitive data with individual military service, demographic, and injury and clinical disease histories. A paper comparing ANAM pre-deployment test results (extracted from the AMP-D) between Army Active Duty and National Guard groups and examining the role of deployment-related factors on neurocognitive health and performance was published in 2015 (Proctor et al., 2015) and reported in a previous Annual Report. Additional manuscripts are in preparation for submission for publication, and two abstracts have been submitted for presentation at national/international conferences."Validation of Select Neurobehavioral Assessments for Concussion/Mild Traumatic Brain Injury (MTBI)" (USARIEM #H09-08), was intramurally funded (MRMC MOMRP) to Drs. Proctor and Heaton (co-PIs). This study seeks to validate the ANAM4TBI Battery against a standard neuropsychological screening battery for mild traumatic brain injury. Additional data collection for this project has been initiated to expand comparison sample.
- "Multidimensional MR Imaging to Assess Subtle Brain Changes Associated with Persistent Postconcussive Symptoms (PPCS) Following Mild Traumatic Brain Injury" (USARIEM Protocol #11-15-HC; PI: Palumbo, co-I: Heaton), was intramurally funded (MRMC MOMRP) to Dr. Palumbo (co-I: Heaton). This study examines neuropathological changes associated with PPCS following mTBI using multidimensional magnetic resonance imaging (MRI) to determine the independent and synergistic effects of structure, function, connectivity and blood flow of the brain in subjects with mTBI. ANAM4-TBI-MIL is being used in this study to examine cognitive performance outcomes. Data collection for this study has been completed; data analyses and manuscript preparation are underway.
- "An Investigation of the Effects of Head Impacts Sustained during Collegiate Boxing Participation on Central and Peripheral Nervous System Function" (USAFA Protocol #

FAC2007010H, PI: MAJ Brandon Doan, USAFA), was funded in part by an AMEDD Advanced Medical Technology Initiative (AAMTI) award to Dr. Heaton and includes use of the ANAM4. Four abstracts have been presented at national/international conferences and professional meetings.

- "Quantification of head sweating during rest and exercise in the heat" (USARIEM Protocol H08-09) (PI: Ms. Catherine O'Brien, USARIEM; Research Associate: Dr. Heaton)
- "Microclimate cooling carrying approach march load" (USARIEM Protocol H09-19) (PI: Mr. Bruce Cadarette, USARIEM; Research Associate: Dr. Heaton)
- "Microclimate cooling for air soldier flight crew" (USARIEM Protocol 11-08-H) (PI: Mr. Bruce Cadarette, USARIEM; Research Associate: Dr. Heaton)

CONCLUSION

Results from Studies 1-3, reported in conference proceedings, and in manuscripts being finalized for peer review, provide evidence supporting the Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) as a reliable and valid measure of cognitive performance under diverse administration scenarios. The target reference dataset developed in Study 4 for Army National Guard provides a needed complement to existing normative data by focusing on a subset of the general military population that research has shown differs on key demographic elements (e.g., dual career status, average age, marital/family status, and education) relative to other military components (e.g., Active Duty), and as such, is expected to facilitate the interpretation of individual National Guard service members' performance on ANAM4 tests. Together, these results add to ongoing efforts to develop and validate the ANAM4 (and ANAM4 Military Traumatic Brain Injury Battery) as an accurate, reliable, and objective measure of military service members' cognitive performance.

The Supplemental study funded under this award provides critical input for the selection and utilization of cognitive assessment tools and approaches for evaluating cognitive performance and readiness in Warfighters under operational conditions. The Final Report presented to the MOMRP provides actionable information regarding key gaps in cognitive assessment capabilities and recommendations for solutions to address these gaps.

APPENDIX A

ABSTRACT for invited talk at the conference 'Issues and Challenges with Rapid Neuropsychological Assessment', University of Toronto Concussion Program, University of Toronto, Toronto Canada, 10-11 Dec 2009

Prospective Assessment of Neuropsychological Functioning Associated with Military Deployments

CORRESPONDING AUTHOR: Susan P. Proctor, D.Sc. U.S. Army Research Institute of Environmental Medicine, Kansas St. Bldg. 42, Natick, MA 01760, USA

In this presentation, two prospective epidemiological studies designed to examine neuropsychological performance changes related to deployment will be described. In each study, assessments were conducted prior to deployment and then within several months of return from deployment. Also, each study included a comparison group of soldiers not deployed over the study period. One study focused on a peacekeeping mission to Bosnia, while the other study involved a war-zone deployment mission to Iraq.

Although increasing medical attention is being focused on better understanding the physical and mental health consequences of deployment and the underlying risk and resilience factors, there are many knowledge gaps. Prospective evaluation of neuropsychological performance patterns following varying deployment scenarios, and thus occupational settings, can provide further insight for more targeted protection, prevention, and treatment strategies.

The views expressed in this presentation are those of the author and do not reflect the official policy of the Dept of the Army or the Department of Defense.

NOTE: Aspects of the research studies described in this presentation have been reported on previously at several conferences and in published articles (Vasterling et al., 2006; Proctor et al., 2009).

-Vasterling JJ, Proctor SP, Amoroso PJ, Kane R, White RF. Neuropsychological outcomes of Army personnel following deployment to the Iraq War. JAMA 2006; 296:519-529.

-Proctor SP, Heaton KJ, Dos Santos KD, Rosenman ES, Heeren T. Prospective assessment of neuropsychological functioning and mood in US Army National Guard personnel deployed as peacekeepers. Scandinavian Journal of Work, Environment and Health 2009; 35:349-360.

APPENDIX B
Abstract for Force Health Protection Conference, August 2010
Automated Neuropsychological Assessment Metrics (ANAM4) Mood Scale is a reliable and valid measure of mood state in a military sample.
Kryskow EM, Proctor SP, Maule A, Heaton KJ
USARIEM

Mood assessment is critical for monitoring soldier health, performance, and operational readiness since altered mood is frequently associated with illness and injury. This study examined the reliability and validity of the Mood Scale (AMS) module of the Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) in a sample of 86 military and civilian participants. AMS was compared to two validated mood measures.

The AMS demonstrated strong internal consistency for all 7 subscales (α =.71-.92); convergent validity was demonstrated by significant correlations between AMS subscales and comparable subscales on the Neurobehavioral Evaluation System Version 3 and Profile of Mood States (e.g., Depression subscales r=.81 and .83, p <.01, respectively). Significant effects for gender and military status also were noted on the vigor, restlessness, tension and anger subscales.
The AMS module of the ANAM4 is a reliable, valid measure of mood state in a military and civilian sample.

The views expressed in this presentation are those of the authors and do not reflect the official policy of the Department of the Army or the Department of Defense.

APPENDIX C
Abstract for Force Health Protection Conference, August 2010
The Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) is robust to differences in several common administration practices
Maule A, Proctor SP, Kryskow E, Heaton KJ
USARIEM

The Automated Neuropsychological Assessment Metrics Version 4 (ANAM4) is a computerized neurocognitive test battery used in clinical, research, and military settings. Given requirements of these diverse environments, a variety of administration procedures have been utilized. However, the effect of different administration practices on task performance is unclear. This study examined the impact of several administration practices on task performance in a sample of 83 military and civilian participants: individual versus group administration, use of practice tests, and completion of the full battery in one session versus two shorter sessions.

Participants taking ANAM4 individually in a single session with practice tests served as controls. No significant differences in task performance across test modules were noted, suggesting the ANAM4 is robust to a variety of administration practices. However, variability in task performance was significantly elevated in non-controls ($F=4.189–17.000$; $p=0.046–0.0001$). Thus further investigation of effects of different administration practices is warranted.

The views expressed in this presentation are those of the authors and do not reflect the official policy of the Department of the Army or the Department of Defense.

APPENDIX D

Descriptive analyses of ANAM4TBI performance among a national sample of U.S. Army National Guard Soldiers

SP Proctor, KJ Heaton, C Dillon, S Rudov, AS Vincent

ABSTRACT

Limited research has focused on the neurological health and performance of U.S. Army National Guard (ARNG) personnel. In light of the dual-job occupational histories and demographic differences (i.e., older, more years of education) of ARNG compared to their Active Duty (AD) counterparts, it is important to identify and characterize possible performance differences on measures of cognitive function.

Current efforts are underway to develop a national reference sample of ARNG Soldiers' performance on the Automated Neuropsychological Assessment Metrics (version 4) TBI Military (ANAM4 TBI-MIL) battery. This reference sample will be comprised of data from a representative sample of 2,400 ARNG Soldiers from 8-10 U.S. states.

Descriptive analyses of questionnaire and performance data (n=695) from three states completed to date (Montana, Maine, and Arizona) were performed. The ARNG sample was 15% female and 30.6 (SD=9.1) years old on average; the majority (64%) had completed education beyond the high school level. ANAM4 TBI-MIL task performance was compared to published normative data from AD personnel (10% female and mean age 27.4 (SD=7.4) years). Overall, no significant performance differences were observed between the ARNG and AD on tasks involving visual memory and complex attention, while ARNG personnel performed with significantly reduced efficiency ($p<.001$) on tasks of simple attention and psychomotor speed. When comparative analyses were restricted to those 21-25 years of age, no significant differences in performance were observed.

In conclusion, neurocognitive performance differences between AD and ARNG were observed on certain neurocognitive tasks, however, results suggest these are related to demographic factors (i.e., age).

DISCLAIMER: The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Army.

APPENDIX E

Demographic differences on ANAM4 TBI performance among U.S. Army National Guard Soldiers

C Dillon, SP Proctor, AS Vincent, KJ Heaton

ABSTRACT

Several studies have examined the neurocognitive performance of the U.S. military, particularly Active Duty personnel. However, minimal research has focused on the neurocognitive performance of U.S. Army National Guard (ARNG) Soldiers. Known demographic differences between Active Duty and Reserve/National Guard personnel on such factors as age and education level may influence neurocognitive proficiencies. Thus, the goal of this analytic study was to examine the role of demographic factors on neurocognitive test performance within a multi-state cohort of ARNG personnel.

The Automated Neuropsychological Assessment Metrics (version 4) TBI Military (ANAM4 TBI-MIL) battery was developed to assess general cognitive functioning, specifically following injuries to the head. A normative dataset for the ANAM4 TBI-MIL has been created for use with U.S. Active Duty personnel. Comparable reference data are not currently available for use with Army National Guard personnel specifically. Use of appropriate reference data is critical to the accurate interpretation of test performance. Data collection from a sample of ARNG personnel designed to be representative of the current U. S. ARNG population is ongoing and upon completion will include ANAM4 TBI-MIL performance data from approximately 2,400 ARNG Soldiers from 8-10 U.S. states.

Performance data were analyzed from three states completed to date (Arizona, Maine, and Montana; n=695). The ARNG sample was 15% female and 30.6 (SD=9.1) years old on average; the majority (64%) had completed some education beyond the high school level. Significant performance differences were observed between age groups (18-24 years old; 25-34 years old; 35 years and older), with younger participants performing better on tasks measuring sustained attention, reaction time, processing efficiency, visuospatial working memory and delayed memory ($p<.001$). There was a significant benefit of advanced education (high school or equivalent vs. greater than high school) on a one test measuring basic computational skills and processing speed ($p<.001$). This benefit is not associated or confounded by age. There were no observed differences in task performance between male and female participants.

In conclusion, neurocognitive performance differences on the ANAM4 TBI-MIL battery were associated with age. However, minimal to no performance differences related to education and gender were observed. Further evaluation of demographic factors will be conducted with the complete multi-state cohort of ARNG personnel.

DISCLAIMER: The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Army.

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Proctor, S.P., Heaton, K.J., Dillon, C., Rudov, S., & Vincent, A.S. (2014). Descriptive Analyses of ANAM4 TBI Performance Among a National Sample of U.S. Army National Guard Soldiers. Poster presented at the Annual Meeting of the Association of Military Surgeons of the United States. Washington, DC, Dec. 2, 2014.

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Dillon C, Proctor SP, Finkelstein K, Heaton KJ. Influence of Group Versus Individual Administration on Performance Outcomes for the Automated Neuropsychological Assessment Metrics (Version 4). *In Preparation.*

Heaton KJ, Smith CD, Quartana PJ, Lieberman HR, Balkin TJ, Doty TJ, Edens EN, Kelley A, Capaldi V, Proctor SP. Assessment of Cognitive Performance in Military Operational Settings: Findings and Recommendations of the Military Cognitive Performance and Readiness Assessment Initiative: *In preparation.*

Heaton KJ, Dillon C, Finkelstein K, Maule A, Proctor SP. Repeatability of Automated Neuropsychological Assessment Metrics (Version 4) Task Modules: Test-retest reliability and practice effects. *In Preparation.*

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4	Elisabeth Kryskow	Research Associate
5	Alexis Maule	Research Associate II
6	Kenneth Nieto	Database Systems Manager
7	Gina Carlton	Meetings Manager